CODE-SWITCHING AS A COMMUNICATIVE STRATEGY TO ENHANCE THE QUALITY IN MATHEMATICS TEACHING AND LEARNING IN GRADE 11

by

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DECLARATION

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I declare that **CODE-SWITCHING AS A COMMUNICATIVE STRATEGY TO ENHANCE THE QUALITY IN MATHEMATICS TEACHING AND LEARNING IN GRADE 11** is my own work and that all sources that I have used or quoted have been indicated and acknowledged by means of a complete reference list.

I further declare that I have submitted the thesis to originality checking software and that it falls within the accepted requirements for originality.

I further declare that I have not previously submitted this work, or part thereof, for examination at Unisa for another qualification or at any other higher education institution.

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SUPERVISOR STATEMENT

This dissertation was submitted with my approval

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This dissertation was submitted with my approval

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DEDICATION

Tintswalo, n'wana wa Masungwini Sam (Thololo) wa Msisinyani

wa Masungwini wa Xiphongo

wa Nkavela wa Yingwani

wa Madzumba a fikile a tshova vurha hi mona a orha

wa Ntsenani wa Riphome wa Mhelembe

wa Shipangatsive wa Magadzila

I mudyi wa Xihenge na Ntsumbula!

Ntombi ya Munyembani!!!

I dedicate this project to my mother, Leti Mihlaba Shilenge, for her prayers, love, care and support.

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ABSTRACT

Code-switching is a communicative strategy that is a useful resource in the teaching and learning process where the learners are taught in a language that is not their home language. The practice has been at the centre of debate for over three decades globally. Researchers have explored this practice in both primary schools and high schools. However, literature on the guidelines of the practice of code-switching in mathematics classrooms seems to be lacking. This study explored how code-switching is a communicative strategy that enhances the quality of mathematics teaching and learning. An overview of social justice theory, behaviourist learning theory, Piaget's constructivist learning theory and social constructivist learning theory was used to present the practice of code-switching as a communicative strategy. The qualitative approach adopted a case study design, sampled thirteen mathematics teachers and thirty-five Grade 11 learners from ten high schools in the rural area of the Mopani Circuit in Limpopo Province, South Africa. Data, collected through semi-structure interviews and focus group interviews, were thematically analysed. The study findings revealed that code-switching is a communicative strategy that enhances mathematics teaching and learning quality. There is relevance, effectiveness and benefits in the use of code-switching in the teaching and learning process. Importantly, the study found no guidelines on how to employ the practice. Mathematics teachers highlighted the lack of home language mathematics terminology and suggested the development of a glossary to assist learners in class and in mathematics assessment. Emerging from the study was the development of a model for code-switching as a communicative strategy. The study proposed that the Department of Basic Education take cognisance of the model and use it to include guidelines and a glossary in the mathematics Curriculum Assessment Policy Statement and the Grade 11 mathematics Annual Assessment Plan to guide both teachers and learners.

KEY TERMS: code-switching, communicative strategy, Grade 11 mathematics, teaching and learning

NKOMISI LOWU NGA NA MONGO WA NDZAVISISO

Code-switching (ku hlanganisa tindzimi eka xivulwa/mbulavulo) i qhinga ra vutihlanganisi leri ri nga xihlovo xa xipfuneto swinene eka fambiselo ra ku dyondzisa naku dyondza laha vadyondzi va dyondzisiwaka hi ri rimi ro ka ri nga ri ririmi ra le kaya ra vona. Tirhelo leri i khale ku ka ri ku ri na mabulu hi rona eka malembe ya makume nharhu lama nga hundza eka misava hinkwayo. Tirhelo leri ri langute matirhelo lama eka ha swimbirhi swikolo swa prayimari na swikolo swa le henhla. Kambe, matsalwa eka vuleteri (tigayidilayini) bya matirhiselo ya code-switching eka tiklasi ta metamatikisi ya komba leswo leswi swa ha salele endzhaku. Ndzavisiso lowu wu valanga leswo xana code-switching tanihi qhinga ra vutihlanganisi yi yisa njhani emahlweni khwaliti ya madyondziselo na madyondzelo ya metamatikisi. Vuhlayi bya *social justice theory, behaviourist learning theory,* na *constructivist learning theory* ya Piaget, na *social constructivist theory* byi tirhisiwe ku tisa matirhelo ya code-switching tanihi qhinga ra vutihlanganisi. Fambiselo ra *qualitative* ri tirhisiwe eka dizayini ya *case study*, ku endliwe sampuli ya vadyondzisi va metamatikisi va khume-nharhu (13) na vadyondzi va Grade 11 va makume-nharhu ntlhanu (35) ku suka eka swikolo swa khume swikolo swa tindhawu ta le makaya ta Mopani District eka Xifundzhankulu (provhinsi) ya Limpopo eAfrika Dzonga. Ku hlengeletiwe vutivi, lebyi byi nga endliwa hi ti semi-structured interview na ti interview ta ti-focus group, swi va swi xopaxopiwa hi tinhlokomhaka. Mbuyelo wa ndzavisiso wu kume leswo code-switching tanihi qhinga ra vutihlanganisi yi yisa emahlweni khwaliti ya madyondziselo na madyondzelo ya metamatikisi. Ku na ku fambelana no faneleka, tirhelo ra vuyelo swinene na mpfuneto hi ku tirhisa code-switching eka fambiselo ra ku dyondzisa na ku dyondza. Swa nkoka, ndzavisiso wu kume leswo a ku na swiletelo (tigayidilayini) hi ku tirhisa tirhelo leri. Mathicara ya metamatikisi ya kombise swinene ku pfumaleka ka matheme ya metemetikisi hi ririmi ra le kaya ra vadyondzi, na ku pimanyeta leswo ku endliwa glosari ya matheme ku pfuneta vadyondzi eklasini na le ka tiasesimente ta metamatikisi. Leswi humaka eka ndzavisiso, ku ve ku endliwa ka modlele wa code-switching tanihi qhinga ra vutihlanganisi. Ndzavisiso wu gangisa leswo va Ndzawulo ya Dyondzo ya Masungulo va amukela modlele no wu tirhisa ku katsa tidayidilayini na glosari ya matheme ya metematikisi eka Curriculum Assessment Policy Statement na le kungu

ra nkambelo ra metamatikisi ra Grade 11 Annual Assessment Plan, ku letela (ku gayida) havambirhi mathicarra na vadyondzi.

MATHEME YA NKOKA: code-switching, qhinga ra vutihlanganisi, metamatikisi wa Grade 11, ku dyondzisa na ku dyondza

MANWELEDZO

U bva kha luṅwe luambo wa shumisa luṅwe ndi tshiṱirathedzhi tsha vhudavhidzani tshine tsha vha tshiko tsha ndeme kha kuitele kwa u funza na u guda hune vhagudiswa vha funzwa nga luambo lune lwa sa vhe luambo lwa ḓamuni. Kuitele kwo vha vhukati ha khanedzano lwa miṅwaha ya furaru ḽifhasini. Vhaṱoḓisisi vho wanulusa kuitele uku zwikoloni zwa phuraimari na zwa sekondari. Naho zwo ralo, hu vhonala hu na ṱhahelelo ya maṅwalwa nga ha nyendedzi dza kuitele kwa u bva kha luṅwe luambo wa shumisa luṅwe luambo kha metse kiḽasini. Ngudo heyi yo wanulusa nga ha uri u bva kha luṅwe luambo wa shumisa luṅwe ndi tshiṱirathedzhi tsha vhudavhidzani tshine tsha khwinisa ndeme ya u guda na u funza metse. Nyangaredzo ya thiori ya vhulamukanyi ha matshilisano, thiori ya u guda nga ha kutshilele, thiori ya u fhaṱa nḓivho ya Piaget na thiori ya u fhaṱa nḓivho ya matshilisano dzo shumiswa u kumedza kuitele kwa u bva kha luṅwe luambo wa shumisa luṅwe sa tshiṱirathedzhi tsha vhudavhidzani. Kuitele kwa khwaḽithethivi kwo shumiswa kha pulane ya ngudo iyi, tsumbonanguludzwa dza vhadededzi vha fumiraru vha metse na vhagudiswa vha Gireidi ya 11 vha furaruṱhanu u bva kha zwikolo zwa nṱha zwa fumi kha vhupo ha mahayani ha Ḽiisela ḽa Mopani kha Vundu ḽa Limpopo, Afrika Tshipembe. Data, yo kuvhanganyiwa nga kha inthaviwu dza mbudziso dzi songo tou dzudzanywaho na inthaviwu dzo tou lavhelesaho kha tshigwada, dzo saukanywa hu tshi khou shumiswa data ya khwaḽithethivi. Mawanwa a ngudo o wanulusa uri u bva kha luṅwe luambo wa shumisa luṅwe ndi tshiṱirathedzhi tsha vhudavhidzani tshine tsha khwinisa ndeme ya u funza na u guda. Hu na ndeme, u tea na mbuelo kha u shumisa u bva kha luṅwe luambo wa shumisa luṅwe kha kuitele kwa u funza na u guda. Tsha ndeme, ṱhoḓisiso yo wanulusa uri a hu na nyendedzi nga ha uri vha nga shumisa hani maitele. Vhadededzi vha metse vho ombedzela ṱhahelelo ya theminoḽodzhi ya metse nga luambo lwa ḓamuni na u dzinginya mveledziso ya giḽosari u thusa vhagudiswa kiḽasini na kha ndingo metse. U bva kha ṱhoḓisiso ho vha u bveledziswa ha tshiedziswa tsha u bva kha luṅwe luambo wa shumisa luṅwe sa tshiṱirathedzhi tsha vhudavhidzani. Ṱhoḓisiso yo dzinginya uri Muhasho wa Pfunzo ya Mutheo u dzhiela nṱha tshiedziswa na u tshi shumisa u katela nyendedzi na giḽosari kha Tshitatamennde tsha

Kharikhuḽamu na Mbekanyamaitele ya u Linga Metse na Pulane ya Ṅwaha nga ṅwaha ya u linga mbalo kha Gireidi ya 11 u endedza vhoṱhe vhadededzi na vhagudiswa.

MATHEMO A NDEME: U bva kha luṅwe luambo wa shumisa luṅwe, tshiṱirathedzhi tsha vhudavhidzani, Metse wa Gireidi ya 11, U guda na u funza

ABBREVIATIONS AND ACRONYMS

AIMSSEC	African Institute for Mathematical Sciences for Schools Enrichment Centre
AMESA	Association Foundation for Mathematics Education of South Africa
ANA	Annual National Assessment
ATP	Annual Teaching Plan
Bed	Bachelor of Education
CAPS	Curriculum Assessment Policy Statement
CAQDAS	Computer-Assisted Qualitative Data Analysis Software
CDE	Centre for Development and Enterprise
CES	Chief Education Specialist
CS	Code switching/ Code-switching/ Codeswitching
DBE	Department of Basic Education
DCES	Deputy Chief Education Specialist
DoE	Department of Education
EFAL	English First Additional Language
EFL	English First Language
FAL	First Additional Language
FET	Further Education and Training
GET	General Education and Training
HL	Home Language
IEA	International Assessment for the Evaluation of Education
IIEP	International Institute for Educational Planning
IQAA	Independent Quality Assurance Agency
IT	Information Technology
LiEP	Language in Education Policy
LOLT	Language of learning and teaching
LTSM	Learner Teacher Support Material

MCRE	Ministerial Committee on Rural Education
MLF	Matrix Language Frame Model
MKO	More Knowledgeable Other
MKOs	More Knowledgeable Others
ML	Matrix Language
MLA	Monitoring Learning Achievement
MRTEQ	Minimum Requirement for Teacher Educations Qualifications
MST	Mathematics, Science and Technology
NAPLAN	National Assessment Program-Literacy and Numeracy
NCS	National Curriculum Statement
NIAF	National Integrated Assessment Framework
NQF	National Qualifications Framework
OECD	Organisation for Economic and Co-operation and Development
PISA	Programme for International Study Association
RNCS	Revised National Curriculum Statement
RSA	Republic of South Africa
SAARMSTE	South African Association for Research in Mathematics, Science and Technology Education
SACMEQ	Southern and Eastern Africa Consortium for Monitoring Educational Quality
SAMF	South African Mathematics Foundation
SAQA	South African Qualifications Authority
SASA	South African Schools Act
SES	Senior Education Specialist
SGB	School Governing Body
STEM	Science, Technology, Engineering and Math
TIMSS	Trends in International Mathematics and Science Study
TLMs	Teaching Learning Materials
UBE	Universal Basic Education

UNESCO	United Nations Educational, Scientific and Cultural Organization
UNISA	University of South Africa
USA	United States of America
WMCS	Wits Maths Connect Secondary Project
ZPD	Zone of Proximal Development

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CHAPTER 1

ORIENTATION TO THE STUDY

1.1 INTRODUCTION

Code-switching in the teaching and learning of second or foreign languages such as English, has generated significant interest over the years. Scholars and researchers have, as a result, seen divergent views coming to the fore. The divergent views have given birth to serious debates and discussions on whether the target language should be the only language used or whether the target language ought to be used alongside the first or the predominant local language in second or foreign language classrooms (Sakaria & Priyana, 2018).

Those who believe that the target language should exclusively be used in second or foreign language classrooms, hold the view that the exclusive use of the target language enables the student to build their language system through communication practices. At the same time, code-switching urges them to lose interest in listening to the target language. The target language, therefore, according to the proponents of the exclusive use of the target language, should be the main language to be used in second or foreign classrooms, both as a language of instruction and communication (Cummins, 2014). These proponents view the exclusion of first language usage in second or foreign language classrooms as a vehicle promoting the target language as the students' primary source of exposure as, according to them, the teaching of English through English introduces authenticity in the process of teaching and learning and finally, facilitates students' familiarity with the target language.

Advocates of a cross-lingual pedagogical strategy see students' first language enhancing target language development and should, consequently, be incorporated in the second or foreign language teaching and learning (Jegede, 2011). This makes it easier for teachers to explain grammar to learners and maintain discipline while helping students understand complex concepts and consolidate their target language competencies (Sakaria & Priyana, 2018).

The primary objective of this study was to explore the use of code-switching as a communicative strategy to enhance the quality of mathematics teaching and learning in Grade 11. This chapter deals with the background to the study, the rationale of the study, problem statement, the aim of the study, research questions and research objectives. A theoretical framework as well as a conceptual framework for the research and the research methods, focusing on the research design and approach, study population and sample, data collection and analysis methods, validity, reliability, and ethical issues, are outlined, defined and briefly described as used in the study. Clarification of concepts is also outlined, followed by the literature review, and finally, the chapter outline is presented.

1.2 BACKGROUND TO THE STUDY

Learners' performance in mathematics in South Africa, especially black learners, has been found wanting. Studies in this regard have been conducted, and they adequately demonstrate this. Mapaire (2016) states that the mathematics pass rates at Grade 12 level in South Africa are low and a source of frustration and embarrassment for the learners concerned. Unfortunately, according to Mapaire (2016), the studies reflect a low-level return for substantial investment that the government, communities and parents have made in their children's education. Research done demonstrates the poor teaching practices to which students in previously disadvantaged schools are exposed. Research has revealed that teachers' inadequate content knowledge of mathematics was the root cause of poor teaching practices of mathematics. Yet, mathematics education in South Africa is one of the cornerstones that produce skilled scientists, mathematicians and other eminent professionals and in addition, it plays a key role in developing the country's economy (Feza & Diko, 2013). Good provision of resources is linked to better educational outcomes which are impacted by either the availability or scarcity of essential school resources (Visser, Juan & Feza, 2015). Jojo (2019) states that mathematics teaching in South Africa has been pronounced the worst in the world. In most public schools, there is unacknowledged poor teaching of mathematics which denies many learners access to higher education and modern knowledge-intensive work skills.

Learners' home language and school infrastructure, according to Visser *et al*. (2015) and Mapaire (2016), are the factors that contribute to poor learner performance in mathematics. Learners from poor communities with uneducated parents usually perform poorly in mathematics (Visser *et al.,* 2015). Their schools lack proper infrastructure and are very poorly resourced, as observed by the researcher who has found that this mainly affects schools situated in disadvantaged and rural areas. Mapaire (2016) has further established that learners in South African high schools perform poorly in mathematics because of their ill-discipline and their teachers' lack of subject content knowledge and pedagogical content knowledge (Shulman, 1986). Diko and Feza (2014) note that the South African government has made strides towards equipping learners in South Africa by endeavouring to provide quality education for all. However, a lack of foundational knowledge in mathematics results in learners' poor performance in mathematics. Teaching methods in mathematics are, in certain instances, below par. This and other factors have resulted in learners' poor performance in mathematics (Alex & Juan, 2016).

South Africa consists of both rural and urban areas. However, the two areas are not equally resourced and developed due to different factors, resulting in learners from rural areas performing far worse in mathematics than those in the urban areas. Reddy *et al.* (2016) state that schools in more affluent provinces (urban areas) are better resourced than those in poorer areas (rural areas). Educated parents who generally use the language of instruction in their homes, enable their children to achieve better in mathematics because they are proficient in the medium of instruction (English) (Reddy *et al*., 2016). Howie (2003) notes that schools in urban areas are more developed than in underdeveloped rural areas. The difference in the development of the schools in the two areas directly affects the learners' performance in mathematics, which is a serious concern for education and should be noted by the authorities and policymakers (Howie, 2003). This, according to Gardiner (2017), is caused by the fact that villages in rural communities are not well developed and resourced which tends to reflect on the schools with the physical conditions, infrastructure and resourcing being inadequate. Learner performance in mathematics in rural schools compared to those in urban areas, is bound to be poor and weak. Du Plessis and Mestry (2019) note that in the twenty-five years after the advent of democracy in South Africa, there has been no noteworthy improvement in this regard.

Performance and participation in Mathematics, Life Science and Physical Science in disadvantaged schools with particular reference to girl learners, has been worrisome. The launching in 2001 of the Dinaledi Schools Project was meant to improve performance and increase participation in Mathematics, Life Science and Physical

Science in disadvantaged schools (DBE, 2018). The Project was supported by (Kolver, 2009) who notes that the strategy has contributed to improving mathematics and science results. In the Witwatersrand Mathematics Connect (WMCS) at the University of Witwatersrand, Adler (2017) discovered that students taught by teachers who had taken the course generally outperformed students in the same schools who were taught by teachers who had not completed the course.

Various studies have shown the need to improve learners' performance in mathematics. The South African Mathematics Foundation (SAMF), to this end, has, as a result, initiated a project to determine the status of formal in-service programmes for in-service mathematics teachers in South African high schools. This came about because the state of training of high school mathematics teachers is generally poor throughout the country and has necessitated assessing what is being done in the informal upgrading of teachers to devise strategies to improve the situation (Olivier, 2020).

Given the fact that the teaching and learning of mathematics in South Africa has resulted in poor mathematics results, it has become clear that the concerns generated have to be given urgent and maximum attention. It, therefore, came as no surprise that on intending to become a qualified teacher, specific requirements are needed to be met. The National Qualifications Framework (NQF) Act, 67 of 2008 and the Minimum Requirements of Teacher Educations Policy (MRTEQ) were enacted as a result, requiring prospective teachers in South Africa to complete a four-year Bachelor of Education (BEd) degree or an appropriate first degree, followed by a one-year Advanced Diploma in Education. Teachers' mathematical knowledge and pedagogical practices are prioritised by universities that offer mathematics (Feza 2014). Adler (2017), taking note of the schools participating in the WMCS Project, found that enhancing teachers' mathematical knowledge leads to a noticeable improvement in teaching and learning. The need to narrow the gap between opportunities for previously disadvantaged rural South African teachers and the others regarding transition rates into mathematics and science careers for their learners, has been noted by the African Institute for Mathematical Sciences Schools Enrichment Centre (AIMSSEC). In addition, South African universities have introduced short courses which are aimed at improving the qualifications of mathematics teachers.

The Department of Basic Education (DBE) has introduced policies to support and guide mathematics teachers in the teaching and learning of mathematics. To assist the teachers in the implementation of the National Curriculum Statement (NCS), the Department introduced the Curriculum Assessment Policy Statements (CAPS). Subjects Statements, Learning Programme Guidelines and Subject Assessment Guidelines were integrated into one curriculum policy statement. Grade 11 mathematics, one of the approved school subjects in South Africa, forms the basis for curriculum delivery in mathematics. For the Further Education and Training (FET) Phase Grades 10-12 teachers and learners use the Mathematics National Curriculum Statement, the Curriculum Assessment Policy Statement (DBE, 2011). As one of the interventions, the education sector has produced and supplies colour-printed Department of Basic Education (DBE) mathematics workbooks for use in schools. In 2017, ninety-six percent of all Grades 1 to 9 learners accessed language and mathematics workbooks, augmenting the supply of workbooks already produced by the provinces. The Department, in this regard, has done well (Department of Basic Education Annual Performance Plan 2019/2020). Reddy *et al*. (2015) note that the aim of some of the policies in the South African Department of Basic Education has been to improve mathematics and science education, which includes the National Strategy for Mathematics, Science and Technology Education, the Dinaledi Schools Initiative and the Youth into Science Strategy.

Most learners in South African schools use English as the medium of teaching and learning mathematics. Those that are not familiar with English are generally disadvantaged and are unlikely to perform well. For the first three years of schooling, the current policy prefers the use of their mother tongue. However, some schools and parents ignore the policy to use English as the Language of Learning and Teaching (LOLT) from Grade 1. The three-year policy, where implemented, compromises the quality of teaching and learning because of weak pedagogy and lack of learning materials in the home language. English is introduced at Grade 4 level and becomes the only language of teaching and learning. English and Afrikaans speaking learners are simply at an advantage because they merely continue using their home language, either English or Afrikaans, from Grades 1 to 12, while learners, whose home language is not English or Afrikaans, are seriously disadvantaged, resulting in gross inequity (Owen-Smith, 2010). Botes and Mji (2010) share this view. Howie (2003) regards the issue of language as a sensitive and controversial topic in South Africa, just as it is in many other post-colonial countries. The researcher holds the same view.

1.3 RATIONALE FOR THE STUDY

The reason for teaching and learning mathematics is its significance to our lives and daily activities. It is, in other words, key. Alex and Juan (2016) regard mathematics as a critical requirement for entry into higher education and most modern knowledge-requiring intensive jobs. Mapaire (2016) states that mathematics is widely acknowledged as one of the cornerstones of future development and prosperity. Gambari, Ezenwa and Anyanwu (2014) regard mathematics as the science of quantity and space, which occupies a key position in Nigeria's education system, reflecting, as it does, the vital role it plays in contemporary society. This, according to the researcher, applies to the South African context as well.

The Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) and the Trends in International Mathematics Science Study (TIMSS) both publish studies on learners' mathematics performance in South Africa. TIMSS (2015) reports that since 1995, Grade 9 South African learners and their teachers have participated in TIMSS in five cycles of the study whose primary focus is mathematics and science (Zuze *et al.,* 2017). Between 2011 and 2015, learner performance in both subjects improved even though the improvement is still a matter of concern since this improved performance has occurred at the lower end of the achievement distribution. According to the above report, South Africa's performance improved because it started from a shallow base. Zuze *et a*l. highlight that in TIMSS 2015 there was still a gap concerning home resources between no-fee paying schools and fee-paying schools. It is noteworthy that although there seems to be a slight improvement in the performance of mathematics and science in South Africa, the country is still performing below the expected international standard.

The Department of Basic Education (2017) in the National Reports for the South African SACMEQ IV study, conducted in August 2013 with Grade 6 learners, indicated an improvement in mathematics performance even though this is still a concern for the country's rating. Limpopo, Eastern Cape and Mpumalanga were found to have the lowest percentage of learners functioning at the highest levels of the mathematics scale. This is a serious concern, particularly taking into account the importance of mathematics and science globally. The positive aspect of the SACMEQ IV report is that there has been considerable improvement in learners’ performance in mathematics and science in South Africa. Accordingly, the above reports are helpful in giving some indication of learner performance and serve as reliable benchmarks for South Africa’s mathematics performance compared to participating countries globally. The researcher views the implementation of international measures to gauge the trends in mathematics performance as beneficial because it enables policymakers to design interventions and strategies to address the situation. However, what is crucial is ensuring that mathematics teachers are well empowered with knowledge and skills that will contribute to quality teaching and learning in mathematics.

Studies have revealed that poor mathematics performance recorded in South African rural schools’ results from factors such as teachers’ content knowledge and English as the language of teaching and learning. Stols, Ferreira, Pelser and Olivier (2015) state that teachers in South Africa and many countries lack mathematical content knowledge and the skills required to apply what they know in the classroom. In South Africa, Grade 6 learners' performance in mathematics declined in the Eastern Cape and Limpopo provinces with results being unsatisfactory, and underperformance being prevalent in rural areas where the socio-economic status is low (Moloi & Chetty, 2011). According to Long and Wendt (2019), societal, political and economic pressures subject teachers and learners to either positive or stressful climates. However, the importance of subject content knowledge and pedagogical content knowledge in mathematics should not be underestimated (Shulman, 1986).

The Department of Basic Education (DBE, 2010) stipulates that the language used in schools is regulated by the Constitution of the Republic of South Africa (RSA 1996b) and the South African Schools Act 84 of 1996 (SASA). The Language-in-education Policy (LiEP), which plays a significant role in education, was adopted in 1997 and clarified in the Revised National Curriculum Statement (RNCS 2002). The Language-in-Education Policy encourages the use of the mother tongue in the learners’ early years of learning. The language of teaching and learning is determined by the School Governing Bodies (SGBs) which are the principals, teachers, parents and learners. Learners who transition from home language to English as a medium of instruction from Grade 4 struggle to understand the subject content, which continues through their schooling. In addition, most Learner Teacher Support Materials (LTSM), except those for home languages, are in English. The researcher's view is that strategies for incorporating home languages as a medium of instruction with English, should be in place. However, second language learners who use their mother tongue as a medium of instruction from the lowest grades to Grade 12 find that learning is better facilitated.

According to Howie (2003), research has shown that South African learners tend to achieve higher scores in mathematics when their language proficiency in English is higher. They are more likely to attain low scores in mathematics when their scores in their English test are low. Botes and Mji (2010) note that teaching and learning mathematics in multilingual classrooms where the medium of instruction is not the learner's home language, becomes a complicated matter. The researcher agrees with Howie (2003) and Botes and Mji (2010) that English as a medium of instruction in the classroom, impedes effective teaching and learning, particularly if English is not the learner's home language. Learners first have to grapple with English which they do not understand, and secondly, they fail to do well in mathematics because they do not have sufficient English language proficiency, which is the language used to teach them.

Cummins's (2008) distinction between basic interpersonal communication skills (BICS) and cognitive academic language proficiency (CALP) enables teachers to see the timelines and understand the challenges that second language learners encounter in endeavouring to be on par with their peers in English language proficiency. Cummins (2008), significantly, has defined academic language proficiency as the extent to which learners have access to and command of the oral and written academic registers of schooling (Cummins, 2000:67). Dowse (2013) indicates that the work of Cummins gives insight into the language challenges encountered by South African learners with the variety of their home languages and English as the medium of instruction. She articulates that basic interpersonal communication skills developed in the home language first and then in the additional language are necessary for the emergence of CALP. The circumstances prevailing in their homes and their previous educational experiences may have impeded the learners' underlying competence (Dowse, 2013). Cummin's theory of language acquisition has enabled the researcher to realise that Grade 11 mathematics teachers and learners find themselves having to use code-switching to obviate the difficulties faced by the learners with regard to LoLT proficiency.

The researcher is a teacher who has taught in rural high schools for thirty-two years. She has observed teachers using the practice of code-switching in a manner that seemed to disadvantage the learners. Driven by the determination to understand the situation and bolster code-switching to enhance the quality of teaching and learning in mathematics, the researcher embarked on this study. Mathematics was specifically chosen because of its importance in people’s daily lives and is notably one of the vehicles learners use to acquire qualifications requiring this subject.

1.4 STATEMENT OF THE PROBLEM

Quality in mathematics teaching and learning encompasses learner achievement, teaching approaches and deeply held beliefs about the nature of mathematics and its teaching and learning (Ernest, 2006). It has been established that most schools in rural communities or areas lack good infrastructure and resources, which has negatively affected learner performance in mathematics. Learners are challenged in mastering English used as the medium of instruction in their classrooms. It is common knowledge that learners’ proficiency in English is often below par (Ngware, Ciera, Musyoka & Oketch, 2015; Stols *et al*., 2015). In addition, learners in rural schools are also disadvantaged in that their teachers often lack proper professional competence and affective qualities. Most teachers in the South African education system were trained under a dispensation that did not adequately equip them to teach the mathematics curriculum (Ngware *et al*., 2015), which accounts for teachers’ lack of professional competence and affective qualities. The learners in such instances are disadvantaged academically in that teachers are ill-equipped to teach mathematics and develop the required mathematical understanding in their learners and in addition, the medium of instruction is foreign to learners. A further issue is that some of the teachers are not proficient in English, the very language they are to use as a medium of instruction. Coombes (2015) regards the teaching of mathematics as genuinely effective when it impacts the learners’ learning. Effective mathematics teachers skilfully integrate a whole range of instructional approaches and resources that meet learners' diverse learning needs. Husarida and Dollete (2019) see teachers as key in the facilitation of teaching and learning because they are the ones who guide the learners in the teaching and learning process. The more professional the teachers are, the more strategies and techniques they will use to support and enhance the teaching and learning process (Husarida & Dollete, 2019).

Bernstein (2013) states that South African learners significantly underperform in mathematics. Mathematics teaching is of poor quality, with teachers ill-equipped as they often cannot answer questions about the curriculum they teach, which does not seem to be acknowledged in a great majority of schools (Bernstein, 2013). However, Bernstein (2013) does not see the issue of poor teacher competence and poor learner results as something that is easily remedied.

The teaching and learning of mathematics in South African schools, to date, has not produced the results envisaged by South African education policies and curricula. Many studies conducted in South Africa by the Department of Basic Education, institutions of higher learning, and other research agencies show that there is a need to investigate low learner achievement in mathematics thoroughly. Both international and national assessment results, such as TIMSS, SACMEQ and the ANAs, have indicated that South African learners perform poorly in mathematics. These studies have demonstrated that the current teaching and learning practices in mathematics are ineffective at producing the required learner outcomes (DBE, 2018).

Maluleke (2019) conducted a study entitled *Code-switching as an empowerment strategy in teaching mathematics to learners with limited proficiency in English in South African schools*. The study observed that mathematics teachers employ code-switching in a number of ways because of the lack of guiding principles that direct this practice. The knowledge gap revealed by code-switching research indicates that mathematics teachers do not have the necessary guidelines on how to effectively implement code-switching in the teaching and learning of mathematics. Kretzer and Kaschula (2019) suggest that the Department of Basic Education should put plans in place to indicate how code-switching should be implemented during the teaching and learning process to benefit those mathematics learners who regard mathematics to be complicated. In addition, Schäfer (2010) indicated a need for a mathematics register to be developed in all the South African indigenous languages to ensure that the learners have the choice of learning through their home language, as envisioned in the Language-in-Education Policy. According to the researcher, these problems, have necessitated conducting this study, which explored code-switching as a communicative strategy that enhances the quality of teaching and learning of mathematics for Grade 11 learners in Limpopo Province, South Africa. Unless and until due regard is had to the use of English First Additional Language the learners' performance in mathematics will not significantly improve as some of the teachers and learners are not proficient in the medium of instruction.

1.5 THE RESEARCH QUESTIONS

The main research question was formulated as follows: *How do mathematics teachers use code-switching as a communicative strategy to enhance quality in mathematics teaching and learning in Grade 11, Limpopo Province, South Africa?*

The main research question necessitated the formulation of the following sub-questions:

1. What does the scholarly literature say about code-switching as a communicative strategy to enhance mathematics teaching and learning quality in Grade 11?
2. How is code-switching relevant in the teaching and learning of mathematics of Grade 11 learners?
3. How effective is code-switching as a communicative strategy in enhancing quality in mathematics teaching and learning?
4. What are the benefits and challenges of code-switching in the teaching and learning of mathematics for Grade 11 learners?
5. What framework could be employed to enhance the quality in mathematics teaching and learning?

1.5.1 Aim and Objectives of the Study

This study aimed at exploring code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in Grade 11, in Limpopo Province, South Africa.

To achieve the aim, the objectives of the study were:

1. to establish scholarly literature regarding code-switching as a communicative

strategy that enhances the quality of mathematics teaching and learning.

2. to evaluate the relevance of code-switching as a communicative strategy that enhances the quality of mathematics teaching and learning.
3. to determine the effectiveness of code-switching as a communicative strategy that enhances the quality of mathematics teaching and learning.
4. to ascertain the benefits and challenges of code-switching in the teaching and learning of mathematics of Grade 11 learners.
5. to propose a model for code-switching that can be employed as a communicative strategy enhancing quality in mathematics teaching and learning.

1.6 THE THEORETICAL FRAMEWORK

The discussion below presents the explanation of the theoretical work for the study.

1.6.1 Explanation of the Theoretical Framework

The theoretical framework is the arrangement of and relation between parts or elements of something complex (a structure) employed to guide research by relying on a formal theory (Eisenhart, 1991). According to Kivunja (2018), the structure summarises concepts and theories developed from previously tested and published knowledge. The knowledge is synthesised to have a theoretical background for data analysis and interpretation of meanings embodied in the research data (Kivunja, 2018). Grant and Osanloo (2014) see the theoretical framework as the cornerstone of all knowledge for a research study, whether metaphorically or literally. Based on the definitions above, the theoretical framework is the structure that guides and summarises the researcher's concepts from previously tested theories and the foundation upon which new knowledge is created.

1.6.2 Theories that underpin this Study

The purpose of the theories in research is to assist the researcher in making valuable predictions, determining the method of data analysis and informing how data should be interpreted while considering the existing literature on the phenomenon under investigation (Mahlambi, 2020). This study is underpinned by the social justice theory, behaviourist learning theory, cognitive constructivist learning theory and the social constructivist learning theory. A detailed discussion of the theories which underpin the study is given in the next chapter.

1.6.2.1 Social Justice Theory

Smith (2018) observes that politicians seriously concern themselves with the role of education in promoting equality and social justice. They are the ones who decide what is taught in schools, where it is taught, to whom it is taught, and by whom.

This study was conducted in rural schools of Limpopo Province, where inequalities regarding resource allocations are prevalent. Hlalele (2012) argues that social justice is badly needed in rural education. Cotton (2013) explains that teaching mathematics for social justice should be based on the premise that mathematics education can and should play a decisive role in addressing issues such as growing inequality, human rights abuses and unsustainable economic growth. Mathematics is an important tool in developing learners' understanding of social justice issues (Wright, 2016). Learners quickly develop a critical understanding of both the meaningful connections between social justice issues and mathematical concepts. The researcher views this as an opportunity to explain to the learners in the mathematics classroom what their rights are regarding their learning of mathematics, especially when they perceive mathematics as a complex subject studied in a language in which they may not be fully proficient. This is where code-switching becomes relevant as it closes the gap where learners use a foreign language (which they do not fully know and understand) as a medium of instruction. In that way, learners begin to understand both the foreign language and the mathematics they are taught. The use of code-switching, in this instance, brings about the interest and love for the subject by the learners. The learners also perceive the value of mathematics in their lives. Social justice theory is further discussed in Chapter 2.

1.6.2.2 Behaviourist learning theory

The two leading creators of behaviourist approaches were Skinner (1904-1990 and Watson (1879-1958) (Lessani *et al.,* 2016). Schunk (2012) states that behaviourist theory regards learning as influenced by environmental events and learning occurs due to observable behaviour. Cherry and Gans (2019) explain that behaviourism is the learning theory based on the idea that all behaviours are acquired through conditioning which occurs through interaction with the environment. Behaviourists believe that our responses to environmental stimuli shape our actions and behaviour can be studied in a systematic and observable manner regardless of internal processes. Ertmer and Newby (2013) explain that behaviourism equates learning to changes in either the form of frequency or observable performance either through classical or operant conditioning. Operant conditioning, found to be effective in the classroom, is the process in which learning can occur through both positive and negative reinforcement to encourage good and wanted behaviour (Skinner, 1972).

The researcher sees behaviourist theory as beneficial in the teaching and learning of mathematics, primarily when classroom management is maintained so that a positive environment for teaching and learning is created. This theory is also applicable when the teacher switches between English and the home language of Xitsonga to explain difficult mathematical concepts to the learners to understand the subject matter. The behaviourist learning theory is further discussed in Chapter 2.

1.6.2.3 Piaget's cognitive constructivist learning theory

Yilmaz (2011) explains the genesis of cognitivism and says that it is a learning theory that can be traced back to the early twentieth century. The failure of the behaviourist theory proponents to describe how mental processes function, spawned cognitivism, developed by Edward Tolman. In cognitivism, it is noteworthy that the emphasis is always on how knowledge is acquired, processed, stored, retrieved and activated by the learner during the different phases of the learning process. The cognitive school of thought views the learner as an active participant when knowledge is acquired and integrated. Knowledge acquisition, according to the theory, is a mental activity. The approach of the cognitive theorists is based on making new knowledge meaningful and the help that the learners receive to organise and relate new information to already stored prior knowledge.

Many theorists such as Piaget (theory of individual cognitive development), Vygotsky (theory of social cognitive growth or zone of proximal development), Festinger (cognitive dissonance theory), Spiro (cognitive flexibility theory), Sweller (cognitive load theory), Brunner (cognitive constructivist learning theory) and Tolman (theory of sign learning), have contributed to the growth and development of cognitive theories. Their contribution has been a bridge between behaviourism and cognitive theories with individual cognitive trends based on Piaget's studies while the socio-cultural trend, based on Vygotsky's work, forms the cornerstones of cognitivism (Deubel, 2003; Duffy & Cummingham,1996; Fosnot,1996; Gillani, 2003: Yilmaz 2011). However, this study pays more attention to Piaget's theory of cognitive development in the next chapter.

1.6.2.4 Social Constructivist learning theory

Social constructivism is a theory that emphasises the importance of society, culture, and language developed drawn from the ideas of Lev Vygotsky (Palmer, 2005). Ernest (1992) contends that immediately one speaks of social constructivist account of mathematics, it has to be noted that there is an assumption, as a starting point, that concepts, structures, methods, results and rules that makeup mathematics are the inventions of mankind. Knowledge, in this perspective, is socially constructed with learning taking place in particular social and cultural contexts. Bay, Bagceci, and Cetin (2012) see Vygotsky as predominantly focusing on the effect of social interaction, language and culture in the learning process.

According to Bay *et al.* (2012), real-world related authentic tasks and interaction and collaboration between experts and peers contribute to meaningful learning. The social constructivist theorists, in their approach, require learners to possess top-level knowledge and skills such as problem-solving, analysis, synthesis, critical thinking, and deep understanding (Bay *et al.*, 2012). Social constructivism was used as the main theory for this study to understand the interaction between teachers and learners during the teaching and learning of mathematics. The practice of code-switching between English and Xitsonga in the mathematics classrooms enables learners to understand complex mathematical concepts especially when clarified in their mother tongue (Xitsonga). Learners in this way will better understand mathematics with its complex concepts, thus enhancing the teaching and learning of mathematics. Social constructivist learning theory is discussed in detail in Chapter 2*.*

1.7 THE LITERATURE REVIEW

Winchester and Salji (2016) regard a literature review as an analysis of a subject based on evidence and detail. The researcher presents a detailed review of the literature to strengthen the study, justifying the need for this study and identifying the gap that exists in research concerning the main aim of this study.

A detailed literature review study is discussed in Chapter 3 with the main topic comprising reviews of the literature which assists in developing specific knowledge and forms the basis for conducting this study. These topics include mathematics performance in secondary schools, English First Additional Language as the language of teaching and learning for mathematics, code-switching as a communicative strategy enhancing quality teaching and learning with special reference to the relevance of code-switching in the teaching and learning of mathematics, the effectiveness of code-switching as a communicative strategy in mathematics teaching and learning as well as, the challenges and benefits of code-switching in the teaching and learning of mathematics.

1.8 RESEARCH DESIGN AND METHODOLOGY

The research design section briefly outlines the paradigm, research approach, research design, data collection, and data analysis methods that guided the study with the full description presented in Chapter 4. Research methodology encompasses a structured process of conducting research (Goundar, 2012). The qualitative research design refers to a plan or strategy moving from the underlying philosophical assumption to a practical enactment (Maree, 2011). The research methodology includes the research paradigms, approaches, type or design and data gathering methods, and data analysis (Goundar, 2012), which are briefly introduced in the sub-sections.

1.8.1 Research Paradigm

Kamal (2019) defines the term paradigm as the Greek word which means pattern. She explains that paradigm is how the world frames the research topic and influences the researcher’s perception of the topic. A paradigm determines how the researcher conducts the study, including data collection and analysis procedures (Kamal, 2019). Kivunja and Kuyini (2017) define a paradigm as the researcher’s world view, which involves one’s perspective or the way of thinking. Guba and Lincoln (1994) define a paradigm as a set of fundamental beliefs that deal with ‘ultimates’ or first principles., Thus, a paradigm relates to how the researcher views the world, which in turn influences how the research is conducted. Paradigms identified by different scholars and commonly used by researchers include positivism, post-positivism, interpretivism, constructivism, transformative, critical inquiry, feminism, postmodernism and pragmatism. In this study, the researcher used interpretivism to explore the experiences of mathematics teachers and their learners and to understand how code-switching as a communicative strategy could enhance the quality of teaching and learning in mathematics.

1.8.2 Research Approach

Three research approaches could be used when conducting a study: qualitative, quantitative, and mixed methods. Creswell (2014) explains that the distinction between qualitative research and quantitative research is often framed using words that relate to non-numerical data (qualitative) instead of quantitative, which refers to numbers. The mixed-method approach combines the qualitative and quantitative approaches involving philosophical assumptions and theoretical frameworks where the researcher collects data qualitatively and quantitatively (Creswell, 2014). This study, which explored code-switching as a communicative strategy that enhances the quality of mathematics teaching and learning in Grade 11, followed a qualitative approach so that participating teachers and learners could share their practical experiences in classrooms at their respective schools (Boru, 2018).

1.8.3 Research Type

Maree (2007) outlines the different qualitative research designs: conceptual studies, historical research, action research, case study research, ethnography and grounded theory. Igwenagu (2016) refers to seven research designs: action research, creative research, descriptive research, experimental research, ex-post-facto research, expository research, and historical research. According to Igwenagu (2016), the research type dictates the research method to be employed in the study, and for this study, a descriptive case study was chosen. A descriptive case study assisted in exploring the strategy of code-switching in the teaching and learning of mathematics where both teachers and learners were interviewed through individual in-depth and focus groups in their natural settings at their respective schools. In the researcher’s view, a case study facilitates the exploration of the phenomenon using appropriately collected data sources (Baxter & Jack, 2008).

1.9 RESEARCH METHODS

1.9.1 Study Population

Majid (2018) explains that the population of interest refers to the population targeted by the study and the population that the researcher intends to study. McMillan (1996) defines population as a group of cases that may be individuals, objects, or events conforming to specified criteria upon which the research results will be generalised. Asiamah, Mensa and Oteng-Abayie (2017) distinguish the general, the target, and the accessible population. Population, therefore, in research means the group of people, objects, or events regarded as having relevant data for the particular study, which are also available for sampling by the researcher. In this study, the researcher acknowledged that there are teachers in various schools (general population) who teach mathematics (target population) as well as those who teach mathematics in Grade 11 (accessible target). However, these teachers need to be willing to participate in the study. Grade 11 learners of mathematics in sampled schools were also considered as an accessible target population for the study.

1.9.2 Sampling Procedures

Bhardwaj (2019), whose definition more or less coincides with the definitions of Majid (2018) and Igwenagu (2016), is that sampling is a procedure of selecting a sample from the population for a specified type of research. According to Majid (2018), sampling is selecting a statistically representative sample of individuals from the population of interest. Sampling, according to Igwenagu (2016), is the process that concerns itself with the selection of a subset of individuals who come from a defined population for purposes of estimating the characteristics of the whole population. Sampling, therefore, is the method of selecting participants who are considered to have rich data for the study while representing the other people who do not form part of the study. In this study, the sampling procedure refers to how the researcher selected teachers and learners to form part of the study: teachers of Grade 11 mathematics and Grade 11 learners of mathematics.

Researchers choose to use the sampling method that best suits the type of research they are conducting. Qualitative researchers can use two types of sampling techniques, namely, probability and non-probability sampling (Bhardwaj, 2016; McMillan, 1996). The researcher used non-probability purposive sampling (McMillan, 1996) to target teachers teaching mathematics in Grade 11 and their learners. The mathematics teachers and some of their learners (as participants) were from rural schools in the Mopani District, Limpopo Province and were accessed through their schools. Teachers were sampled because they taught Grade 11 Mathematics and spoke Xitsonga together with their learners as their home language. In addition, the schools, which served as the participants' natural settings, were suitably situated for the researcher where accessibility was informed by the research guidelines (McMillan 1996). Permission to conduct the research was sought from the District Director, the Circuit Managers of the schools concerned, the principals of the schools, and the participants themselves or through their parents or guardians.

1.9.3 Data Collection Procedures

Data, in qualitative research, is collected from different sources, including documents, personal interviews, telephonic interviews, questionnaires or schedules (Boru, 2018; Kothari, 2004). In this study, data were collected from Grade 11 mathematics teachers and Grade 11 learners using semi-structured interviews, non-participatory observation and telephonic interviews for follow-ups when and where necessary. Data were collected from participants in ten high schools situated in the rural area of the Mopani District in Limpopo Province.

Interviewing is a technique used to generate data from relevant sources, which may be individuals or groups (Jackson, Drummond & Camara, 2007). Semi-structured interviews were used as these allowed flexibility and responsiveness to the emerging themes (Jackson *et al.*, 2007). Mathers, Fox and Hun (2009) describe the types of interviews as being individual interviews, group interviews, face-to-face interviews, telephonic and video link interviews and web interviews. Individual face-to-face and telephone interviews were conducted with mathematics teachers and focus group interviews with Grade 11 mathematics learners because of their relevance to the study. Individual interviews enabled the researcher to gain insight into participants' understanding, perceptions, and experiences of code-switching in teaching and learning mathematics (Ryan, Coughlan & Cronin, 2009). The researcher used telephonic interviews because of the challenge created by the Covid-19 pandemic which prevented face-to-face individual follow-up interviews with the teachers (Ryan *et al.,* 2009). During the interviews, the researcher used an audio device to record the interview sessions, so that accurate information was captured and transcribed at a later stage for analysis (Dilshad & Latif, 2013; Mahlambi, 2020,). The fieldnotes taken during the interview sessions were also used in the data analysis process and assisting in the reporting of data.

1.9.4 Data Analysis and Interpretation

The researcher concurs with Kothari (2004) who posits that the process of preparing and organising data, as alluded to by (Creswell, 2013), comes after data collection. Maree (2011) indicates that qualitative data analysis uses an interpretative approach that meaningfully examines the content of collected data. According to Kothari (2004), the analysis of data requires, among other things, the establishment of categories, their application to raw data through coding, tabulation and drawing statistical inferences. The researcher analysed and interpreted data through thematic data analysis using an inductive approach, by examining and recording patterns within data (Boru, 2018).

1.10 SIGNIFICANCE OF THE STUDY

The study hopes to inspire more researchers to continue the debate on code-switching as a teaching approach that can effectively enhance mathematical knowledge acquisition in mathematics teaching in secondary schools where teachers and learners use a foreign language and not their home language. The framework, and the strategies or guidelines for the effective use of code-switching in the teaching and learning of mathematics in secondary schools, should benefit the stakeholders within the education sector such as mathematics teachers and learners. The school management teams in secondary schools, including the departmental heads for mathematics, and school principals should benefit. The benefits should also be acknowledged by, members of the School Governing Bodies, mathematics Senior Education Specialists and Mathematics District Education Specialists at District level and Circuit Managers. The Department of Basic Education policy developers, Association Foundation for Mathematics Education of South Africa (AMESA) and the South African Mathematics Foundation (SAMF) should also recognise the relevance of the framework and the strategies or guidelines for the effective use of code-switching in teaching and learning mathematics in secondary schools.

1.11 TRUSTWORTHINESS

Korstjens and Moser (2017) explain trustworthiness as quality criteria in qualitative research based on Lincoln and Guba’s norms (1985), including transferability, credibility, dependability and formability.

1.11.1 Transferability

Cope (2014) explains that transferability in qualitative research relates to the findings that may apply to other settings or groups. Lietz and Zayas (2010) assert that transferability is the degree to which findings are applicable or useful to theory, practice, and future research.

1.11.2 Credibility

According to Cope (2014), credibility is the truth of the data or the views of the participants. This includes how the researcher interprets and represents them. Lietz and Zayas (2010) see credibility as the degree to which the study findings illustrate the meanings of the research participants.

1.11.3 Dependability

Cope (2014:1) explains dependability as the constancy of the data over similar conditions. According to Boru (2018), dependability is the researcher’s provision of rich description research procedures and the use of instruments to enable and allow other researchers to collect data in the same way. The researcher should achieve dependability in this study by using relevant and appropriate research procedures. Aspects that serve as guidance for ensuring dependability are the profile of the interviewees (teachers and learners) which is explained in detail, the interview questions for the collection of data, detailed notes for the interview session which should reduce bias (Boru 2018).

1.11.4 Confirmability

Confirmability is seen by Cope (2014) as the ability of the researcher to show that the data embodies the participants' responses and not their biases or viewpoints. On the other hand, Lietz and Zayas (2010) define confirmability as the researcher's ability to confirm or corroborate the findings. All methodological norms are discussed in detail in Chapter 4.

1.12 ETHICAL MEASURES

This section briefly explains how ethical measures are observed, with more details being provided in Chapter 4 (*cf*. 4.7). The researcher secured an ethical clearance certificate from the Ethics Committee of the University of South Africa before engaging in data gathering. Permission from the District Director in Mopani District to collect data was sought and letters to request permission were sent to the Circuit Managers of the schools where the study was to be conducted. Informed consent was sought from all the participants, and in the case where the learners were below eighteen years, their parents or guardians were asked to give consent for their children to participate in the study. The study involved learners aged between sixteen and eighteen years. Anonymity and confidentiality of all the participants were assured and observed; hence, participants signed the consent forms and codes were used to report the findings.

1.13 DEFINITION OF OPERATIONAL CONCEPTS

1.13.1 Code-switching

Yusob, Nassir and Tarmuji (2018:60) define code-switching as "the use of more than one language in the same speech". The term code-switching refers to the practice in which teachers in secondary schools in Mopani District alternate between English as the medium of instruction and Xitsonga as the teachers' and learners' mother tongue or home language.

Nilep (2006) describes code-switching as a practice of parties in a discourse that signals changes in context by using alternate grammatical systems or subsystems or codes. The Department of Basic Education (DBE, 2018) explains code-switching as the term that refers to the conscious switching from one language to another during teaching and learning. Bullock and Toribio (2012) explain that bilingual speakers code-switch when they alternate using two languages in the same stretch of discourse. Yusob *et al.* (2018) define code-switching as using more than one language in the same speech and Mugo and Ongo'nda (2017) see code-switching (CS) as the practice of moving back and forth between two languages, a widespread phenomenon in bilingual speech. Memory, Nkengbeza and Liswaniso (2018) explain code-switching as the alternating use of two or more languages in teaching and learning for easy acquisition of knowledge by learners. According to them, code-switching is time effective because teachers do not waste time explaining or searching for simple words that would simplify any confusion. In addition, code-switching in South African classrooms provides access to mathematical knowledge construction (Chikiwa, 2016).

Mugo and Ongo'nda (2017) state that code-switching does not necessarily involve a complete switch to the other language. Myers-Scotton's Matrix Language Frame Model (MFL model) determines the grammatical frame of utterance and therefore plays a more predominant role in code-switching. The language which takes a principal role in code-switching is regarded as the Matrix Language (ML) or base 'language' of the interaction while the other is the embedded or guest language. According to Mugo and Ongo'nda (2017), there may be one matrix language only and one or more embedded languages in a code-switching situation. It is important to note that the ML determines the syntax of a code-switching instance, and its presence is obligatory in the instance. The contribution of the embedded language in the code-switching instance is minimal. The researcher points out that English First Additional Language (FAL) represents the ML in the current study while Xitsonga represents the embedded language. Promnath and Tayjasant (2016) see code-switching as the alternation of two languages or more in the same discourse or the alternation of linguistic varieties within the same conversations.

The researcher holds the view that code-switching is a communicative strategy that is relevant in the teaching and learning of mathematics, even though there are challenges that are associated with this practice (Maluleke, 2019). A detailed discussion of code-switching as a communicative strategy enhancing quality in mathematics teaching and learning, the relevance and effectiveness of code-switching in the teaching and learning of mathematics as well as the benefits and challenges is presented in Chapter three. The study was conducted in Limpopo Province in schools where teachers and learners speak Xitsonga, their home language. In this instance, the commonality of their home language is conducive to the employment of code-switching for communicative purposes to facilitate teaching and learning mathematics.

According to the social constructivist theory, the role of language in the teaching and learning of mathematics is essential. Setati, Adler, Reed and Bapoo (2002) state that code-switching as a learning and teaching resource has been the focus of study in mathematics education in Southern Africa. Their studies demonstrated that using the learners' home language in teaching and learning mathematics has provided the necessary support. In contrast, the learners continue to develop proficiency in the medium of instruction. It must be noted that language as a tool for the acquisition of knowledge in social constructivism is critical.

1.13.2 Communicative Strategy

Spromberg (2011) defines communicative strategies as means of communication used by language learners to understand better and overcome the lack of linguistic resources. In this study, the communicative strategy refers to code-switching between English and Xitsonga during the teaching and learning of mathematics in Grade 11, with the intention to improve the quality of teaching and learning. Viseu and Oliveira (2012) assert that communication in mathematics is essential to enable learners to understand the processes, discussions and decisions. The achievement of curricular rules hinges on how they are interpreted by the teachers and how they adjust them to their conceptions in the act of teaching. Communication by regulating the social interactions generated in the classroom enables the sharing of ideas and clarification of mathematical understanding. Mahofa (2014) posits that effective communication with the help of the teachers, allows the learners to share ideas, thoughts and ways to solve mathematical problems. According to Mahofa (2014), the learner should be able to follow and understand what happens during mathematical lessons. Mathematical communication skills in mathematics learning should thus foster students' mastery of thinking and convey ideas (Triana, Zubainur & Bahrun, 2019). The National Council of Teachers of Mathematics (2000) identifies verbal writing, graphic and visual forms of mathematical communication skills, key to presenting mathematical ideas. Effective communication in mathematics teaching and learning is significant. Viseu and Oliveira (2012) discuss the significance, and the researcher identifies the aspects discussed and chooses to refer to them as functions of communication because of what communication does. Communication contributes to the understanding of processes and discussions, contributing to teachers and learners' sharing of ideas which is essential and helpful in clarifying mathematical concepts while fostering thinking skills. Code-switching as a communicative strategy in the teaching and learning of mathematics, should occur so that it observes and respects communicative functions.

This study argues that code-switching enhances the quality of teaching and learning mathematics in this context.

1.13.3 Teaching and Learning

Teaching and learning mean the interaction between teachers and Grade 11 learners in acquiring new knowledge in mathematics (Dogo 2016). Therefore, teaching and learning refer to the interaction between the teacher and the learners in Grade 11 mathematics classrooms to master new skills.

1.13.4 Mathematics

Sa'ad, Adamu and Saqid (2014) regard mathematics as one of the essential school subjects in the curriculum, asserting that it directly relates to other school subjects such as technology and sciences as it is a compulsory subject in primary and secondary schools. The concept 'mathematics' has not always been easily defined. Skovsmose and Valero (2005) state that mathematics covers various ideas, techniques and practices employed by many people in different parts of the world without depicting any unifying attributes. It is for this reason that mathematics of Western mathematicians, of professional mathematicians nowadays, of mathematicians doing applied mathematics in industrial development and even in warfare, of the Inca indigenous people in Peru, of carpenters in their workshops, or street children, of nurses and doctors, is practised. Valero (2005) further says formal mathematics education and informal mathematics learning can occur in different sites with their own rules of practice, demands and expectations. Therefore, there is school mathematics education in urban and rural areas in South Africa, mathematics education for adults in the work place, and in-practice learning of mathematics of newspapers vendors.

According to Yadav (2017), no precise definition of mathematics exists as there is no consensus on the definition, even among professionals. Because of this difficulty, Yadav, in the conclusion to his study, defines mathematics "as the study of assumptions, its properties, and applications" (Yadav, 2017:41). He asserts that the order of assumptions, properties and applications, must be maintained in teaching, an order which must be maintained in assignments to get the desired aim in teaching mathematics. Yadav (2017) cites several scholars who have proffered their definitions of mathematics. Valero and Zevenbergen (2004) contend that it is impossible to think about mathematics education practices and research without realising that they are social spheres for the struggle of worldviews and positioning for gaining access to the dominant culture and its generation of particular nationalities and organising principles in society. The definition of mathematics, as reflected in the Curriculum Assessment Policy Statement, is:

> *"Mathematics is a language that uses symbols and notations to describe numerical, geometric, and graphical relationships. It is a human activity that involves observing, representing, and investigating patterns and qualitative relationships in physical and social phenomena and between mathematical objects and themselves. It helps developmental processes and enhances logical and critical thinking, accuracy, and problem-solving to contribute to decision-making. Mathematical problem solving enables us to understand the world (physical, social and economic) around us, and, most of all, to teach us to think creatively."* (DBE, 2011:8)

Ernest (1992) explains that the nature of mathematics, at any given time, is determined by a set of information-technology artefacts, which are books, papers, software and so on, a set of persons (mathematicians) and a set of linguistically based rules that they have adopted as well as activities that mathematicians carry out. For developmental purposes, Choudhury and Bose (2011) looked at mathematics as a topic, mathematics as a language, and the link between the two. Firstly, they observe that mathematics is an important school subject taught from the kindergarten level across most contemporary cultures. They note that the linguistic and social nature of mathematics allows it to develop together with language (Barton, 2009). This is simply because language and mathematics are socially constructed.

1.13.5 Grade 11 learner

The South African Schools Act (SASA) 84 of 1996 defines **grade** as "that part of an educational programme which a learner completes in one school year, of any education programme which the Member of the Executive Council may deem to be equivalent to it." (RSA,1996: B-4). In this study, Grade 11 refers to the eleventh year of the child’s formal learning in South Africa.

The SASA describes a **learner** as “any person receiving education or obliged to receive education in terms of this Act” (RSA, 1996: B-4). In this study, the concept Grade 11 learner refers to a child registered in the South African public school who has managed to achieve academic goals until their eleventh grade, which is also the eleventh year of the normal learning period. In this study, the word learner also refers to pupils or students who learn in primary or secondary schools.

1.14 DIVISION OF CHAPTERS

Chapter 1: **Introduction and background**

The first chapter served as an introduction to the study. The background, the rationale, as well as the statement of the problem were discussed. This was followed by an indication of the research questions, research aim, and research objectives. The chapter also briefly introduced the theories that underpin the study, followed by a brief explanation of the research design and methods used in this study. The significance of the study, ethical measure, trustworthiness, and clarification of concepts were given and the chapter concluded with a summary.

Chapter 2: **Theoretical Framework**

The second chapter is the researcher’s provision of an overview of the study's theories. The theoretical framework is presented and a detailed discussion is given of the theories that underpin the study: social justice theory, behaviourist learning theory, cognitive constructivist learning theory, and social constructivist learning theory. The researcher discusses social justice theory indicating how it applies to the study. The traditional behaviourist learning theory is discussed to indicate how it contributed to the birth of the constructivist theories, leading to the cognitive constructivist learning theory and the social constructivist learning theory. The strengths and weaknesses of the theories are indicated, and finally, the researcher’s justification for the choice of these theories is given. The chapter’s summary ends the chapter.

Chapter 3: **Literature Review**

The third chapter is a detailed discussion of the relevant literature regarding code-switching in teaching and learning mathematics. The chapter begins by explaining the concepts of code-switching, mathematics and the language of learning and teaching (LoLT). The relevant policies that relate to teaching and learning mathematics are highlighted. The general mathematics performance of learners locally and internationally is also discussed as is literature-based code-switching as a communicative strategy. Finally, the challenges of code-switching as a communicative strategy are outlined to provide insight into how code-switching as a communicative strategy enhances the quality of mathematics teaching and learning. Lastly, the chapter's summary concludes this chapter.

Chapter 4: **Research Methodology**

The fourth chapter presents the research design and methods used for this study. The researcher begins with an explanation of the research paradigm and the research approach adopted for this study. A lengthy discussion of the research method is presented where the research site, sample and sampling procedure, study population, data collection and analysis procedures are detailed. The reasons for the choice of the above are also indicated while citing the advantages and disadvantages of these techniques and procedures. Thereafter, the ethical measures that were put in place and trustworthiness are indicated. The chapter concludes with a summary.

Chapter 5: Analysis, findings, and discussion of the results

In the fifth chapter, the findings of the empirical study are presented. The chapter begins with the highlighting of the analytical framework that was adopted. Inductive data analysis was used to analyse individual in-depth and focus group interviews. Two phases of interview sessions were conducted. The necessity of the second phase was to add more data that related to the practice of code-switching in the teaching and learning mathematics, as well as the importance of learning mathematics in schools. Data were broken into manageable pieces and coded accordingly. The emergence of the themes resulted in identified patterns and categories. A narrative description of the research findings, based on the research questions and objectives, is presented. The chapter, again, concludes with a summary.

Chapter 6: **Conclusion, recommendations, and suggestions for the future**

The sixth and last chapter provides the significant findings that emerged from this study based on the research and the research questions. The chapter begins with an overview of the literature review and the methodology used in the research. The synthesis of the research findings is presented according to each of the research questions. There are suggestions on how code-switching might be used as a communicative technique to improve the quality of mathematics teaching and learning in Grade 11 and a discussion of the study's shortcomings bring the study to a close prior to offering recommendations to stakeholders and recommendations for future research.

1.15 CHAPTER SUMMARY

The main intention of this study was to explore the Grade 11 mathematics teachers' views and those of the learners regarding the use of code-switching as a communicative strategy that increases the knowledge acquisition of mathematics. Chapter 1 offered the background of this study which highlighted mathematics performance in South Africa and factors contributing to poor performance in the subject, especially in rural areas. This gave rise and light to the understanding of the problem for investigation through the aims and objectives. The chapter also briefly explained the theories which underpin the study and introduced the research methodology used in the study which comprised the paradigm, design, study population and sample, data collection and analysis, ethics, and issues. Finally, the chapter indicated the significance of the study, definition of operational terms and outlined the division of chapters. In Chapter 2, the researcher discusses the different theories supporting the practice of code-switching as a communicative strategy enhancing the quality of teaching and learning mathematics in Grade 11.

CHAPTER 2

THEORETICAL FRAMEWORK

2.1 INTRODUCTION

The previous chapter discussed the research background, the study's rationale, problem statement, research questions, objectives, and theories underpinning the investigation. The research design and methodology were also briefly discussed and the synopsis of all the study's chapters. Chapter 2 describes the various educational theories underpinning this study, explaining how knowledge is acquired in the teaching and learning mathematics.

The study's foundation, social constructivism, is thoroughly addressed. The discussion demonstrates the benefits and drawbacks of social constructivism while also justifying reasons for selecting the theory. The chapter also highlights social justice theory, behaviourist theory and constructivism as additional theories that strengthen the study. The link between the discussed theories and the teaching and learning of mathematics is also discussed.

2.2 THEORETICAL FRAMEWORK

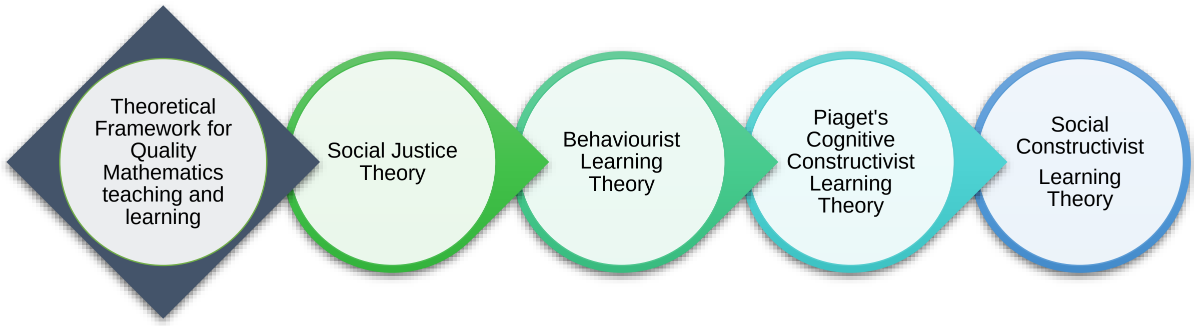
This section defines the theoretical framework and discusses the social justice theory as one of the theories underpinning this study. The learning theories that form the basis of this study are behaviourism, Piaget's cognitive constructivist learning theory and social constructivist theory, all of which are discussed in this section.

2.2.1 Definition of the Theoretical Framework

Researches have endeavoured to clarify the concept and process of learning. This endeavour has resulted in diverse theories. Kawulich (2009) contends that theory is a plausible system of principles used to explain a phenomenon while Adom, Hussein and Agyemi (2018) explain that a theoretical framework is based on an existing theory in a field of inquiry related to and reflecting the study's hypothesis. They regard it as a design plan that the researcher uses to build their own *house* or research inquiry. The Sacred Heart University Library (2020) suggests that the theoretical framework is the structure that holds or supports the theory of the research or study. The definition of the theoretical framework that Grant and Osanloo (2014) proffer is in line with the definitions that Kawulich (2009) and Adom *et al. (*2018) have offered and also shared their attributes. In brief, the theoretical framework is the structure that demonstrates how the researcher approaches the research philosophically, epistemologically, methodologically and analytically.

Grant and Osanloo (2014) maintain that students should select and clarify a theoretical framework when the research topic is conceived. Casanave and Li (2015) recommend that a theoretical framework should justify why and how the study is conducted. Accepting this view assists the reader in understanding that the researcher uses existing philosophical knowledge to identify theories to determine how the research approach and the research methods were chosen for the study. Casanave and Li (2015) observe that using a theory in a study should enable the researcher to support and interpret their research findings, thereby bringing together their work and larger ideas outside the confines of the study.

The diagram below, Figure 2.1, is an indication of the theories that underpin this study.



Source: Researcher's own diagram

Figure 2.1: Theories that apply to teaching and learning mathematics

The discussion of the relevant and necessary theories for quality teaching and learning of mathematics follows in the sub-sequent sections.

2.2.2 The Social Justice Theory

The next sections present an overview of social justice theory, and then there is a discussion on the role of social justice theory in mathematics education. Equity, inequality and fairness in teaching and learning mathematics in rural areas is discussed. The final sections discuss the educational value of social justice theory for quality in mathematics teaching and learning and then highlight challenges in promoting social justice for quality in mathematics teaching and learning.

2.2.2.1 Overview of the social justice theory

Imbalances, inequalities and injustices have characterised the South African education system. The Constitution of the Republic of South Africa Act 108 of 1996, in its preamble, brings this out. The preamble reads: “We the people of South Africa, recognise the injustices of our past; We, therefore, through our freely elected representatives, adopt this constitution as the supreme law of the Republic to - Heal the divisions of the past and establish a society which is based on democratic values, social justice and fundamental human rights” (RSA Act 108 of 1996:1). The Constitution, the South African Schools Act 84 of 1996, the Norms and Standards for Education 2001, and the National Education Policy Act of 1996 are an attempt to redress previous historical inequalities and injustices (Martin, 2015). According to Martin (2015), the legislation has aimed to improve the quality of life for all in South Africa with the Constitution as a working blueprint against social injustice and oppression. The inclusion of social justice in the Constitution of the Republic of South Africa, according to the researcher, is a positive contribution by the legislature to ensure that education in South Africa is free from imbalances, injustices and inequalities.

The South African government is commended for infusing Human Rights into the current curriculum, the Curriculum Assessment Policy Statement (CAPS) where, according to Jojo (2019), the inequalities and imbalances of the past are duly taken care of. Hlalele (2012) sees social justice as a humanising process and a response to human diversity in terms of ability, socio-economic circumstances, choice and rights. O’Brien (2010) traces the history of education in South Africa, specifically designed to disenfranchise black Africans by withholding or not providing proper access to quality education. Blacks were only to be skilled for trade that would perpetuate a servitude life, thereby ensuring white domination in the country. The African National Congress, which is the governing party, for many years now, according to Hlalele (2012), has been endeavouring to fix the broken education system. This has not been easy due to economic apartheid, which has maintained inequalities in the education system.

Significant financial discrepancies between whites and blacks in South African are rampant (Hlalele, 2012).

The social justice debate is not exclusively a South African concern but a concern globally. Gates and Jorgensen (2009) contend that there is considerable international interest in social justice, which is key to many government strategies and fundamental policy objectives. Gates and Jorgensen (2009) state that international organisations view social justice as embracing a fundamental policy objective; however, the connection between social class and educational underachievement, according to them, remains a worrying concern to date.

2.2.2.2 Social justice theory in mathematics education

Panthi, Luitel and Belbase (2018) observe that social justice and mathematics education have always been significant issues in education. They ask several questions about education and mathematics in their exploration of mathematics education and the theoretical foundations of social justice in mathematics in the classrooms. They then define social justice in education as a phenomenon that involves children who are provided with equal opportunities to learn and grow. Panthi *et al*. (2018) cite Bell (2007:1), who says that "the goal of social justice is full and equal participation of all groups in society that is mutually shaped to meet their needs". Panthi *et al.* (2018) then state that teaching for social justice applies good teaching strategies in support of all types of students in a classroom who expect to succeed irrespective of their gender, social and economic background, level of intelligence, or ability.

Gates and Jorgensen (2009) identify mathematics teaching in schools as key in that it positions learners and their developing identities as learners and citizens. They posit that mathematics and social justice have been the focus of much research which has, inter alia, concentrated on the process of learning, the content of the curriculum and its assessment. Wright (2014) argues that to ensure that all learners are treated equally and fairly in their classrooms, mathematics teachers must apply different approaches to teaching their subject, in line with social justice theory.

Skovsmose and Valero (2005) contend that the last decade has experienced a rise in research on mathematics education and its connection with society focusing on equity, social justice, and democracy. Because the study is about code-switching as a communicative strategy enhancing quality in mathematics teaching and learning in Grade 11, the definitions of social justice demonstrate that one cannot talk of code-switching without mentioning social justice theory and language. It then becomes clear why social justice theory is necessary to underpin this study.

2.2.2.3 Equity, inequality, and fairness in teaching and learning mathematics in rural areas

Hlalele (2012) is concerned that the South African Department of Basic Education's policies and legislation have failed to provide education rights to most South Africans, particularly those in the rural areas. South African rural communities in comparison to the communities in the urban areas, remain disadvantaged.

The Ministry of Education, according to Bryant (2010), seems to acknowledge the inadequate manner in which it addresses the problems in education with respect to rural communities when the Ministerial Committee on Rural Education (MCRE) (DoE, 2005) suggested that the intervention strategies employed in addressing the complexities of rural development and education should aim at ensuring consistency in the government's rural strategy. The government, in the suggestion, is well aware that access to economic activities should be expanded to reduce poverty and invest in human rights and social justice, thereby improving living conditions.

The poor state of rural education in Africa and Nigeria has been covered in a study conducted by Uzobo, Ogbanga and Jack (2014) which reveals the dire situation of education in poverty-stricken rural areas, which are not favoured by the educational policies. In the schools where the study was conducted, learners' backgrounds do not allow them access to the resources that assist them in becoming proficient in English. Through interaction with learners of English FAL in Grade 11 over the years, the researcher has observed that communication skills in English are a challenge; hence, these learners became more active in those lessons when code-switching was practised, a situation similar in other content subjects. It is noteworthy to indicate that these learners do aspire to pursue studies in mathematics and science-related careers that enable them to become chartered accountants, engineers, actuarial scientists, pilots and so on. The researcher discovered this when going through the learners' essays in English First Additional Language, the language the researcher taught.

The socio-economic status of learners and the improper implementation of social justice have resulted in poor performance in mathematics. Hlalele (2012:111), in desperation, asserts that notwithstanding all efforts deployed by countries around the world and the strenuous mobilisation of international communities, rural people still lag far behind in education and are still highly affected by poverty and hunger.

The responsibility of mathematics teachers should be to ensure that they act as agents of change by applying strategies in line with addressing mathematics education as a human right and a social issue (Hlalele, 2012) when teaching and learning take place. The researcher agrees with Hlalele (2012) who argues that code-switching should occur in the classrooms to enable learners to actively participate using their home language, which improves their understanding of difficult concepts in mathematics and adds value to the language of teaching and learning. Skovsmose and Valero (2005) assert that mathematics education becomes an education for democracy as there is an intrinsic resonance between mathematics education and democracy. They further assert that mathematics and its proper teaching and learning bring enormous empowerment to learners.

De Kadt (n.d) argues that even though education can address injustice by ensuring equal opportunities, facilitating development and strengthening democracy, South Africa has not yet realised this, attributing it to low-quality education, high inequality and an uneven distribution of resources. Visser *et al.* (2015) argue for the establishment of a healthy environment conducive to learning and academic achievement. However, the availability or scarcity of critical resources impacts educational outcomes with sufficient resources yielding better results, while insufficient resources produce negative results.

Skovsmose and Valero (2005) argue that depending on the context and how mathematics education is organised, it may support social justice or perpetuate exclusion processes based on race, language, gender, social class, ethnicity, and ability. Their view makes the relationship between mathematics education and equity critical as they see no intrinsic resonance or dissonance. The researcher's experience as a teacher in rural areas has demonstrated that the learner's locality impacts their teaching and learning outcomes. Learners who come from poor backgrounds and attend poorly equipped rural schools are always at a disadvantage as they are excluded from normal and proper mathematics education. The researcher has found that communication in English First Additional Language (FAL) which is the medium of instruction and not the learners' home language, is a challenge to these learners whose knowledge of English is poor. The consequence is that education and equity are miles apart. The researcher has observed that learners from good backgrounds communicate well in English as they have ready access to meaningful facilities which enable them to improve their performance in mathematics. In contrast, learners in rural areas who come from disadvantaged families, have not developed English language proficiency which impacts on understanding of the content of the subject taught.

Wright (2016) asserts that alternative approaches towards teaching mathematics should address issues of equity and fairness and social justice and should, as a result, be adopted. Although the apartheid era ended in 1994 with the dawn of democracy, despite high levels of resource allocation in certain areas, there are still high levels of poverty and extreme social and economic distance between rich and poor which continue to manifest and play out in education in complex ways (Graven, 2013). According to Graven (2013), extreme levels of inequality and poverty continue to be at the heart of the failure of educational innovation aimed at reducing inequality.

Social justice in mathematics education is a problem not only in South Africa but also in other countries. For example, Atweh, Vale and Walshaw (2017) argue that academic mathematics and science performance in Australia depends on the learner's school where learner achievement is heavily influenced by their family's ability to afford a good school. They argue that the achievement gains are sharpest in middle-high and high socio-economic status schools. Atweh *et al.* (2017) contend that language is an essential resource in teaching and learning of mathematics. They see code-switching in the classroom as contributory to a better understanding of mathematical concepts as it builds bridges between learners' intuitive understanding of mathematics and the world.

2.2.2.4 The educational value of social justice for quality in mathematics *teaching and learning*

Skovsmose (1994) asserts that learners are human beings and should be seen as such in complex situations where mathematics learning is but one particular aspect.

According to Skovsmose (1994), learners are members of a classroom and part of a school and society, acting with reference both to their background and foreground. According to Skovsmose and Valero (2005), foreground refers to how learners interpret and conceptualise explicitly or implicitly, consciously or unconsciously their future, possibilities and living conditions regarding the social, cultural, economic and political environment in which they live. They see the foreground as framing what learners do and want to do (learners' future careers). It provides resources and reasons for the involvement or not of the learners in their learning as participating persons. Skovsmose and Valero (2005) assert that society may assign different foregrounds to different learners. Apartheid in South Africa stole the future of certain groups of children. The act of stealing destroyed the foreground of some of them and thereby eliminated many possible motives for learning mathematics. To them, identifying those acts of stealing is more important for understanding the learning obstacles of certain groups of children than detecting certain mathematical misconceptions (Skovsmose & Valero, 2005). Social justice theory appears to be the gateway to fully address the problems that affect these learners, particularly the learners of mathematics living in rural areas, such as Limpopo rural learners.

The South African Department of Education has introduced legislation and established policies dealing with the principles of social justice. These are, among other things, Regulation About the National Curriculum Statement Grades R-12 (2012), the Curriculum Assessment Policy Statement for Mathematics Grades 10-12 (2011) and the National Strategy for Mathematics, Science and Technology as well as Mathematics, Science and Technology (MST) Education in GET and FET (2019-2030). The success of the policies and strategies demonstrate the resolve with which the Department of Education is moving towards eradicating inequalities and seeing social justice in place and at play. Social justice forms the foundation for this study. It provides learners with new and equal opportunities in the learning of mathematics (Skovsmose & Valero, 2005). According to the researcher, the teachers have the responsibility of instilling and encouraging positive attitudes towards mathematics as they motivate the learners during teaching and learning. The question remains about how they aim to achieve this. Recognising the difficulties learners encounter when they use a foreign language during mathematics teaching and learning, code-switching seems to be the answer because the medium of instruction may not be their home language. This will make teaching and learning more meaningful, relevant and interesting to the learners (Wright, 2014). Code-switching, the communicative strategy promoted in this study, enables the learners to communicate freely, effectively and love mathematics as a subject and the language used to teach it.

Mathematics is a potent tool to develop learners' understanding of issues of social justice and mathematical concepts in a case where a meaningful link between the two exists (Wright, 2015). Teaching mathematics for social justice becomes more significant when collaborative, discursive, problem-solving and problem-posing pedagogies are employed (Wright, 2015). Learners become involved in teaching and learning mathematics, they recognise and draw on their real-life experiences to emphasise the cultural relevance of mathematics, they facilitate mathematical investigations that lead to a better understanding of their socio-cultural, economic and political situations, they facilitate mathematical investigations that lead to responsible citizenship and realisation of their foregrounds and they develop a critical understanding of mathematics (Scovesmose, 2011).

2.2.2.5 The challenges in promoting social justice for quality in mathematics teaching and learning

Atweh *et al.* (2017), discussing social justice theory, talks about a movement from desperate agendas of equity, diversity and inclusion to a more comprehensive and unifying social justice construct. However, they see gender, language and culture, and socio-economic status remaining an impediment to many learners regarding access to and participation and achievement in mathematics. Many years of concerted policy and action to remove inequalities in mathematics education have met with inadequate gains. This position is not foreign to the South African situation as it is equally applicable. Very little social justice is seen being applied in South Africa, which is plagued by extreme poverty resulting from the implementation of the policy of apartheid. This has left, in particular, rural communities with an insufficient distribution of resources which would account for poor quality teaching and learning of mathematics.

The social standing of families has determined good performance in mathematics in South Africa. Some are well off, while others are not. The poorest parents tend to live in rural areas which invariably has little infrastructure and facilities. The researcher, who has been a teacher for over thirty years in high schools in Limpopo Province, has noted a lack of resources for teaching and learning mathematics in the learners' home language (Xitsonga). In addition, many learners are living in abject poverty and many homes do not even have television sets or smartphones. In contrast, learners who come from affluent homes and can access various resources such as televisions and cellphones, where there are platforms that offer mathematics lessons for Grades 10 to 12. Learners who speak the language of teaching and learning in their homes have no problems communicating in and writing English. They find it much easier to understand and follow when the teachers teach mathematics and are better positioned to perform well in the subject than those who speak an African language (Setati, Molefe & Langa, 2008).

The researcher believes that, despite the challenges, as soon as resources for teaching mathematics are available in the African languages, it will positively contribute to a better understanding of the subject. This will promote better performance and embrace social justice, resulting in the proper redressing of the ills that have been brought about by policies designed to disadvantage and place certain members of communities under perpetual subjugation.

To promote good performance in mathematics, true social justice should concern itself with educating learners in mathematics through instruction that should embrace the learners’ home language (Setati *et al.*, 2008). In this regard, Hlalele (2012) cites Gerwitz (1998), who maintains that social justice aims to address the discourse of disrupting and subverting arrangements that promote marginalisation and exclusion.

Adler and Sfard (2017) argue that learners and teachers of mathematics become disadvantaged when the learners’ home language is not used or allowed as an important tool for thinking and communication purposes in the classroom. The challenges that teachers and learners face when teaching and learning occur, where the medium of instruction is not the learners’ home language, are obviated by the movement between the language of learning and teaching and the learners' home language (code-switching). According to Adler and Sfard (2017), the challenge of code-switching lies in the fact that there is a lack of mathematics register in the African languages, which weakens the discussions in these classes. The researcher has observed that mathematics textbooks have not been translated into African languages, which, in particular, includes Xitsonga. There is also a lack of Xitsonga-English dictionaries dealing with mathematical concepts. This has also been observed by Bethel (2016), who has found that one of the barriers to effective teaching in mathematics relates to mathematics textbooks used in classrooms written in English, the teacher's and learners' second or third languages. This is the case in the schools where the study was conducted. Both the teachers and the learners are Xitsonga speaking and use mathematics learner teacher support materials written in English. Low levels of investment, poor physical conditions in schools, insufficient teaching and learning materials (TLMs), and shortages of well-qualified teachers, particularly in rural areas, are all challenges identified by Bethel (2016) in Sub-Saharan African countries, of which South Africa is a member.

Setati and Adler (2001) find the application of social justice in mathematics code-switching a requirement. The practice enables the learners to harness their primary language as a learning resource. Code-switching is necessary to reformulate questions or instruction, clarify concepts and facilitate communication and understanding during teaching and learning of mathematics (Setati & Adler, 2001). The researcher agrees with this view because the practice of code-switching has the added advantage of ensuring that no learner is left behind in the teaching and learning of mathematics. This view is further bolstered by Shinga-Hadebe (2019), who states that code-switching has become part of teaching and learning in those South African classrooms where second language interaction has become a barrier to effective teaching and learning across the curriculum. The researcher believes that learners' assessment in mathematics in their home language would serve a positive purpose. To this end, learners would be allowed to be assessed either in the medium of instruction or their home language. In this way, learners' understanding and enjoyment of mathematics could be developed.

The Mathematics Teaching and Learning Framework for South Africa (DBE, 2018) recognises mathematics teaching through code-switching. Mathematics teachers need to focus on mathematics, *but* this cannot be done without a language. This is a powerful and welcome statement. Research shows that it is beneficial for learners (throughout the school system) to use their home language together with English when discussing mathematical ideas. Whatever the language of expression might be, spoken language needs to be used so that learners can express their thoughts as clearly as possible. At the same time, they grapple with the mathematical concepts they are learning. The researcher has observed a major improvement in the language of learning when code-switching is employed. The use of language should not interfere with the learners' ability to speak about what they are doing and make conceptual generalisations. The practices of code-switching and (more recently) translanguaging, speak about flexible language practices. Both practices are beneficial to the teaching and learning of mathematics and contribute immensely to the understanding referred to in the framework. It is quite evident from the Mathematics Teaching and Learning Framework for South Africa (DBE, 2018) that code-switching has to play a critical role in the teaching and learning of mathematics, especially in rural areas. Setati and Adler (2001) and Hlalele (2012) evidently and strongly share this view to which the researcher subscribes.

The South African government has found social justice and distribution of school resources to be the cornerstone of equal education. The government, as a result, spends money on schools based on the socio-economic status of the schools' situation. The most poorly situated schools are given more funding as a way of addressing such imbalances. Post-1994, all public schools were ranked on a quintile poverty index. Quintile rankings 1 and 2 indicate the high poverty level, with Quintile 1 schools typically located in rural areas or informal settlements and Quintile 2 schools in urban townships. Quintile 5 shows affluence, and these schools typically serve the middle class. Quintile 1 and 2 are 'no fee' schools, with all funding coming from the state. Quintiles 3,4, and 5 schools charge fees at very different levels, with relatively high fees in Quintiles 5 schools.

The schools where the study was conducted are classified as either Quintiles 1 or 2 and receive full funding from the Department. However, the researcher considers the funding as insufficient for proper teaching and learning to occur. It is worrisome to note that Quintiles 1 and 2 perform more poorly than their counterparts in Quintile 5. Spaull (2015) states that learners' performance in Quintiles 1,2, and 3 is three grades-levels lower than the Quintile 5 learners. Observing average performance by quintile in Grade 9 shows that the difference between Quintiles 1,2, and 3 and Quintile 5 students has now grown to more than four grade levels with Grade 9 learners performing at an estimated Grade 5 level in Grade 9.

2.3 THE LEARNING THEORIES

In this section, the learning theories that underpin this study are discussed. The diagram below (Figure 2.2) reflects the learning theories which underpin this study.

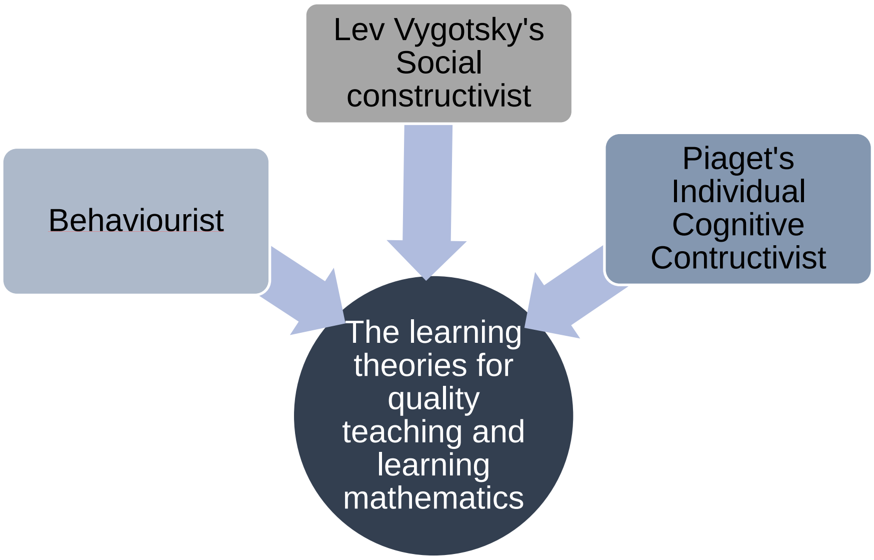


Figure 2.2: The learning theories applicable in quality teaching and learning of mathematics

The diagram above serves to help the reader understand the discussions relating to the learning theories underpinning this study. The learning theories are behaviourism and constructivism and within constructivism, Piaget's cognitive constructivist and Lev Vygotsky's social constructivist learning theories form the basis of the study.

Quality teaching and learning are required for the learners to understand the foundational theories that drive teaching, which encompasses ideas relating to how they should learn, what they should learn, and how teachers should help them. The scope includes current ideas that say that learning is a process of active construction, a social phenomenon and an individual experience (Wilson & Peterson, 2006). The learner differences, therefore, should be seen as resources rather than obstacles. This, according to the researcher, is in line with the behaviourist learning theory, cognitive constructivist learning theory and social constructivist learning theory. Wilson and Peterson (2006) refer to these theories as ideas that underlie most current perspectives and practices that speak of learning as a process of active engagement and individual, social and learner differences as resources to be used and not seen as obstacles to be confronted. Three learning theories, referred to as positions of learning and/or distinct perspectives of the learning process include behaviourism, cognitivism and constructivism (Ertmer & Newby, 2013). The researcher selected behaviourism and constructivism as the learning theories that apply to code-switching in quality teaching and learning of mathematics. Constructivism embodies two learning theories - Piaget's cognitive constructivist learning theory and Vygotsky's social constructivist learning theory.

McCain (2013) defines learning as the acquiring of knowledge through practice, training and experience. Through the process of learning, people come to discover and understand the world around them. Learning moulds, the actions and thoughts of each person. One, through learning, obtains the capabilities to understand human behaviour and development. According to Schunk (2012), learning is acquiring and modifying knowledge, skills, strategies, beliefs, attitudes and behaviours which involves cognitive learning, linguistic, motor and social skills and can take many forms. In the context of this study, the mathematics learning process refers to the process in which Grade 11 students acquire mathematical knowledge, concepts and skills in the classroom while using English First Additional Language (EFAL) as the medium of instruction and code-switching as a communicative strategy to improve the quality of mathematics teaching and learning. The Curriculum Assessment Policy Statement for Mathematics Grades 10-12 (Further Education and Training Phase) prescribes the mathematics learners' qualities. These qualities are that the learners should be able to:

1. identify and solve problems and make decisions using critical and creative thinking; work effectively as individuals and with others as members of a team.
2. organize and manage themselves and their activities responsibly and effectively; collect, analyse, organise and critically evaluate information.
3. communicate effectively using visual, symbolic, and language skills in various modes.
4. use science and technology effectively and critically showing responsibility towards the environment and the health of others; and lastly,

5. demonstrate an understanding of the world as a set of related systems by recognizing that problem-solving contexts do not exist in isolation (DBE, 2011:5).

Ertmer and Newby (2013) state that learning theories provide instructional designers with verified instructional strategies and techniques for facilitating learning and a foundation for intelligent strategy selection. They deal with what they refer to as three relevant learning positions: behavioural, cognitive, and constructivist. Powell and Kalina (2009) explain that an effective classroom is where communication between the teachers and the learners optimally depends on using constructivist strategies, tools and practices such as cognitive or individual constructivism based on Piaget's theory and social constructivism based on Vygotsky's theory, which have been selected for this study. These learning theories were preferred because the quality of the learner envisaged in mathematics teaching and learning, as listed in the previous paragraph, refers to applying the three learning theories.

The discussions hereunder revolve around the behaviourist learning theory, cognitive constructivist learning theory, and the social constructivist learning theory, which are the theories that underpin this study. The choice of the three preferred learning theories emanates from the fact that they inform how the learning process takes place in mathematics classrooms. The theories, discussed in the subsequent sections, provide a better understanding of the teaching and learning of mathematics where code-switching as a communicative strategy, is used to enhance the quality of the teaching and learning process.

2.3.1 The Behaviourist Learning Theory for quality in Mathematics Teaching and Learning

The behaviourist learning theory is discussed first with Figure 2.3 illustrating its applicability to quality teaching and learning in mathematics classrooms.

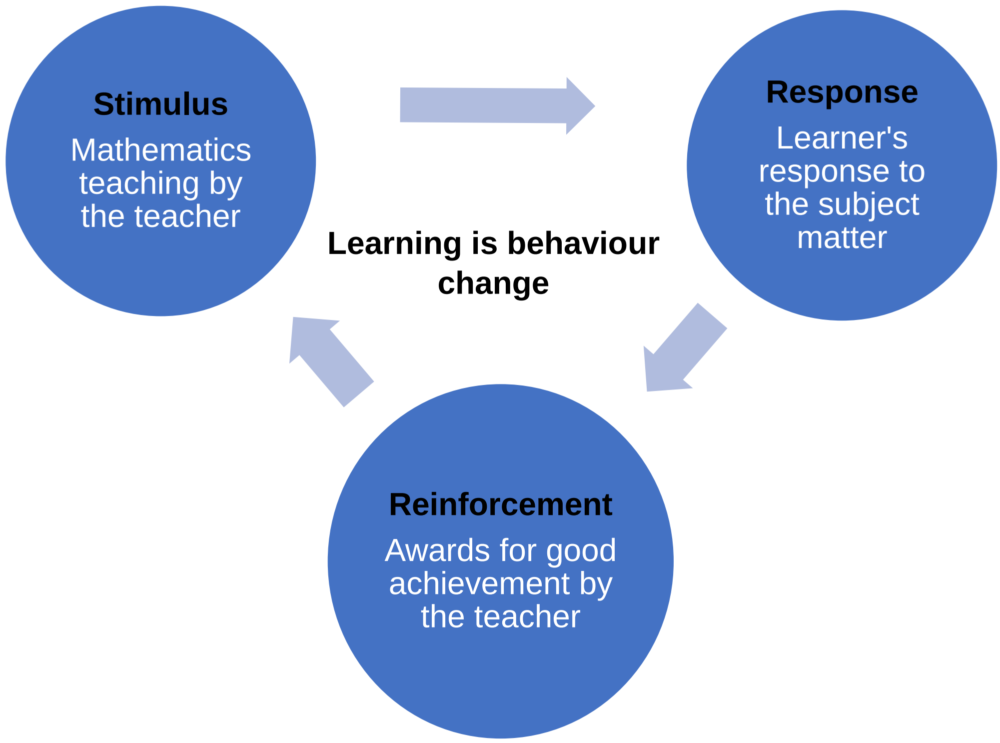


Figure 2.3: Behaviourist learning theory applied to quality teaching and learning of mathematics

Behaviourism is a teacher-centred learning process beneficial when explaining complex mathematics concepts to learners. When learners who speak an African language are taught in a foreign language, such as English in this study, they sometimes find it difficult to understand mathematical concepts. Code-switching in these instances, becomes a valuable and relevant tool. Behaviourism demonstrates that healthy environmental conditions are essential in teaching and learning (Etmer & Newby, 2006).

Cottrill (2003) regards behaviourism as a learning theory that attempts to explain learning through observable interactions of the learner within the environment, without inferring anything inside the learner. The learning theory, which attempts to apply scientific methods to the study of human learning, is based on the stimulus-response model of Skinner. Behaviourism which gave rise to the use of empirical, quantitative studies of learning, was engineered by Pavlov and later Skinner, and was prevalent from the 1950s through the 1970s (Cottril, 2003). Behaviourist theory is considered one of the traditional learning theories still applied by most teachers in the teaching and learning environment (Kashefi & Ismail, 2017). According to Zhou and Brown (2017), behaviourism is concerned with observable aspects of human behaviour. In defining behaviour, behaviourists learning theories emphasise changes in behaviour resulting from stimulus-response associations made by the learner (Zhou & Brown, 2017).

It is noteworthy that this study is based on what occurs in mathematics classrooms during the teaching and learning of mathematics. The researcher has noted that English as a medium of instruction often creates problems for the learners, some of whom are not proficient in the English language. This then makes it difficult for them to follow the lesson as the instructions are not adequately understood and carried out. Where code-switching is applied by the teacher and the learner and the teacher succeeds in getting the learner to understand and carry out the instruction, the researcher believes that the behaviourist theory achieves what the teacher is putting across to the learner.

Cherry and Gans (2019) discuss operant behaviour and positive reinforcement. Positive reinforcement involves the addition of a reinforcing stimulus following a behaviour that is more likely to recur. An example of positive reinforcement is where a learner is praised for successfully assisting other learners during mathematics teaching and learning by code-switching. Because of the language barrier, code-switching during the giving of this assistance by other learners becomes very useful (Pollard, 2002). Instructions are given to the learners by the teachers during teaching and learning. Code-switching embraces behaviourisms when the teacher commends the learner for carrying out the instruction correctly and adequately without scolding the learner for their lack of English proficiency (Maluleke, 2019).

Skinner's behaviourist learning theory regards learning as a change in the rate or frequency of occurrence or form of behaviour or response caused primarily by environmental factors (Schunk, 2012). The researcher has noted that from time to time, the order is maintained in the classroom and concepts that the learners may not have understood may have to be explained in a manner that will simplify those concepts for them. Having noted that the medium of instruction is to an extent, an impediment in the learning and teaching of mathematics, scholars have in that regard come to agree that code-switching may well be the answer (Maluleke, 2019; Selamat, 2014; Sepeng, 2013; Uys, 2010; Yusob *et al*. 2018).

Gila (1995) and Pollard (2002) outline the functions of code-switching to clarify, emphasise or repeat the main points of a lesson and create interpersonal relationships in the classroom. The researcher also observes that code-switching becomes a conduit to better understanding for learners whose mother tongue is not the medium of instruction (Gila, 1995; Uys, 2010). Code-switching, in this context, according to the researcher, improves the learning process in mathematics classrooms and the researcher encountered this in her thirty years of teaching English FAL subject in Grades 10 to 12. In certain instances, she also code-switched between English and Xitsonga to explain concepts that seemed difficult. The exercise was plausible in that the researcher succeeded in her endeavour.

Skinner, a revered theorist and the father of behaviourism, has contributed to this learning theory. His theory distinguished two different types of behaviour, namely respondent behaviour and operant behaviour. The two types of behaviour are essential in observing and measuring humans, the action of humans and the environment, and the consequences of human behaviour. McCain (2013) says that known stimuli elicit respondent behaviours and depend on the stimuli that precede them. Operant behaviours, according to him, are not initially elicited by known stimuli and are controlled by their surrounding environment, which generates specific responses. On this aspect, Skinner (2014:64-65) states:

> *It is customary to refer to the organism's movement as a 'response.' The word is borrowed from the field of reflex action and implies an act that answers a prior event – the stimulus. But we may make an event contingent upon behaviour without identifying, or identifying, a prior stimulus. We did not alter the environment of the pigeon to elicit the upward movement of the head. It is probably impossible to show that any single stimulation invariably precedes this movement. The behaviour of this sort may come under the control of stimuli, but the relation is not that of elicitation. Therefore, the term 'response' is not wholly appropriate but is so well established that we shall use it in the following discussion. A response that has already occurred cannot, of course, be predicted or controlled. We can only predict that similar responses will occur in the future. The unit of predictive science is, therefore, not a response but a class of responses* (Skinner, 2014, 64-65).

McCain (2013) observed that respondent behaviours respond to specific stimuli in the environment while operant behaviours, on the other hand, act on the environment and change it. McCain (2013) speaks of unconditioned responses as examples of respondent behaviour. This is reflexive to certain stimuli by a response that occurs without conscious thought. McCain (2013) gives examples of respondent behaviour as salivating when presented with food, blinking and flinching. He says that many common human activities are operant behaviours because operant behaviours are based on their surrounding environments, which generate consequences. McCain (2013) gives examples of walking around, clapping and turning one's head. According to him, the response is the exact time that the head turns, while the operant is the behaviour.

The researcher argues that behaviourism in mathematics classes is evident where their teachers guide learners to draft classroom rules that they must follow during teaching and learning. These rules deal with learners' behaviour. Unbecoming behaviour may attract punishment (negative reinforcement), and the drafted rules must disclose this. In aligning with positive reinforcement, most well-behaved learners are recognised and rewarded. Repeated action, verbal support and incentives are crucial to behaviourism (Zhou & Brown, 2015).

Behaviourism can help when the learners become demotivated due to communication breakdown when a foreign language is used such as English when it comes to code-switching in the classroom. Learning becomes effective when the teacher uses code-switching to motivate the learners (Wilson & Peterson, 2006). Spooner (2017) supports the view and argues that the behaviourist theory is helpful in a classroom as it brings about behaviour modification and has a beneficial role to play in the classroom.

2.3.1.1 Criticism of behaviourism in teaching and learning mathematics

It is essential to indicate that behaviourism, like any other theory, is subject to critique and the researcher discusses some of the criticisms of this theory. According to Steven-Fulbrook (2019), behaviourism is based on the idea that knowledge is independent and on the exterior of the learner. Cottril (2003) explains behaviourism as the learning process resulting from observable interactions between the learners and their environment. Therefore, the learning process does not regard the intellectual aspect of the learners, and this cannot fully benefit learners as they learn mathematics. Another challenge of behaviourism is said to be that the exclusive use of the theory would fail the proper realisation of the aims of mathematics outcomes, as outlined in the CAPS document, such as "identify and solve problems and make decisions using critical and creative thinking" (DBE, 2011:5).

Behaviourists view the teacher as the transmitter of knowledge because teaching takes place by telling (Hackman, 2004). Kashefi and Ismail (2017), as stated earlier, indicated that behaviourism leads to rote learning method. It is important to suggest that when the teacher is the only active participant in the transmission of knowledge, the learners may lose concentration and become disinterested because they are not involved in the lesson presentation. This is undeniable as the result thereof is ineffective teaching and learning (Pollard, 2002). Learners in the classrooms, to avoid the wandering of their attention, need continuous motivation and encouragement. Teachers have to create a conducive atmosphere and good relationships to achieve good performance in mathematics (Maluleke, 2019). Situations which only permit the teacher to transmit knowledge expecting the learner to absorb a predefined body of knowledge passively, may not be helpful to teaching and learning mathematics.

Schunk (2012) states that stimuli and reinforcement may explain some human learning. However, much research demonstrates that to explain knowledge, especially higher-order and complex learning, the need remains to consider people's thoughts, beliefs, and feelings. Pange, Kekka and Toki (2010) observe that behaviourists view learners as passive participants who only respond to environmental stimuli. Ameri (2020:1535-1536) states that many critics see behaviourism as "a one-dimensional approach to understanding human behaviour and that behaviourist theory does not account for free will and internal influences such as moods, thoughts, and feelings…behaviourism tends to be superficial or shallow in explaining behaviour and learning". Pange *et al.* (2010) explain that behaviourists view the teacher as an instructor who produces learning by transferring information to the learner and organises, codes and recalls the information when needed.

Situations that only allow the teacher to be the sole participant in transmitting the knowledge and leaving the learners as passive participants who only respond to environmental stimuli, are not beneficial to effective teaching and learning in mathematics. This is because learners find it difficult to concentrate and grasp what is being communicated to them by the teacher due to the language barrier when teaching and learning take place in a foreign language. Proper teaching and learning are rendered ineffective unless code-switching is permitted and adequately employed. Where learners are refused permission to code-switch during the teaching and learning process, the freedom of free participation and gaining confidence is taken away. Proper teaching and learning should take account of the moods, thoughts and feelings of the learners in the classroom. The behaviourist learning theory fails to regard this, and the learners become despondent and lose interest in mathematics. Code-switching encourages learners to participate in the classroom in a manner that brings life to teaching and learning. The transmission and the acquisition of knowledge then become realisable. Notwithstanding the criticisms, according to the researcher, the behaviourist learning theory remains helpful where it is advantageous to apply it, especially when it is used in conjunction with constructivist learning theories.

2.3.2 Constructivist Learning Theories

According to Liu and Chen (2010), constructivism is divided into cognitive constructivism and social constructivism. Constructivism was developed by several psychologists and educators, including Jerome Bruner, Jean Piaget and Lev Vygotsky. In explaining constructivism, Liu and Chen (2010) state that learning occurs when the learners construct, create, invent and develop their knowledge and meaning while being assisted by the teacher acting as the facilitator, who provides information and organises activities for learners to discover their learning. Constructivists regard the learner as an active participant in the teaching and learning process (Lerman, 1989). McLeod (2019) supports this and indicates that constructivism’s central idea is that human learning is constructed by the learners who build new knowledge upon the foundation of previous learning. Observing how teachers and students interact when code-switching is employed as a communication approach in mathematics teaching and learning, the researcher believes that learners in Grade 11 have already acquired mathematical knowledge, which serves as their prior knowledge for developing additional mathematical knowledge in their present grade. However, as learners engage in their mathematics lessons and are introduced to new topics and concepts, they often switch from English to Xitsonga, their home language, when they find the medium of instruction challenging and when they learn amongst themselves in their groups. The constructivist learning theories applicable for quality teaching and learning of mathematics are Piaget's cognitive constructivist and Vygotsky's social constructivism.

The diagram below (Figure 2.4) illustrates the constructivist learning theories that apply to quality teaching and learning of mathematics and are discussed in the sub-sequent sections.

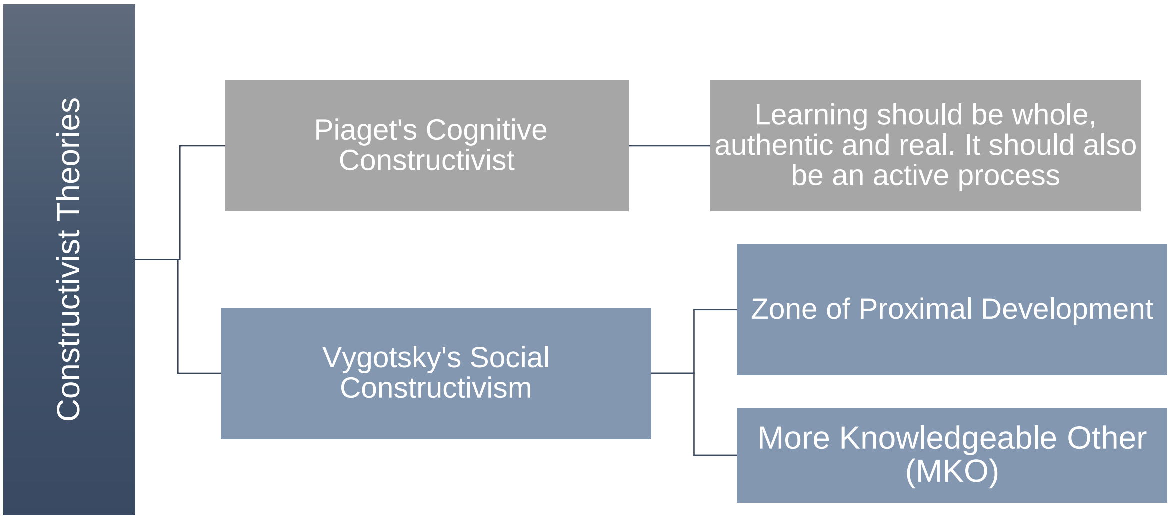


Figure 2.4: Constructivist theories applicable to quality teaching and learning

2.3.2.1 Piaget's cognitive constructivist theory for quality in mathematics teaching and learning

Cognitive constructivist learning theory was developed in the early 1900s in Germany to improve the behaviourist learning theory (Corbett 2003). According to Kashefi and Ismail (2017), cognitivism concentrates on an individual's mental processing activities such as thinking, knowing and problem-solving. Jean Piaget, a Swiss Psychologist, famous for his pioneering work on developing intelligence in children played a significant role in the fields of psychology and education. Piaget identified four stages of the person's development, namely sensory-motor stage (birth-2 years), preoperational stage (2–7 years), concrete operational stage (7-11 years) and formal operational stage (from adolescence to adulthood) (Zhou & Brown, 2017). The four stages of development mentioned above are of significance because they determine how learning will unfold, considering the developmental stage of a human being. Cognitivism is based on Piaget's theory, where learning takes place through intelligence development in mental and biological classification (McCain, 2013). In mathematics teaching and learning, the subject content is organised according to the person's cognitive development and age. This is evident in curriculum planning, where Grades 10-12 mathematics content differs developmentally from content taught in Grades 7-9.

Kashefi and Ismail (2010) state that cognitivists explain that learning occurs in four stages: how information is received, organised, stored and retrieved in the mind. Cognitive constructivist learning theory in the mathematics classroom is applicable in teaching and learning because learners must receive mathematics information, organise the information they have received, store the data and retrieve it later. For the mathematics teacher to impart mathematics knowledge to the learner, communication in the language of learning and teaching (English) must of necessity take place. When learners struggle to understand the language of learning and teaching, they also struggle to receive the information, internalise it and develop some understanding. That is where and when code-switching as a communicative strategy becomes relevant and necessary. Once the information has been duly received, the learner efficiently organises the acquired knowledge, which is successfully stored and ready for retrieval, when the learner engages in-class activities or writes homework and formal assessment.

According to Kashefi and Ismail (2017), the teacher has the responsibility to ensure that learners receive relevant information that assists them in organising and relating new information to the knowledge they previously gained and stored in their memories. The teacher must arrange suitable and effective teaching practices to assist learners in developing cognitive structure. Code-switching becomes an effective strategy for this purpose, particularly where the learners experience language problems especially when foreign language is used as a medium of instruction (Graven, 2013). The South

African curriculum aims to develop learners who identify and solve problems and make decisions using critical thinking and creative thinking (DBE, 2011). Cognitive theory is more relevant, helpful and beneficial because it forms the basis of some of the principles of the South African Curriculum, which are “high knowledge and high skills the minimum standards of knowledge and skills to be achieved at each grade are specified and set high, achievable standards in all subjects; progression: content and context of each grade show the progression from simple to complex…” (DBE, 2011:4).

As with theories there are criticisms. According to Alanazi (2016), a flaw in the Piagetian concept of constructivism is that it ignores important contextual factors in learning environments such as educational resources, the need to integrate media into learning environments, learners' preferences and affordance of individual student thinking. The researcher supports Alanazi’s (2016) view because the learners of mathematics are supposed to be critical and creative thinkers as CAPS (DBE, 2011) has prescribed. However, disadvantaged and poverty-stricken learners encounter many difficulties such as low language proficiency resulting in them having to code-switch in their classes. They are expected to use English as a medium of instruction (Uys, 2010) and engage in complex tasks and develop their critical and creative thinking abilities, which is challenging in a language in which they are not proficient. One of the functions of code-switching, as outlined by Uys (2010), is that it assists when learners wish to discuss tasks in their home language, which the researcher perceives as an opportunity for learners to ask engaging questions that develop their critical and creative thinking abilities.

According to Schunk (2012), the central theme of cognitive constructivism is the mental processing of information. Not all cognitive theories agree on those mental processes that they regard as important. Although Schunk (2012) explains that cognitive learning theories are considered essential and helpful, Alanazi (2016) argues that the theories do not capture the complexities of human learning. The researcher argues that Piaget’s cognitive constructivist learning theory has room for applying and employing code-switching in the teaching and learning of mathematics.

2.3.2.2 Social constructivist theory for quality in mathematics teaching and learning

The social constructivist theory is the main theory employed in this study. It is almost unthinkable to begin to speak about social constructivism without paying regard to Lev Vygotsky, who is seen as the father of social constructivist theory (Adam, 2017) and subsequent constructivist theories, such as socio-cultural theory based on his theory (Wilson & Peterson, 2006). When one deals with social constructivism, the starting point is that it is assumed that concepts, structures, methods, results and rules that makeup mathematics come from humankind (Ernest, 1992). In this section, Vygotsky's social constructivist theory and mathematics education are discussed together with the role of language in teaching and learning mathematics. In addition, the role of the Zone of Proximal Development (ZPD) in teaching and learning mathematics, the educational value of social constructivist learning theory as well as the criticism of social constructivism are also discussed in this study.

Akyol and Fer (2010) explain that social constructivism relates to Vygotsky's social-centred approach to knowledge construction. A learner, according to the theory, is regarded as an active participant in the learning process. According to Akyol and Fer (2010), Vygotsky perceived the social environment as a facilitator in the learner's development and learning. Parents, through language, play such an important role in transferring culture to the child and are seen as the conduits (Adam, 2017). When a child is born, the first communication between the child and the world takes place between the child and the mother (parent), where a particular language, referred to as a home language, is spoken. The home language that is acquired has culture embedded in it, and the child understands this language better. This language can successfully be used as a tool for code-switching in mathematics classrooms. From the social perspective, the learners' background and culture acquired from their homes, are key during the learning process.

Social constructivism is prevalent in the school environment where learners register for different subjects, including mathematics and teachers, some of whom are specialists in the subject, form part of the social environment characterised by active participation. In Limpopo Province, where the study was conducted, Grade 11 learners acquire knowledge through the assistance of their teachers in mathematics classrooms. The school is seen as the social environment within which teaching and learning takes place. The social aspect of learning in schools becomes evident when learners interact as peers or as groups in the classrooms. Such teams positively impact the learners' development and understanding (Wilson & Peterson, 2006). The learner's home language is a very effective tool in the classroom when code-switching as a resource of effective communication occurs as soon as the language used for teaching becomes an impediment to effective teaching and learning.

Schunk (2000) explains that social constructivism emphasises the significance of the learner's social interaction with knowledgeable members of society. Similarly, Grade 11 mathematics learners primarily rely on their teachers, whom they regard as the more knowledgeable people in mathematics. Amineh and Asl (2015) see social constructivism as a theory of knowledge in sociology and examine the knowledge and understanding of the world developed jointly by individuals. The researcher has observed that learners come to school already having acquired some mathematics concepts from their homes, for example, the principles of addition and subtraction. They already know how many members there are in the family, and they also know how many members remain in the family if some of them have paid visits to members outside their families. Learners, in this way, incorporate their prior knowledge into the knowledge they gather in their classrooms during teaching and learning. Teaching and learning, according to this theory, occur when teachers and learners are together, which demonstrates that learners are social beings (Wilson & Peterson, 2006). Knowledge acquired at home enables learners to develop more knowledge in the classrooms during teaching and learning.

Leeds-Hurwitz (2009) identifies the essential elements of the social constructivist theory, which are the assumption that human beings rationalise their experience by creating a model of the social world and how it functions, and the belief in the language as the essential system through which humans construct reality. The elements that Leeds-Hurwitz (2009) refers to are situational positions where learners visualise a world with people who have made it in life and what happens in that situation. As an analogy to this, one can think of a learner who visualises a situation where mathematics could lead them to a better position and considers language as a conduit to achieve what they visualise. According to Palincsar (1998), learning and development occur in socially and culturally shaped contexts that are not static. No universal scheme can adequately represent the dynamic interaction between external and internal aspects of development. Recent educational reform efforts encourage learners to assume a meaningful and more active role in their learning by explaining their ideas to one another, discussing disagreements and co-operating to solve complex problems that have generated contemporary interests in social constructivist perspectives.

Bay *et al.* (2012) explain that the teacher helps the learners acquire and improve top-level skills such as research and problem-solving in a social constructivist learning environment. According to Bay *et al.* (2012), meaningful learning takes place with real-life world-related authentic tasks, and where there is interaction and collaboration between the experts and the peers. In this way, learners become responsible for their learning. According to the researcher, social constructivism, seen in this perspective, is conducive to the realisation of the aims of the South African mathematics curriculum (Bay *et al.*, 2012). Social constructivist learning theory, here, clearly gives room to the application of code-switching. This occurs during mathematics teaching and learning, where language is central to the aims and objectives of the real and proper teaching and learning process. Where the language fails, code-switching should bridge the gap between the two languages so that learners acquire and develop top-level skills such as research and problem-solving. Stevens-Fulbrook (2019) explains that new ideas are constructed based on experience and knowledge that already exists. Each learner has their own experiences, which makes them unique while informing future learning.

2.3.2.3 Social constructivist perspective and the role of language for quality teaching and learning in mathematics

Ernest (1992:94) describes mathematics as “a branch of knowledge which is indissolubly connected with other knowledge, through the web of language.” This definition is in line with mathematics as a language (DBE, 2011:8). It indicates that social constructivism views language as an important resource in teaching and learning because it makes thought possible (Amineh & Asl, 2015). Language assists in human development and passes culture from one person to another. It has considerable value as it is key to social interaction. Steven-Fulbrook (2019) agrees that language is an important component of social constructivism. Botes and Mji (2010) assert that language and education are inseparable and that there is an interrelationship between them. For proper teaching and learning to occur, language is critical. Teachers ensure that relevant strategies to facilitate quality teaching and learning are developed (Botes & Mji, 2010). The problem created by lack of proficiency in the LoLT has necessitated the use of code-switching in mathematics classrooms. The learners' proficiency in English, according to the researcher, in an instance such as this, maybe such that effective teaching and learning is unachievable. Code-switching may be helpful and relevant during communication between learner and teacher and learner and learner. It must be remembered that the learner faces a mammoth task of knowing the language used for teaching and learning as well as the subject itself, namely mathematics. Botes and Mji (2008:128) support this and say that "Learners who are taught in a language that is not their mother tongue probably do not achieve academic excellence mainly because of reasons they may not have control over".

As teaching and learning occur in these mathematics classrooms, language (English) is used as the official medium of instruction. The researcher's view is that the practice of code-switching from English to Xitsonga has developed in Limpopo, where the study was conducted. This development has been brought about because there is less use of English in this particular area. The learners are thus not exposed to English. In addition, parents are poor and uneducated and are unable to encourage their children to develop their knowledge of English. The researcher observed that poverty and lack of education have resulted in the learners not knowing the resources they need to help them improve their knowledge of English. The learners appear to learn the language of teaching and learning better whenever code-switching is used. Language, therefore, becomes the tool used by both teachers and learners in the classroom to acquire mathematical knowledge. It becomes clear that, according to social constructivism, knowledge is a human development that is socially situated and constructed when people interact with one another. Thus, construction takes place when teachers guide the learners as well as when learners help one another.

As previously indicated, English as the First Additional Language is used in teaching and learning of mathematics. This means that learners need to know and understand English in order to grasp the mathematical concepts. The learners' lack of English language proficiency has prompted the use of Xitsonga, that is code-switching, as a helpful technique.

Adler (2015) states that new students to the school, may experience the challenge of having to communicate in English, especially if their home language is not English. During her years of teaching, the researcher observed that many learners face challenges when communicating with their teachers or peers, who also find it challenging to communicate in English. If learners cannot communicate in the language of teaching and learning, they will take time to understand the subject matter, resulting in them becoming despondent, losing interest in mathematics and even dropping mathematics as a subject. Adler (2015) also points out that using the learners' home language is sometimes necessary to help learners understand and enjoy mathematics. This supports the researcher's view that code-switching is the communicative strategy that can be successfully used in mathematics classrooms to bridge the gap caused by learners finding it difficult to learn mathematics in a foreign language, which aligns with Maluleke (2019).

Zevenbergen (2008) observed that working with indigenous students in Australia has been exceptionally difficult because of the tensions around the language. Negotiating mathematical meanings with limited access to the language of instruction and mathematics has been very daunting, especially when many concepts and dominant modes of teaching have little relevance, application or embeddedness in the home culture or context. The challenges and the problems encountered are caused by the different cultures which are part of the language. A way is always required to prevent and confront the challenges in the learning process. Code-switching has become more relevant, imperative and meaningful to the learners and the teachers to achieve this. Through code-switching and associations, the learners learn better and understand better what takes place in the mathematics classrooms.

South Africa is a country with diverse cultures dominated by multilingualism. It has eleven official languages: Afrikaans, English and nine African languages, isiNdebele, isiXhosa, isiZulu, Sepedi, Sesotho, Setswana, isiSwati, Tshivenda, and Xitsonga that were afforded official status in 1996 by the Constitution of the Republic of South Africa. Previously, only Afrikaans and English were official languages. The Language-in-Education Policy gives the schools the right to choose the language of teaching and learning through the School Governing Bodies. Most parents, however, prefer their children to be taught through English (Setati *et al*., 2002), as evident in the schools that participated in this study who have also adopted English as the medium of instruction for all the subjects, except Xitsonga Home Language (HL).

Ernest (1996:41-42) states,

> *Social constructivism views mathematics as a social construct. It draws on conventionalism in accepting that human language rules and agreements play a key role in establishing and justifying the truths of mathematics. The grounds for describing mathematical knowledge as a social construction and for adopting this name are threefold: The basis of mathematical knowledge is linguistic knowledge, conventions and rule, and language is a social construction; Interpersonal social processes are required to turn an individual's subjective mathematical knowledge, after publication, into accepted objective mathematical knowledge; objectivity itself will be understood to be social.*

To understand mathematics and its concepts, one first needs to accept that language, rules and agreements form the cornerstone for successfully unearthing exactly what constitutes mathematics. Language is a social construction which together with conversions and rules, enables a learner to gain mathematical knowledge. Social constructivism explains that an individual's subjective mathematical knowledge is turned into accepted objective mathematical knowledge by interpersonal social processes. Teachers who guide and direct learners through language (medium of instruction) impart the knowledge they have gained. The knowledge starts as subjective and then becomes objective. Mahofa (2014:7) states that teaching and learning processes occur in a social setting. The teacher communicates to learners, learners to the teacher, and learners to other learners, through language. Here, social constructivism is better understood because the language used is either the medium of instruction or the native or home language. Learning, therefore, occurs in the social setting of learners where learners interact with each other, with parents, community members, and with their teachers. Learners learn from more advanced peers and experts who are the teachers through the medium of language but scaffolded by the zone of proximal development.

2.3.2.4 The role of Zone of Proximal Development (ZPD) for quality teaching and learning of mathematics

One of the principles of social constructivism is the Zone of Proximal Development (ZPD) which, according to Vygotsky (1978:86), is *“the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance and in collaboration with more capable peers”.* Shabani, Khatib and Ebadi (2010:238) explain that

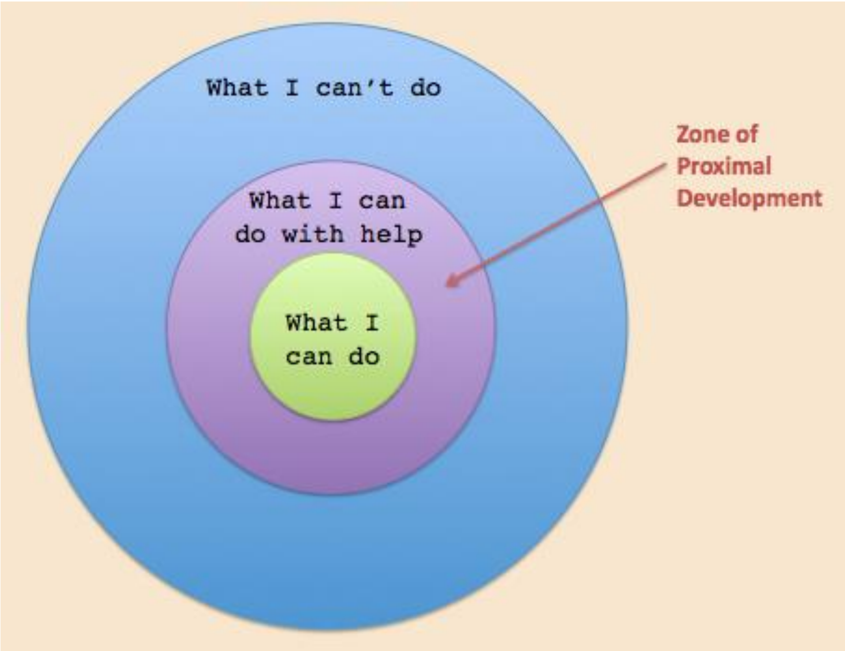
> *Vygotsky understood ZPD to describe the current or actual level of development of the learner and the next level attainable through the use of semiotic environmental tools and capable adult peer facilitation. The idea is that individuals learn best when working together with others during collaboration, and it is through such collaborative endeavours with more skilled persons that learners learn and internalize new concepts, psychological tools, and skills.*

According to Siyepu (2013), ZPD refers to the difference between mathematics tasks that the learner can do on their own and those tasks that the learner can only do with the help of others and mostly the More Knowledgeable Others (MKOs). Understanding of the concept of ZPD assists slow learners in reaching their level of potential development such as understanding certain mathematical concepts that they find difficult, through problem-solving under peer or adult guidance using their mother tongue where necessary, which is code-switching. This understanding of the ZPD enhances quality in the teaching and learning of mathematics, assuming that teachers are more knowledgeable and can scaffold learners in gaining the knowledge and proper understanding of mathematics. Palincsar (2015:352) explains that the introduction of ZPD was influenced by Vygotsky’s idea that learning should be matched in some manner with the child’s level of development. The researcher subscribes to this view and observes that the mathematics curriculum is designed according to the learners’ level of development, as demonstrated in the Curriculum Assessment Policy Statement for Mathematics Grades 10-12, but each new concept is introduced and scaffolded by teachers as more knowledgeable others.

According to Amineh (2015), social constructivism assumes that cognitive growth occurs on a social level and later on an individual level which emphasises the role of the ZPD. In drawing on the theory of social constructivism, teachers provide support and help for the learners but gradually withdraw to allow the learners to work independently. Learners in social constructivist classrooms are active participants. The created environment is democratic, with interaction playing a crucial role in the learning process (Gray, 1997) where collaboration is through language. The More Knowledgeable Others (MKOs) in the social constructivist theories are the teachers who communicate ideas to the learners to understand the subject matter but scaffold their learning. As the learners understand the subject matter, they also internalise their understanding of their world. This means they work within the ZPD, which according to Hudson (2013), is often referred to as the optimal learning zone or the gap between what learners know and what they can achieve given appropriate and pedagogically sound guidance and educational support. Each learner is unique in multiple and different zones depending on the content and the individual's prior knowledge and interests as well as their language proficiency.

> *From the Vygotskyan perspective, the use of the first language is to mediate the interactions between learners (inter-psychological) and within learners (intra-psychological). Intra-psychology refers to the private speech directed to the learner himself, which regulates their learning cognition. Inter-psychological refers to the first language's function as a peer support resource that enables learners to provide assistance within their Zone of Proximal Development.* (Antón & DiCamilla, 1999, as cited in Selamat, 2014:29).

Hudson (2013) recognises the difficulties when considering the different learning spaces, habits of mind and prior knowledge of individual learners in mathematics. According to Hudson (2013), the ZPD connects unlearned material to teachers playing a pivotal role in its application in the classroom. Teachers provide appropriate scaffolding, strategic social interactions, learning experiences and instruction based on a learners' past performance, intuition and current thinking to guide effective learning and development. In light of what scholars (Amineh, 2015; Hudson, 2013; Palincsar, 2015; Siyepu, 2013; Vygosky,1978) have to say about ZPD, MKO and scaffolding, it is clear that social constructivism underpins this research, and that adequately considered and applied code-switching is also relevant and applicable to this research, as indicated in Figure 2.2.



Source: http://www.instructionaldesign.org/theories/social-development.html

Figure 2.5: The Zone of Proximal Development in mathematics

The inner circle represents mathematical tasks the learner can do on his own in Grade 11 based on the prior knowledge gained in the previous grades, including the use of English in learning mathematics. The middle circle, regarded as the Zone of Proximal Development, represents those mathematical tasks that the Grade 11 learner can do scaffolded by the teacher's assistance and the MKOs, who could be peers in the class. The learners can solve mathematical problems with the teacher's help and work towards areas that they cannot do. However, because learners may find difficulty understanding certain concepts in English as the LoLT, the teacher may code-switch and use the learners' home language to develop a greater understanding. In addition, learners who have grasped the concept being taught, may also assist those who are still struggling to understand the subject matter. This means that code-switching will be used differently in these classes but become predominant in the outer circle where the learners struggle with tasks they cannot do. With scaffolding by their teachers and peers and code-switching, learners will find themselves adequately accommodated in the lessons by communicating freely, which enables them to develop greater understanding of the complex tasks.

2.3.2.5 The educational value of social constructivist theory in this study

This study is based on the social constructivist learning theory, supported by the social justice theory, the behaviourist learning theory and the cognitivist learning theory. The social constructivist theory is more aligned with the aims and realisation of the mathematics curriculum as outlined in the CAPS document (DBE, 2011:5). Both Adam (2017) and Ernest (1992) support this, stating that the social-cultural approach to teaching is mainly used in mathematics, science and language, which attests to the recognised impact of social-environmental learning.

The Department of Basic Education (2018) has developed a framework for mathematics teaching and learning aimed at teaching mathematics for understanding. One of the dimensions is a learning-centred classroom which refers to the learning environment conducive to learning. The Department of Basic Education (2018) explains that the learning environment should depict the teacher who uses teaching strategies most suitable for a specific lesson by designing relevant learning experiences for the learners. The reading and interpretation of this statement includes code-switching as one of the communicative strategies that can be employed in teaching and learning mathematics in the classrooms to enhance the quality of teaching and learning.

The researcher argues that for quality teaching and learning, code-switching should be employed in the teaching and learning of mathematics in the classroom in most South African schools. Linked to language is the application of social constructivist characteristics that are beneficial in teaching and learning mathematics. These characteristics include:

1. the learning of mathematics is based on social construction according to social constructivist theory.
2. learners develop their thinking through language during an interactive communication in a collaborative learning environment and vice versa (Akyol & Fer, 2010);
3. learner construction of knowledge is the product of social interaction, interpretation and understanding.

4. language is the most important tool for the acquisition of knowledge where there is a development from social speech to private speech.
5. peer collaboration is viewed as the shared social interaction where learners work on tasks collaboratively which can be seen when learners perform group tasks (Kapur, 2018).
6. learners are active co-constructers of meaning and knowledge (Adam, 2006:6) and that
7. the enhancement of social and interpersonal skills assists in the establishment of effective means of communication with the outside world (Kapur, 2018);

Learning has become a successful social environment in which teachers and learners collaborate in finding meaningful learning through code-switching when challenges of the use of English are experienced. The recognition of social constructivism in the teaching and learning of mathematics contribute to the active construction of knowledge through code-switching. The uniqueness of the learners and their differences serve as resources and not obstacles (Wilson & Peterson, 2006). Finally, the effective use of code-switching as a communicative strategy in mathematics classes results in quality teaching and learning, which, in turn, produces better performance in mathematics as a subject.

2.3.2.6 Criticism of social constructivism for quality teaching and learning of mathematics

Zhou and Brown (2017:36-37) observe that Vygotsky's writings were criticised during his lifetime and after death. It is said that Vygotsky did not do empirical work to validate his findings and that he merely relied on observation and testing. He is said not to have identified the types of social interaction that are best for learning. According to the researcher, the findings of this study will reveal how the social constructivist theory can be fully applied in mathematics classrooms. The theory's concepts have been carefully examined to evaluate how successful and relevant this approach may be utilised to improve the quality of teaching a subject by interacting with participants on the code-switching phenomenon.

Some critics argue that learning is not always the result of the active construction of knowledge as it can also take place passively or osmotically (Zhou & Brown, 2017). Some children, it is said, may develop at a slower rate, thereby suggesting that other factors such as genetics may play a role. It is indicated that psychologists refute the idea that cultural influences play a dominant role in developing a language. Despite criticism that learning is not always the product of active knowledge creation, the researcher contends and maintains that learning occurs when learners are actively involved in the process, regardless of whether they are slow or quick in their information acquisition. They work and perform at their pace under the direction of their teachers and by engaging with one another in the classroom. The table below summaries the ideas that drive this study and their relevance to the classroom and the research itself, as provided by the researcher.

Table 2.1: The theoretical framework for quality teaching and learning of mathematics

THE THEORETICAL FRAMEWORK FOR QUALITY TEACHING AND LEARNING OF MATHEMATICS			
THEORY	**PRINCIPLES**	**RELEVANCE TO THE CLASSROOM**	**RELEVANCE TO THE RESEARCH**
Social Justice Theory	Children are afforded equal opportunities to learn and to grow within educational institutions. Gender, social class, economic background, level of intelligence, and ability should not be the source of hindrance to their acquiring of knowledge.	Assists mathematics teachers in treating all the learners equally, having the potential to learn mathematics irrespective of gender, social class, and race.	The theory assists in ensuring that all participants are treated equally and have valuable potential to contribute to the study.
Behaviourist Learning Theory BF Skinner (1904-1990)	Based on the stimulus-response model of Skinner. Explains mathematics learning aided by observable interactions of the learner and the teacher within the school environment	Shows the researcher how discipline is managed in the mathematics classrooms during teaching and learning where code-switching cannot be avoided. Code-switching is the communicative strategy that enhances the quality of teaching and learning in mathematics.	The interview guide brings out the relevance of behaviourism during interview sessions.

THE THEORETICAL FRAMEWORK FOR QUALITY TEACHING AND LEARNING OF MATHEMATICS			
THEORY	**PRINCIPLES**	**RELEVANCE TO THE CLASSROOM**	**RELEVANCE TO THE RESEARCH**
Piaget's Cognitivist Constructivist Learning Theory Jean Piaget (1896-1980)	Concerns itself with students processing information through finding new explanations or adapting old ones. Prior knowledge is key. It also deals with how information is received, organised, stored, and retrieved by the mind.	Mathematics teaching and learning involves problem-solving. Thus, the theory assists the researcher and the mathematics teachers in understanding how the learners acquire knowledge. Learners bring into their classroom prior knowledge, which assists them in understanding the new subject matter.	The researcher receives information during interview sessions. The information received from the participants (data) is organized, analysed, and interpreted later.
Social Constructivist Theory Lev Vygotsky (1896-1934)	Complements behaviourism and cognitivism during mathematics teaching and learning, thus contributing to all learners' active participation.	The theory helps the researcher to understand that teachers and learners interact in the mathematics classroom because they are social beings who are actively involved and often communicate through code-switching.	The participants and the researcher interact during interview sessions, and social constructivism assists in active participation during data collection.

2.4 CHAPTER SUMMARY

Chapter 2 has given a detailed discussion of the theories related to mathematics teaching and learning. These theories include social justice theory, behaviourist learning theory, cognitive constructivist learning theory and social constructivist theory. The theories were discussed based on their value in the study.

Social justice theory highlighted how mathematics teaching and learning is supposed to benefit all the learners in South Africa irrespective of their background, gender or race. In this study social justice became relevant because some Grade11 mathematics learners struggle to understand complex mathematical concepts which are taught in English resulting in the employment of this practice to enable them to understand and perform better in the subject. Behaviourist theory relates to how mathematics teachers use the theory to manage their classrooms as a way of improving learner behaviour in those classrooms. This bolsters the proper management of the learners in the classrooms as a way of improving learner behaviour in those classrooms. This is achieved by effective employment of code-switching. Piaget's cognitive constructivist learning theory for quality in mathematics teaching and learning focusses on the type of the subject content to be presented to the learners which should be in accordance with their level of development.

Lastly, the researcher detailed the discussion of the social constructivist learning theory, which is the main theory that underpins this study. The theory is applicable when learners are taught through the language that enables them to comprehend the subject matter. The Zone of Proximal Development assists the learners to know what they themselves can do, what they can only do assisted by the others and what they cannot do. It is important to indicate that the theories discussed in this chapter support social constructivism in this study and serve as the basis for developing the framework for code-switching as a communicative strategy that enhances quality in mathematics teaching and learning.

Chapter three reviews the literature providing a more detailed description of the concept of code-switching as a communicative strategy that enhances quality teaching in mathematics teaching and learning.

CHAPTER 3

LITERATURE REVIEW

3.1 INTRODUCTION

The literature review is the process of establishing what is known about a subject area and, by association, what is not yet known (Arshed & Danson, 2015), a process as central to the skill for students, researchers, and practicing managers. In academic circles, the process is referred to as reviewing the literature, which allows one to understand the current state in a subject area and relate it to the ongoing research and identify gaps in the knowledge. In Chapter 3, the literature on code-switching in teaching and learning mathematics is reviewed.

Chapter 3 begins with a discussion on code-switching in a number of countries. This is followed by a discussion on learners' performance in mathematics, taking note of national and international studies. The sub-sequent sections look at causes of poor mathematics performance, followed by the value of mathematics in society. English First Additional Language (FAL), the language of teaching and learning mathematics, is then discussed. Literature on code-switching as a communicative strategy that enhances quality in the teaching and learning of mathematics is reviewed followed by a detailed discussion of code-switching with special reference to the relevance of code-switching, the effectiveness, and the challenges and benefits of code-switching in teaching and learning mathematics.

3.2 OVERVIEW OF COUNTRIES INVOLVED IN THE DISCUSSION ON CODE-SWITCHING

This section presents a review of code-switching practised in Australia, Malaysia, Nigeria and South Africa, which is key in the discussion and which concerns the different languages spoken in those countries and the occurrence of code-switching. These countries share common aspects relating to the language of teaching and learning, school location in urban and rural settings, cultural diversity and Indigenous languages. The overview of code-switching in those countries starts with identifying the languages spoken with special reference to the medium of instruction used.

3.2.1 Australia

According to the Australian Bureau of Statistics, in June 2020, Australia had a population of 25 687 041. Clarkson (2007) describes Australia as a land of many languages, their official and dominant language being Australian English. There are many other dominant languages that are used as Australians go about their daily businesses. Clarkson (2007) has noted that in the late 1980s, 14% of the population of 16 million people spoke languages other than English in their homes.

Cahyani, De Courcy and Barnett (2016) reported on teachers using code-switching, which they regard as an important factor in achieving dual goals of content learning and language learning in bilingual programmes. Cahyani *et al.* (2016) regard teachers' code-switching as translanguaging because it is an intentional strategy employed in teaching in bilingual classrooms by integrating two languages to achieve better communication and participation in learning.

3.2.2 Malaysia

Thien (2016) cites the Department of Statistics, which reveals that Malaysia is a multi-cultural country with a population of 31 million. It has five levels of the education system: (1) pre-school education, (2) primary education, (3) secondary education, (4) post-secondary education and (5) tertiary education. According to David, Kuang and Dealwis (2018), Malaysia is a developing country, made up of Peninsular Malaysia and East Malaysia. It is a multi-ethnic state made up of Malays (50%), Chinese (25%), Indians, particularly Tamil (10%), and 15% indigenous people. The native languages spoken in Malaysia include Malay, Mandarin, Tamil, and many languages spoken by indigenous groups (146 different historically spoken languages). Although Malay is the official language in Malaysia, English which bears no official status, is an important second language. It is noteworthy that English is the language of business, international trade and diplomacy.

Ting (2002 cited in Selamat, 2014), states that in multilingual communities like Malaysia, code-switching is a widespread phenomenon that extends from daily life and workplaces to classrooms where specific languages have been instituted as the language of instruction. Low (2016) notes that code-switching is practised in Malaysia and that this takes place during teaching and learning when there is a sudden switch from the medium of instruction to the learners' home language and vice versa. Low (2016) further observes that code-switching in English medium classes provides strategic and valuable functions for classroom management and transmission of content knowledge. According to Low (2016), the learners are very receptive to classroom code-switching, which they regard as improving their language skills, adding to the importance of code-switching in the teaching and learning process, and contributing to better understanding (Lim & Presmeg, 2011).

3.2.3 Nigeria

According to the United Nations Data, the population in Nigeria, as of 7 March 2021, is 206 139 589. Ugwu (2020) states that Nigeria is a highly multilingual nation with 515 living languages, 505 of which are indigenous, while 10 are non-indigenous (Ugwu, 2020 citing Simons and Charles (2018). There are three major languages, namely, Hausa, Igbo and Yoruba. However, English serves both as a national and sole language because it has the highest number of speakers than any other language. According to Ugwu (2020), in many Nigerian homes, especially the educated elites in the cities, English has become the language of daily communication, which is promoted in education more than any Nigerian language serving as the medium of instruction from upper primary school to the tertiary levels of education.

Adedun and Shodipe (2011), dealing with Yoruba-English bilingualism in central Lagos Nigeria, observed that code-switching as a phenomenon worldwide, has received hostile perception and has sometimes been rejected as a hybrid degenerate form of communication which is seen as a mark of incompetence at different levels of usage. This notwithstanding, Jegede (2011) explains that code-switching is practised in teaching and learning mathematics in the primary schools of Nigeria. The National Policy on Education (NPE) (2004) in Nigeria prescribes the mother tongue or the language of the immediate community as a medium of instruction at pre-primary and primary levels of education. English only becomes a medium of instruction later at primary school level (Jegede, 2011). Incompetency in the medium of instruction in the upper classes of public primary schools in Nigeria has resulted in the employment of the learner’s home language (Jegede, 2011), an issue also reported by Alexander, (2018) where the medium of instruction is not the learners’ home language which is seen as a problem in Nigeria when it comes to the teaching and learning of mathematics.

3.2.4 South Africa

Statistics South Africa (Stats SA) (2020) gives the estimated 2020 mid-year population at 59,62 million. The country is divided into nine provinces: Gauteng, Kwa Zulu-Natal, Western Cape, Eastern Cape, Limpopo, Mpumalanga, North West, Free State, and Northern Cape. As recorded by Stats SA, the population groups found in South Africa are Black African (80,8%), Coloured (8.8%), Indian/Asian (2.6%) and White (7.8%). Alexander (2018) records the following official and spoken languages recognised by the Constitution of the Republic of South Africa: Afrikaans, English, isiNdebele, isiXhosa, isiZulu. Sepedi, Sesotho, Setswana, siSwati, Tshivenda and Xitsonga, all recognised in Section 6 (1) of Act 108 of 1996 of the Constitution, as official languages. Alexander (2018) reports that South Africa's official languages were European languages for centuries, namely Dutch, English, and Afrikaans. He states that African languages were ignored until 1996, when the Constitution of the Republic of South Africa embraced them. In addition, Section 6 (5) of Act 108 of 1996 has tasked the Pan South African Language Board established by National Legislation to promote and create conditions for the development and use of (i) all official languages, (ii) the Khoi, Nama, San languages and (iii) sign language.

Howie (2003) explains that although English in South Africa is spoken as a first language by less than ten percent of the population and that it is the language of business and government, the language together with Afrikaans, is used as a medium of instruction at schools. During the Foundation Phase, comprising Grades 1-3, learners are taught in their home language but switch to English or Afrikaans in Grade 4, where either these two languages become the LOLT, as decided by the SGB (Van der Berg *et al.,* 2011; Wildsmith-Cromarty & Balfour, 2019). The South African language policy allows schools to choose a language of teaching and learning (LOLT). Most schools choose either English or Afrikaans and not an African language spoken in the area. African languages are merely taught as subjects and rarely used as the medium of instruction (Kretzer & Kaschula, 2019).

Kretzer and Kaschula (2019) report that it is not uncommon when stepping into a classroom in Limpopo province, to find a teacher code-switching from one language to another from English to an African language (learners' home language) and vice versa as learners are not proficient in English. Van der Berg *et al.* (2011) confirm this.

Howie (2003) notes that the most significant factor in learning science and mathematics ties up with whether or not the learners are fluent in English. The learning outcomes in this regard are affected and driven by learning factors. Learners whose home language is not English and are not frequently exposed to English outside of the classroom, are at a serious disadvantage, resulting in the need for code-switching (Fleisch, 2008) as learner performance in mathematics is influenced by the language of learning and teaching.

3.3 LEARNER PERFORMANCE IN MATHEMATICS IN SOUTH AFRICA

Lazarus (2020) explains performance in learning as the attainment of a particular goal based on pre-set standards of accuracy, completeness, cost and speed. Performance, therefore, is two-fold in that it can either be positive (good) or negative (bad). Good performance is a performance that meets all set requirements or standards. Put differently, a learner who has performed well is a learner who has accomplished that which the teacher (examiner) expected them to achieve based on the examination. Poor performance, therefore, will be the direct opposite of good performance. Here, the learner fails to achieve the goal that is set by the teacher (examiner). Seen in this light, good performance has its benefits, such as opening doors for the learners who can gain recognition, admission and assistance at institutions of higher learning. This is how careers are aspired for, pursued and obtained.

The Department of Basic Education (2011) explains that recording and reporting is a process in which the teacher can document learner performance in a specific task. Learner performance is communicated to learners, parents, schools and other stakeholders through the seven levels of competence described for each subject listed for Grades R-12. The table below highlights the seven-point scale and descriptors for learner performance in South African schools.

Table 3.2: Determining learner performance in mathematics in South Africa

Rating Code	Description of Competence	Percentage
7	Outstanding achievement	80-100
6	Meritorious achievement	70-79
5	Substantial achievement	60-69
4	Adequate achievement	50-59
3	Moderate achievement	40-49
2	Elementary achievement	30-39
1	Not achieved	0-29

Source: Adapted from Mathematics Curriculum and Assessment Policy Statement Grades 10-12

According to the performance scale above, good performance refers to the learner who has obtained adequate achievement (50-59), substantial achievement (60-69), meritorious achievement (70-79), or outstanding achievement referred to as a pass with distinction (80-100). The higher the pass percentage rate, the bigger the chance of admission at institutions of higher learning, which is the next phase of academic learning in South Africa. The Department of Basic Education Annual Performance Plan 2020/2021 confirms this, stating, “In the case of mathematics, this 50% threshold is the lowest threshold applied for entry into mathematically-orientated university programmes such as accounting and economics” (DBE, 2020:32).

Assessment is the process that determines the quality and the occurrence of the learning process in South Africa as informed by the policy documents of the Department of Education, the South African Qualifications Authority Act (SAQA), the Independent Quality Assurance Agency (IQAA) and Umalusi (Brown, 2011). The aim of the assessment is dual in that it determines the extent to which learning has taken place and informs the teaching and learning process. Whether learners have adequately achieved in mathematics depends on the assessment conducted to discover how they have achieved. The World Data (2010/11) identifies three international studies that assess mathematics performance: Monitoring Learning Achievement (MLA) Project, Trends in International Mathematics and Science Study

(TIMSS) and Southern Africa Consortium for Monitoring Educational Quality (SACMEQ). Coe, Aloisi, Higgins and Major (2014) explain that effective teaching involves an activity that leads to improved outcomes that matter to the future success of the prospective learners and to judge whether or not teaching is effective. The national and international studies mentioned above demonstrate that the South African Department of Basic Education uses assessment as a critical yardstick for determining whether or not the country is engaged in ensuring that its learning population is given quality education comparable globally. Hereunder is the discussion on national and international assessments of mathematics performance in South Africa.

3.3.1 Annual National Assessments (ANAs)

In 2011, the Annual National Assessments (ANAs) were introduced by the Department of Basic Education for Grades 1 to 6 and 9 (Van Staden, 2017). The Annual National Assessment constitutes nationally standardised assessments that measure learners' knowledge and skills from the teaching and learning process based on the mathematics and languages curriculum (Van Staden, 2017). Table 3.1 presents the average marks for mathematics for all grades.

Table 2.3: National average percentage marks for mathematics

GRADE	MATHEMATICS AVERAGE PERCENTAGE MARK		
	2012	2013	2014
1	68	60	68
2	57	59	62
3	41	53	56
4	37	37	37
5	30	33	37
6	27	39	43
9	13	14	11

Source: Report on the Annual National Assessment of 2014, Grades 1 to 6 and 9

Table 3.2 presents the percentage of learners in Grade 3, 6 and 9 who achieved over 50%

Table 3.4: Percentage of learners achieving 50% or more

GRADE	PERCENTAGE OF THE LEARNERS ACHIEVING 50% OR MORE		
	2012	**2013**	**2014**
3	36	59	65
6	11	27	35
9	2	2	3

Source: Report on the Annual National Assessment of 2014, Grades 1 to 6 and 9

In 2012, it was reported that only 36%, 11% and 2% of learners achieved 50% or more in Grades 3, 6 and 9 respectively in mathematics. In 2013 and 2014, there was a marked increase in the results for Grades 3 and 6. Of relevance to this study are the result for Grade 9 where only 2% of learners achieved 50% and more. In order for teachers to ensure good results in the National Senior Certificate (NSC), they are expected to make up for large deficits in knowledge and skills through Grades 10 and 11.

The Annual National Assessments in South Africa have been discontinued. The teacher unions perceived them as over testing the learners and would be replaced by the National Integrated Assessment Framework scheduled for commencement in 2018 and conducted in a three-year cycle for Grades 3, 6, and 9 (Juan, Reddy & Arends, 2019). The Official Guide to South African Education (2017/18:5) confirms saying: “The Annual National Assessments, and the department’s diagnostic of teaching and learning in the Foundation and Intermediate phases of schooling, have been discontinued and were replaced by the National Integrated Assessment Framework (NIAF) in 2018”.

3.3.2 Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ)

The Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ), a consortium of education ministries, policy-makers, and researchers, in conjunction with United Nations Education Scientific and Cultural Organization’s (UNESCO) International Institute for Educational Planning (IIEP), play a key role in the improvement of the research capacity and technical skills of educational planners in participating countries in Africa (Spaull, 2015).

Table 3.5: Overall achievement trends of Grade 6 learners in Mathematics

SACMEQ II	SACMEQ III	SACMEQ IV
486	495	552

Source: The SACMEQ IV Project in South Africa: A Study of the Conditions of Schooling and the Quality of Education (2017:27)

South African Grade 6 learners achieved 552 Rasch Scores in Mathematics in SACMEQ IV which is above the Mean SACMEQ score of 500. This is an upward trend as compared to SACMEQ II and SACMEQ III with 486 and 495 respectively. According to SACMEQ IV (2017) South Africa's overall performance in mathematics. shows an upward trend with higher improvements in mathematics. This, according to the report, is attributable to the streaming and strengthening of the National Curriculum between SACMEQ III and SACMEQ IV; the focus on monitoring teaching and learning through the National Strategy for Learner Attainment and regular exposure to standardised assessments through the Annual National Assessments (ANAs).

3.3.3 The Trends in International Mathematics Sciences Study (TIMSS)

TIMSS, an international study developed by the International Association for the Evaluation of Educational Achievement (IIEA), tests the mathematics knowledge of Grade 8 learners comparably across sixty countries over time (Mullis, Martin, Foy & Drucker, 2012). TIMSS, a four-year cycle process, was administered for the first time in South Africa in 1995. It was administered again in 1999, 2003, 2007, 2011, and 2015. In 2015, focusing on Grade 9 learners, TIMSS covered fifty-nine countries and nations and 425 000 students. The importance of mathematics as a subject for social and economic development through assessing the health of education systems has been the main focus of TIMSS in South Africa and the world (Reddy *et al.*, 2015). The results of three cycles of TIMSS results are presented in Table 3.4.

Table 3.6: Mathematics performance of Grades 5 and 9 South African learners

GRADE	2003	2011	2015	2019
5	-	-	376 (3.4)	374 (3.6)
9	285 (4.2)	352 (2.5)	372 (2.5)	389 (2.3)

Sources: Isdale *et al*. (2017); Reddy *et al*. (2020); Zuze *et al*. (2017)

South Africa is one of the lowest-performing countries in mathematics compared with the other participating countries. This has been confirmed by Howie (2003), Reddy (2006), and Van Staden (2017) who observed that South African learners perform poorly in mathematics in comparison with other participating countries. The national average falls short of the lowest international benchmark. Three in five South African learners (61%) do not reach the minimum competencies in basic mathematical knowledge required at the required Grade 5 level.

The results of learners' performance, which is below the center point of 500, in all three cycles, raised a concern regarding the quality of education in the country. The learners' performance is related to their lack of higher order thinking skills. It is accepted that learners in most South African public schools perform poorly in mathematics which sparked debates relating to the causes of such poor performance. Letaba (2017) specifically states that the release of the 2015 TIMSS reports for grades 5 and 9 has again generated debates relating to the problem as South Africa grapples with the reasons that result in mathematics performance. Letaba (2017) attributes poor mathematics performance to factors related to home, school and the community environments.

The following observations have been made about South African learners, based on both local and international standards: if a learner's language of teaching and learning corresponds to the learner's native language (home language), a positive relationship with performance is observed, especially in intensive language subjects like mathematics (Reddy *et al.,* 2015), learners' performance in mathematics is poor, the progress that has been noticeable over the last twenty years is steady but slow, and finally, mathematics achievement across the country is unequal and socially graded (Reddy *et al.*, 2016).

Using the TIMSS results, there is a noticeable difference between South African learner performance and other countries in mathematics. For example, Anderson *et al.* (2007) report that Australian learner performance was higher than South African learner performance, according to the TIMSS 2003 report, which was significantly below that of the 46 participating countries.

3.3.4 The Programme for International Students Assessment (PISA)

PISA is an international, standardised assessment of the performance of 15-year-old students in mathematics, science, and reading developed by the Organisation for Economic Co-operation and Development (OECD) (Perry & McConney, 2010). It is administered in a three-year schedule which began in 2000 with a focus on reading, followed in 2003 with a focus on mathematics, and in 2006 with a focus on science. Although South Africa has not participated in this assessment result, Australia and Malaysia can be reported.

The PISA results indicate a decline in Australian students' mathematical literacy with Australia being outperformed by countries such as China, Singapore, and others in this regard (Reid, 2019). According to Smith, Ladewig and Prinsley (2018), the state of mathematics in Australian schools has concerned parents, educators, industry groups and governments. There are questions as to why a prosperous country like Australia, which ranks second on the UN Human Development Index, is falling behind in global education rankings. According to these scholars, Australia's mathematics performance has either stalled or declined in the National Assessment Program-Literacy, and Numeracy (NAPLAN), the Trends in International Mathematics and Science Study (TIMSS), and the Programme for International Student Assessment (PISA) while government funding per student has increased.

Thien (2016) observes that there is a significant improvement in Malaysia according to the three major national assessments: (1) Primary School Evaluation Test; (2) Lower Secondary Assessment; and (3) Malaysian Certificate of Education. The national assessments have shown steady improvement in students' academic achievement. However, the differences in gender, socio-economic status, and school location have left the narrowed achievement gaps intact. Malaysian results from PISA 2018, indicated that the learners scored lower than the OECD average in reading, mathematics, and science.

3.4 CAUSES OF POOR MATHEMATICS PERFORMANCE

After discussing mathematics performance, it becomes necessary to deal with what causes the learners to perform poorly in mathematics. Several reasons account for poor performance in mathematics by learners, and these reasons vary. It is interesting to note that countries, in many instances, share common experiences concerning the causes of poor performance in mathematics, as evident in this discussion on causes found in Australia, Malaysia, Nigeria and South Africa.

3.4.1 Causes of poor mathematics performance in Australia

Language and socio-economic status have played a significant role in mathematics performance (Thomson, Wernert, Rodrigues & O'Grady, 2020). Nierche (2009) after noting that language is one of the causes of poor performance in mathematics in Australia, has argued for the use of the learners' home language in mathematics classrooms. He suggests that language features as an important factor in the learning and teaching of mathematics for the purpose of bringing about meaning, emphasis should be place on the use of home languages which he sees as a valuable resource. This means that language features as an important factor in teaching and learning mathematics.

3.4.2 Causes of poor Mathematics Performance in Malaysia

Malaysian students' achievement in mathematics does not appear to have reached the expectations of educators and society in general (Ting & Tarmizi, 2016). TIMSS 2015 reveals that Malaysian students scored poorly in mathematics with rural students lagging behind their urban counterparts in both primary and secondary schools. Cox (2000) observed that weak academic achievement has to do with learning cultures, deprived backgrounds, and shortage of teachers with teacher support being a critical element contributing to a successful school.

Code-switching, employed to enhance teaching and learning in mathematics and other science classrooms (Low, 2016), is widespread and found particularly in multilingual post-colonial societies such as Malaysia. Tan (2011) claims that learners' inability to express themselves in English has a negative impact on their examination performance. Malaysia, a former British colony, switched its medium of instruction from Bahasa Malaysia, its national language, to English in 2003 to promote learners' mathematics and science learning while increasing English proficiency. However, language features as an important factor in teaching and learning mathematics.

3.4.3 Causes of poor Mathematics Performance in Nigeria

Socio-economic status and language have played a role in poor mathematics performance in Nigeria (Umugiraneza, Bansilal & North, 2018). In addition, Umugiraneza *et al*. (2018) have observed that learner confidence in mathematics, gender, experience of bullying, frequency of absence from school, education levels of parents, and home resources have been key to poor performance in mathematics. They also observed that school location and school safety, limited resources such as school furniture, telephones, photocopiers, learner resource materials, electricity, water ablution facilities and audio-visual equipment have also had their fair share in poor performance in mathematics.

Alordiah, Akpadaka and Oviogbodu (2015) specifically dealt with situations where learners attend rural schools. There, they argue, learners and their parents are poverty-stricken compared to their counterparts in urban schools. They established that English, the language of tests, is not widely spoken in rural schools where the native language is mostly used. This badly affects the rural learner. Owoeye (2002) found that urban learners performed far better than rural students in every form of achievement test used. Once again, language features as an important factor in teaching and learning mathematics. This equally applies to the South African situation where the language impedes good performance in mathematics.

3.4.4 Causes of poor Mathematics Performance in South Africa

Language and socio-economic status have been identified as major factors in either poor performance or good performance (Visser *et al.,* 2015). Learners from higher socio-economic backgrounds who speak the language of the test (English) in their homes with at least one parent who had passed Grade 12, perform better in mathematics (Reddy *et al.,* 2019). This implies that the learners who live with uneducated parents or people experience challenges when it comes to the issue of language. They can neither get assistance from the parents nor other people in so far as it involves their school work after school. These are the most vulnerable and disadvantaged learners who lack resources that would enable them to learn, study and enjoy mathematics (Acharya, 2017).

Van der Berg *et al*. (2011:17) explain that researchers believe that poor mathematics performance in mathematics, measured according to local and international tests, is primarily attributable to the language disadvantage experienced by the South African learners. Barwell *et al.* (2016) have noted the challenge that diverse languages have brought about in South Africa, as evidenced in other countries such as Malaysia and Australia. These scholars have indicated that many languages are spoken out of school. Still, the language of teaching and learning in many instances is English. However, learners' lack of proficiency in the language of instruction, has necessitated the use of code-switching.

This is confirmed by Mlachila and Moeletsi (2019) who identified poor command of English among Black South African learners, which is the medium of instruction, as one of the reasons for their low performance in mathematics. Mullis *et al*. (2012) reveal that learners who rarely speak the test language (as in TIMSS) at their homes fall amongst those who do poorly in mathematics, resulting in lower average reading scores. Howie's (2003) research aligns with this and attributes learners' poor performance in mathematics in South Africa to the language. This means that learners will not be in a position to do well in mathematics unless and until they understand the language through which mathematics is taught. Knowing and understanding the medium of instruction makes learning and teaching enjoyable and rewarding.

Isdale *et al.* (2017), reporting on TIMSS 2015, suggest that a cause of poor mathematics performance by South African learners could be confidence in their ability to do mathematics and enjoy it. This indicates that learners with low levels of confidence in the subject would find it very difficult to enjoy doing mathematics and ultimately do well in the subject.

Arends *et al*. (2017) regard students, teachers, classroom, school and curriculum being linked to poor mathematical achievement. Bethel (2016) argues that in some cases teachers lack confidence in their own ability to teach mathematics and that they are not equipped with the relevant knowledge and skills (Howie, 2003). As a result, these teachers find it very difficult to foster the desired attitudinal changes in their learners (Bethel, 2016). In many cases teachers do not adapt and adjust their teaching and interaction strategies to cater for diverse learning styles. In addition, they do not use understandable and straightforward classroom instructions to engage in classroom discussion as a learning tool to motivate learners' communication skills and prompt thinking and problem-solving, which would be beneficial to the learning process (Arends *et al.,* 2017). How teachers interact with learners has a significant bearing on learner performance and influences learner attitude to the subject.

Howie (2003) regards the following as factors contributing to learners' poor performance in mathematics: inadequate subject knowledge of teachers, inadequate communication ability of learners and teachers in the language of instruction, lack of instructional materials, difficulties experienced by teachers when managing activities in the curriculum, heavy teaching loads, overcrowded classrooms, poor communication between policymakers and practitioners and lack of support due to the shortage of professional staff in ministries of education.

3.5 THE VALUE OF MATHEMATICS IN SOCIETY

Mathematics is considered one of humankind's most significant cultural achievements (Ernest, 1998) as numbers and measures play such an essential role in people's lives. Through them, one sees and understands the world better. According to Ernest (1998), mathematics provides a language of its kind and the socially all-important work, commerce and economics practices. The digital computers and the full range of information technology (IT) applications are regulated by and speak to each other exclusively in the language of mathematics. Without this language, there would have no meaning. In this day and age, it is a given that mathematics is an important tool in all spheres of modern technology and life in general.

3.5.1 The Importance of Mathematics in the School Curriculum

The diagrammatic representation of the South African school structure is used to indicate the mathematics education. Figure 3.1 indicates mathematics education in the hierarchical phases from Grade R to Grade 9, being the GET phase and Grades 10 Grade 12, the FET phase. The transition into the FET phase culminates in the national matriculation and school leaving at the end of Grade 12, after which the learner can be admitted to institutions of higher learning.

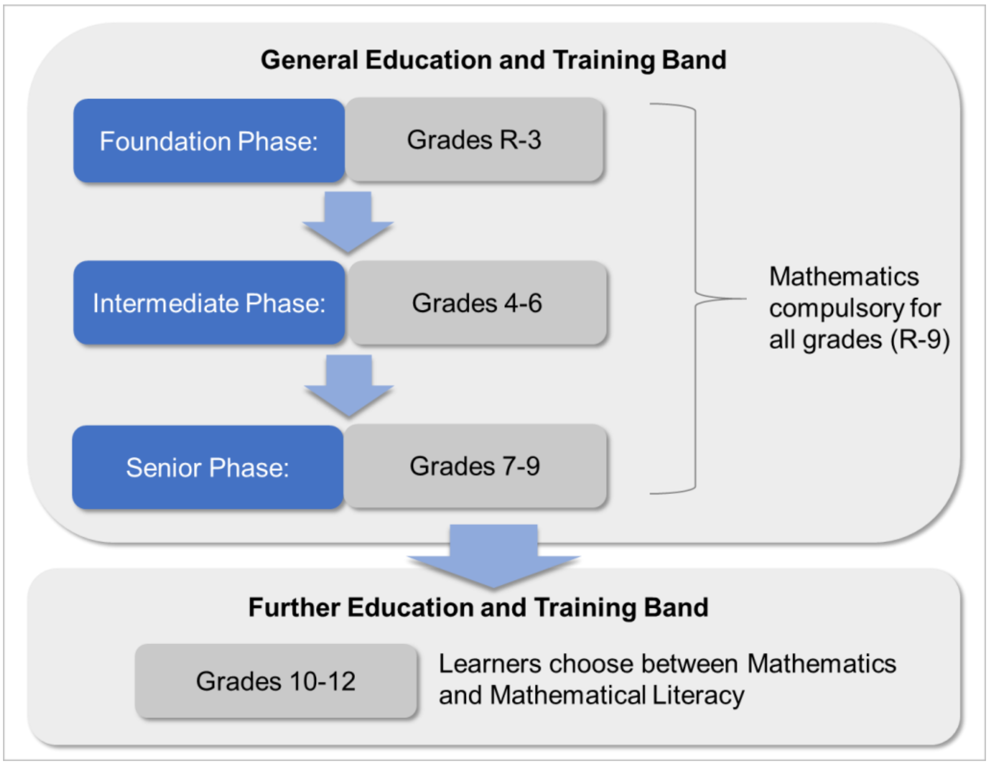


Figure 3.6: Mathematics education at the various phases and grades

Mathematics is compulsory in the General Education and Training Band which comprises Grades 0- 9 within the three phases - Grades R-3 constitute the Foundation Phase; Grades 4-6 constitute the Intermediate Phase, and the Senior Phase is composed of Grades 7-9. The Further Education and Training Band consists of Grades 10-12. The learning and teaching of mathematics from Grades 1- 9 is compulsory whilst in Grades 10-12, the learner has a choice of either mathematics or mathematical literacy (Adler & Sfard, 2017). The language of teaching and learning for mathematics in South African public schools has been discussed in the first chapter.

Basic Education is delivered, managed and administered in either public or independent mainstream schools and special schools under the auspices of each of the nine Provincial Departments of Education. The nine Provincial Departments of Education are the Free State, Gauteng, KwaZulu Natal, Limpopo, Mpumalanga, the North West, Northern Cape and the Western Cape. The National Department of Basic Education (DBE) is charged with the responsibility of developing policy, monitoring and evaluation of education. With the broad policy framework provided by the DBE, each province can initiate and adapt programmes that are meant to enhance the delivery of education in the province.

The Centre for Development and Enterprise (CDE), a non-profit organisation, states that mathematics and science at school levels is vital to higher education, skilled jobs and the national economy (Simkins, 2010) and is one of the most important subjects in human life (Acharya, 2017). This emphasises the significance of mathematics, which forms the basis of the country's skills and economic development. Mapaire (2016) endorses the significance of mathematics, which he regards as fundamental to national prosperity as it provides tools for understanding science, technology, engineering and economics. Mathematics equips learners with uniquely powerful ways to describe, analyse and change the world (Mapaire, 2016). In alignment with the above, Alex and Juan (2016) regard mathematics as an essential requirement for entry into higher education and modern knowledge-intensive jobs.

In Nigeria where the education system is based on Universal Basic Education (UBE) introduced in 1999 and commonly referred to as the 9-3-4 system, mathematics is a compulsory subject at primary and junior secondary school, covering six and nine years respectively, senior secondary school level (three years) and tertiary level (four years). Regardless of whether learners are in science, commercial, arts or social science class, learners at senior secondary school level have to do mathematics (Omobude, 2014).

Yemi and Adeshina (2013) have argued that the significance of mathematics is so obvious and is vital for producing resourceful graduates that are needed for economic development (Omobude, 2014). Therefore, mathematics in Nigeria, considered the backbone of science, technology, medicine, economics and even government, is seen as indispensable in the development of technology and crucial to the understanding of the world in which we live.

3.5.2 The Role of Mathematics in Society as a Whole

Society is made up of a group of people who live in the same area. With time, the people become a large social grouping that share the same geographical or virtual territory subject to the same political authority and dominant cultural expectations (Fatima, n.d.). Society, therefore, can simply be described as an economic, social or industrial infrastructure, made up of a varied collection of individuals. Fatima (n.d) sees the role of mathematics in personal development as actual social development. A person is a social being that is dependent on the co-operation of others and in this way, group work enhances the development of social skills. In teaching and learning, learners work individually or as a team led and supervised by a teacher. Within society, language is the means of communication.

Fatima (n.d) argues that mathematics plays a major role in vocational development, preparing learners for technical and other vocations such as engineering, architecture, accountancy, banking, business, agriculture, tailoring, carpentry, surveying and office work. Fatima (n.d) notes that learners develop aesthetic sensibility, gratification, confidence and self-reliance as soon as they can solve mathematical problems. Learners begin to appreciate and love mathematics and this, in the final analysis, results in their everlasting joy and gratification. Sinyosi (2015) explains the fundamental significance of mathematics to people. She finds an interrelationship between mathematics and human development which advances the cause of humans.

Bethel (2016) regards mathematics as one of the subjects that cut across science, technology, engineering and mathematics (STEM) fields. As a result, it has become a must-do subject in these areas as it plays a critical role in national economic development and various other fields. Nitisha (2018) argues that mathematics is crucial in the development of any nation.

On a basic level, very little can be done without the involvement of mathematics. Simple things such as counting, addition, subtraction, division in our daily engagements involve mathematics. The pursuit of esteemed careers such as medicine, engineering, agriculture, accountancy, becoming a pilot, motor mechanic, actuary, psychiatry, to name but a few, is almost unthinkable without the involvement of mathematics. Therefore, one has to acknowledge that mathematics is the backbone of our lives as it opens doors leading to the careers referred to herein (Nitisha, 2018).

The significance of mathematics in Nigeria, has resulted in the government mandating mathematics in the National Policy on Education as a compulsory subject for all primary and secondary school learners (Gogo & Nduka, 2017). Mathematics is regarded as a vital tool for the understanding and applying science and technology, a precursor and harbinger to the much-needed technological and natural development of the world's developing nations (Gogo & Nduka, 2017). Mathematics is thus regarded as a universal subject, necessary for successful schooling and unavoidable for human survival in everyday life (Adeniyi, Ogundele & Odetola, 2014).

As previously discussed, mathematics is taught through the chosen medium of instruction. In many countries, this may not be the learners' home language, which could impede learning and teaching. In the South African context, in many rural schools English First Additional Language (FAL) is used as the language of learning and teaching in mathematics for learners whose home language is not English.

3.6 ENGLISH FIRST ADDITIONAL LANGUAGE (FAL) AS THE LANGUAGE OF TEACHING AND LEARNING IN MATHEMATICS

Before dealing with English as the language of teaching and learning in the context of this study, there are a few concepts such as mother tongue, home language, the language of learning and teaching, an African language, and First Additional Language that require explanation.

The explanations of these terms are based on the *Status of the language of learning and teaching (LOLT) in South African public schools* (DBE, 2010). Mother tongue is the language that a learner acquires in his/her early years and which has normally become his/her natural instrument of thought and communication. Nishanthi (2020) describes the mother tongue as the first language one grows up knowing, which is also known as the native language. In the context of this study mother tongue refers to Xitsonga, the language that is spoken in the Mopani District of Limpopo Province where the study was conducted. The definitions offered by the Department of Basic Education (DBE, 2010) and Nishanthi (2020) are flexible or all-embracing as they cover the language of the father and the language of the mother. Home language is the language that is most frequently spoken at home by a learner.

Language of learning and teaching (LOLT) is the language medium in which learning and teaching, including assessment, takes place. The language of teaching and learning is commonly referred to as a medium of instruction. African languages, in terms of the Constitution of the Republic of South Africa, and the context of the Report of the Department of Basic Education (DBE, 2010), refer to South Africa's nine official languages which are isiNdebele, isiXhosa, isiZulu, Sepedi, Sesotho, Setswana, Siswati, Tshivenda, and Xitsonga. First Additional Language means the language subject that the learner is compelled to study at a given level. The First Additional Language is a language other than the learner's home language that is used for learning and teaching. In the context of this study, the language is English First Additional Language (FAL), referred to as English in certain instances in this study. In the context of this study, mathematical language refers to the First Additional Language or English used in the teaching and learning of mathematics.

3.6.1 The role of Language in the Teaching and Learning of Mathematics

Botes and Mji (2010) explain that language acquisition is associated with and attuned to the expansion of the child's world of meaning and influences the extent to which child's intelligence is actualised. Danesi (1998) argues that learners who are taught in a non-mother tongue language often do not achieve academic excellence due to an artificially created linguistic problem and not because they are less able. This means that teaching and learning mathematics in multilingual classrooms where the medium of instruction is not the learners' home language, is a complicated matter (Botes & Mji, 2010) as learners have to deal with the new terminology of mathematics and the new language in which mathematics is taught.

The Language-in-the-Education (LieP) policy of South Africa (1997) emphasises the use of mother languages which is helpful to learners in teaching and learning mathematics as it enables the learners to freely and easily communicate, interpret and interact with others when sharing information and promoting the easy transfer of mathematical knowledge and skills to learners. Mahofa (2014) regards mother tongue language as a useful tool for communication in teaching and learning mathematics and will facilitate the learning and enhance the quality of teaching and learning in mathematics classrooms. Nomlomo and Mbekwa's (2013) research found that both teachers and learners benefitted from using isiXhosa (learners' home language) in teaching and learning mathematics as the home language facilitated learner participation and a better understanding of mathematics.

Adler and Sfard (2017) argue that learners and teachers in mathematics classes are disadvantaged when the learner's main language is not utilised as a significant resource for thinking and communication purposes in the classroom. The difficulty is encountered when the teacher and the learners do not share the same mother language. Teachers and learners with poor language proficiency, where code-switching is prohibited and not used, are always at a disadvantage because code-switching, in this instance, may not be readily accessible. This has the effect of curtailing mathematical discussions in the classrooms. However, if code-switching is used in the teaching and learning of mathematics, it could facilitate learning particularly when teachers and learners share the same native language, such as Xitsonga language, as in this study.

3.6.2 English First Additional Language as the Language of Teaching and Learning in Mathematics discussed

The Department of Basic Education (DBE, 2012) describes the First Additional Language level as the language proficiency level that embraces the basic intercultural and interpersonal communication skills needed in social situations and the cognitive academic skills essential for learning across the curriculum. Learners in South African public schools are taught through the medium of their home language in the Foundation Phase and then transition to a First Additional Language from Grade 4 (Wilsmith-Cromarty & Balfour, 2019). The First Additional Language that is used as a medium of instruction in South Africa is either English or Afrikaans.

The South African Language-in-Education Policy demonstrates that the South African Government has given the parents the right to choose the language of learning and teaching (LOLT) for their children in schools. Notwithstanding the parents' choice, most parents prefer that their children be taught in English. The LOLT, in this study's context, refers to English, the language that is chosen by the parents through their School Governing Bodies for use in the classrooms for instruction and assessment purposes. This language is also used in the teaching resources provided by the school in the form of textbooks and workbooks (DBE, 2012).

A new understanding of the important role that the language plays in teaching mathematics has emerged in the last decade (De Sanchez, Gabriel & Turnbull, 2018) with language being considered a way of teaching mathematics and constructing new meaning in mathematics. However, language proficiency is key in comprehending the mathematical tasks as mathematical abstractions become dependent upon understanding the language in which it is put forth (Halai, 2009). Choudhury and Bose (2011) observe that learners who learn mathematics in a foreign language need to learn both mathematics and the language itself, resulting in poor quality learning. Language negotiation, therefore, serves as a useful pedagogical resource that provides a comfortable and flexible mode of communication between the teachers and the learners. For successful mathematics education, mathematics educators need to investigate how the negotiation of languages is conducted in the classroom both by the teachers and the learners (Choudhury & Bose, 2011). Mahofa (2014) explains that because English is used as the LOLT in South African schools, it enables learners to keep abreast with scientific and technological developments that are mostly recorded in English whilst at the same time providing opportunities for the learners to increase their proficiency in the language.

However, Setati *et al*. (2008) query the value of teaching or learning mathematics in a language that is different from the home language, first or main language, particularly when the LOLT used in most classrooms in South Africa is English. The main problem in multilingual classrooms in South Africa is the fact that English is the medium of instruction while many of the learners are not proficient enough in the language to engage in mathematical tasks set in the language.

Howie (2003) found that learners in South Africa tended to achieve higher scores in mathematics when their proficiency in English was high and more likely to attain low scores in mathematics where their proficiency in English was low. Kunene (2011) conducted a study in schools in a rural poverty-stricken area where the schools were referred to as Quintile 1 schools. The findings revealed that learners' lack of proficiency in the language of learning and teaching (English FAL) and lack of resources resulted in them being disadvantaged which affected their performance.

Isdale, Reddy, Juan and Arends (2017) confirm that mathematics performance by South African learners is poor nationally and internationally which could be a result of language proficiency. Learners who regularly speak the language of the test at home are at a particular advantage compared to those whose language of English or

Afrikaans is a second or a third language. The latter’s performance in these instances is at a lower level.

Jegede (2011), conducting a study in Nigeria, found that the medium of instruction has far-reaching consequences in all educational systems because language plays a major role particularly in multilingual classrooms where children from different linguistic and socio-cultural backgrounds are found. Selamat (2014) states that education in Malaysia, with the introduction and implementation of the ‘Teaching and learning of Science and Mathematics in English Policy’ is a bid to address the declining level of English proficiency among Malaysian students. To ensure that students keep abreast with the advancement in science and technology in the era of globalisation, this policy has undergone a revision. The medium of instruction for mathematics and science in Malaysia is English; however, Malay, Chinese and Tamil learners code-switch during the teaching and learning in mathematics classrooms. (Sen, 2011) states that learners who speak a native language but are taught in the second language, code-switch during the lessons to obviate the challenges resulting from the language barrier.

Nierche (2009) in a study conducted in Australia, explained that home languages should be perceived as important resources in teaching and learning mathematics where the language of instruction is different from the home language. However, Barwell and Clarkson (2004) argue that education ought to address the relationship between language and mathematics learning from a theoretical perspective that combines the current perspective of mathematics learning and classroom discourse with current perspectives on language.

The discussion in this section highlights the relevance, significance and reward of teaching and learning when acknowledging the relationship between mathematics and the language of learning and teaching. The language of teaching and learning ought to help learners understand mathematics easier. Failure to be proficient in the language used for learning and teaching leads to poor performance. To be able to participate meaningfully in learning and teaching, learners require the necessary confidence in themselves and in the language used in the classroom. This, properly considered and acknowledged, leads to building the necessary confidence of the learner and the teacher in the use of the language, making it easy for the learners to love and enjoy learning and teaching mathematics. The same confidence that the learners will exhibit in mathematics is the very confidence that the teachers require for them to be best able to impart the knowledge of mathematics meaningfully. In instances where teachers and learners share the same home language and particularly where it is clear that language forms a barrier in the teaching and learning of mathematics, ways and means have to be devised to circumvent the difficulty of teachers and learners failing to find each other because of the language of the test. Chikiwa and Schäfer (2014) assert that teaching mathematics in English to learners whose first language is not English gives rise to challenges for the teachers who are compelled to code-switch from English to native languages to enhance conceptual understanding of mathematics.

Notwithstanding the importance of English and its use as the LOLT, there is a need for the movement of the languages used in the classroom (Halai, 2009). The movement between the languages refers to switching from one language of instruction to another language of instruction during teaching and learning. Setati (2005, 2008) encourages code-switching as it is a tool that enhances better understanding and comprehension of the subject matter (Choudhury & Bose, 2011).

According to Selamat (2014), code-switching has invoked a debate among linguistics, educators, and policymakers and a further debate has arisen globally concerning language and learning which creates a dichotomy between learning in English and learning in the home languages (Mahofa, 2014: Manyike & Lemmer, 2014; Van der Berg *et al.,* 2011).

3.7 CODE-SWITCHING AS A COMMUNICATIVE STRATEGY TO ENHANCE THE TEACHING AND LEARNING OF MATHEMATICS IN GRADE 11

Selamat (2014) sees code-switching as a linguistic phenomenon associated with bilingual and multilingual learners comprising two cardinal principles - deliberate, proactive and strategic use of the learners' main languages and the selection of real-life interest and high cognitive demand of mathematics tasks. Code-switching plays a significant role in the classroom because when learners and the teachers adequately communicate with each other, they find it easy to understand the content of the subject (mathematics) and its concepts. The practice of code-switching generates interest and love for mathematics by the learners.

Bilingualism and multilingualism were studied to determine the relevance, effectiveness, benefits, and challenges of code-switching as a communicative strategy to enhance mathematics teaching and learning.

3.7.1 Code-Switching Defined

For more than three decades, code-switching has been researched by eminent scholars whose definitions of code-switching share common elements. Code-switching is defined as “the alternation of two languages within a single discourse, sentence or constituent” (Poplack, 1980:583). The Department of Basic Education (DBE, 2010:3) defines code-switching as “switching from one language of instruction to another language of instruction during teaching and learning”. Myers-Scotton (1997) explains that code-switching is the practice of alternation by bilinguals between two languages during their interactions. The definition of code-switching that Jegede (2011) gives is detailed because it embodies the definitions of other scholars such as Adler (1998), Hoffman (1991) and Poplack (2001). This definition, as cited, states that code-switching is the use of languages with different grammatical systems in the same speech. Adler (1998) views code-switching as the speech which uses more than one language as alternation. Hoffman (1991) refers to code-switching as the use of two languages in the same utterance. Poplack (2001) states that code-switching is the mixing, by bilinguals (or multilingual) of two or more languages in the discourse, often with no change of interculator or topic and Hamid (2016) views code-switching as the alternate use of two or more languages in the same utterance or conversation by bilinguals and multilinguals.

Aljoundy (2013) states that code-switching occurs naturally and that it is the expected practice of teachers and learners who share a common first language. The language that comes in between during code-switching is the native language of the teachers and learners and does not have a homogenous definition. What happens in the language during code-switching is the shifting or change of ascent by a speaker from one language (L1) to another (L2). Supplementing English with the learners’ home language (code-switching) enables the learners to understand mathematics better and easier (Jegede, 2011).

Code-switching, a phenomenon that exists in bilingual societies where people are allowed to use two or more languages simultaneously to communicate (Johansson, 2013), has raised two different views with its practice: the view that supports code-switching and the other that is against its use. Jinxia (2010) calls those that support code-switching in the teaching and learning environment advocates of cross-teaching strategy and calls those against the practice as advocates of intralingual teaching strategy.

Ustunel (2016) argues that code-switching bridges the teaching and learning process and is viewed as an opportunity to apply the right function of code-switching rather than the hurdle it gives. In supporting code-switching, Peregoy and Boyle (2013) argue that L1 facilitates both teaching and learning such as confidence, security, motivation and friendship. Nurhamida, Fauziati and Supriyadi (2018) see the use of L1 in EFL as giving learners a more comfortable setting in which they can speak freely without the strict rule of an English only policy. The scholars that support code-switching believe that this practice is very helpful for both teachers and learners in classrooms.

Sridhar (1996), however, finds that the use of L1 in a classroom is a sign of laziness, sloppiness, or any other weakness during the teaching and learning process. Brown (2006) says that code-switching shows a lack of confidence. Selamat (2014), dealing with code-switching by teachers and learners, states that code-switching is often viewed with suspicion and contempt. The monolingual fallacy can dominate that the act of mixing languages is a sign of deficit and incompetence. Jinxia (2010) states that the overuse of code-switching slightly affects the learners' optimisation of using English compared to the class that uses English all the time. Zhou and Wei (2007) hold the view that code-switching distributes more disadvantages and is likely to affect learners' communication later.

Code-switching with its disadvantages and benefits should be viewed as an asset as it offers many functions for both teachers and learners (Nurhamida *et al.,* 2018). However, code-switching has invoked debate relating to its benefits and challenges in the teaching and learning process as code-switching is helpful to both teachers and learners and assists in achieving the learning target (Nurhamida *et al.,* 2018:79). However, there are still challenges in the use of L1 in the classroom context, and it has been argued that its use in classrooms should be reduced to avoid the mixing of languages (Moore, 2010), even though teachers find it challenging to engage in whole English instruction with language barriers (Ustunel, 2016).

The relationship between bilingualism and multilingualism necessitates a discussion on how they are related to the concept of code-switching. According to Hutauruk (2018), code-switching is one of the characteristics of a bilingual, a person who knows and uses more than one language, or a multilingual person who knows and uses more than three or more languages. Code-switching or the alternate use of two or more languages in the same utterance is common in bilingual classrooms (Hutauruk, 2018). Code-switching in the case of a bilingual speaker, frequently happens in a community because when bilingual speakers code-switch, they stop speaking one language and begin to speak another or adapt patterns of one language into the patterns of the other. Sridhar (1996) states that bilingualism and multilingualism are terms that have been used interchangeably in the literature to refer to the knowledge of two or more languages by a person or community and each term is discussed below.

3.7.1.1 Bilingualism

Selamat (2014) defines bilingualism as the regular use of two or more languages and bilinguals as people who need and use two or more languages in their everyday life. Baker (1988) defines bilingualism as a person's ability to listen, read, speak and write in two languages while Wei (2000) states that the word bilingual describes a person who possesses two languages which can either be a home language or mother tongue and a language that the person later acquires in the community or at school. A bilingual classroom consists of the majority language that learners speak and referred to as mother or L1 (Xitsonga) and minority language which is referred to as the medium of instruction (English) or L2 (Pollard, 2002), as found in in this study.

3.7.1.2 Multilingualism

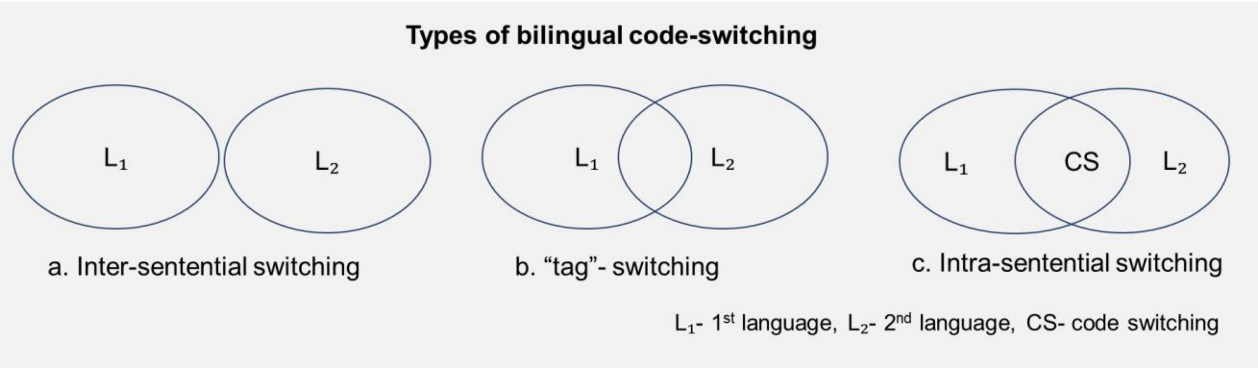
Okal (2014) explains that the term multilingualism comes from two Latin words: *multi,* which means many, and *lingua*, which means language. Multilingualism is the ability of a speaker to express himself or herself in several languages with equal and native-like proficiency. In South Africa, multilingualism is evident in the use of the eleven official languages namely Afrikaans, English, isiXhosa, isiNdebele, isiZulu, Sepedi, Setswana, Sesotho, Siswati, Tshivenda and Xitsonga.

Nigeria has about 400 languages which represent Niger-Congo, Nilo-Saharan and Afro Asiatic. The country officially recognises English as an official language while Yoruba, Hausa and Igbo are regarded as national languages. In explaining multilingualism, Aronin (2019) says it is the presence of several languages in one country or community or city, the use of three or more languages and the ability to speak several languages. Individual multilingualism relates to the personal sphere that covers the acquisition and use of several languages (Aronin, 2019). Understanding the terms bilingualism and multilingualism enables a learner to properly understand a relationship between code-switching, bilingualism and multilingualism because code-switching is one of the characteristics of a bilingual or multilingual.

Learners overcome their difficulty of understanding the language in the teaching and learning process through the constant use of code-switching and gain a degree of proficiency in the language which leads to their better understanding of mathematics.

3.7.2 Types of Code-Switching

The following three types of code-switching are relevant to this study: intersentential-switching, tag-switching, and intrasentential-switching. (Bhatti, Shamsudin & Said, 2018; Jinxia, 2010; Kebeya, 2013; Poplack, 1980; Zirker, 2007). Zirker (2007) states that code-switching differs in the point at which the language switch occurs. It also occurs between intersentential (language switches at phrasal, phrase or discourse boundaries) and intrasentential (language shifts in the middle of a sentence) sentences. It is usually done without pausing, interrupting or hesitating. The three types of code-switching are illustrated in the diagram below, Figure 3.2, and then discussed in the sub-sequent sections.



Source: adapted from Poplack (1980:615)

Figure 3.7: Types of code-switching

3.7.2.1 Intersentential-switching

Hutauruk (2016) explains that intersentential-switching occurs at clause or sentence boundary, where each clause or sentence is in one language or the other. According to Kebeya (2013), in intersentential-switching, a speaker switches from one language to another between different sentences. When an individual's speech is divided into sentences, one sentence will be in one language while the other sentence will be in a different language. Bhatti *et al.* (2018) explain that intra sentential switching refers to the insertion of words, phrases or clauses in the middle of a sentence, performs an explanatory function and gets students' attention.

The following are examples of how code-switching can be applied in the mathematics classroom:

Example 1:

When teaching fractions of a quarter, half, three quarters and four quarters, one may give the learners an example using a loaf of bread which can be cut in half to be given to two people. One may also cut the loaf into three or four parts depending on the number of people who must share the loaf. Where three people share the loaf they each will get a third of the loaf while four will each receive a quarter of the loaf.

> *Loko hi teka lofo ra xinkwa hi lava ku nyika vanhu vambirhi* they each receive half of the loaf, but *loko hi teka lofo rin'we hi xerela* three people *ku huma* three

pieces (one for each person) and finally *loko hi xerela* four people *va kuma* four pieces (and each receives a quarter of the loaf).

Teacher: …and finally *loko hi xerela* four people *va kuma* four pieces (and each receives a quarter of the loaf).

[…and finally, when we share the loaf between four people, four pieces means that each receives a quarter of the loaf.]

In the sentence above, intrasentential code-switching occurred when the teacher used both English and Xitsonga (italicised) words in the same sentence.

Example 2:

Teacher: Today's lesson is about fractions. *Namuntlha dyondzo ya hina i ya tifraction*.

Intersentential code-switching is evident when the teacher explains the lesson's topic in Xitsonga after indicating the same in English.

3.7.2.2 Tag-switching

Hutauruk (2016) calls tags emblematic switching. She says emblematic switching is a tag or exclamation and explains that in this kind of code-switching, tags and set phrases in one language are inserted into an utterance of another. Jinxia (2010), defining tag-switching, cites Poplack (1980) and says that tag-switching is the insertion of a tag phrase from one language into an utterance from another language.

Example 3:

Learner: Xana mi nga ni hlamusela njhani tifractions ta half, third na quarter?

[How will you explain to me the fractions half, a third and a quarter?]

The sentence above displays tag-switching as the learner asks the question for the clarification of the fractions.

The researcher's examples above demonstrates that code-switching is an appropriate and effective strategy to achieve and enhance the quality of teaching and learning in mathematics and it has relevance in teaching and learning mathematics.

3.8 THE RELEVANCE OF CODE-SWITCHING DURING THE TEACHING AND LEARNING OF MATHEMATICS

In this section, the researcher discusses the relevance of code-switching by bringing out the factors which compel the teachers to code-switch in the teaching and learning of mathematics in that the two are interlinked.

Maluleke (2019), Uys (2010) and Modupeola (2013) see code-switching as an important resource used by teachers to disseminate knowledge to learners in bilingual and multilingual contexts. It is a beneficial communicative practice employed by speakers who skilfully switch from one language to another without disturbing the flow of ideas. The practice usually takes place in bilingual or multilingual communities for specific reasons. There is a close relationship between the poor performance of South African learners and the relevance of code-switching. To improve poor performance in mathematics in South Africa, the Curriculum Assessment Policy Statement (CAPS), was introduced. Notwithstanding this, teachers still encounter serious problems and challenges when English is used as a medium of instruction for mathematics teaching and learning (Maluleke, 2019). Diaz (1983) suggests that bilingual learners easily switch to their mother tongue when engaging in complex tasks in a second language in a bid to clarify doubts and understandings encountered in the second language. They also use their mother tongue to demonstrate their understanding of the content presented even though they cannot explain it in English. Setati (2005b) indicates that code-switching can be used to introduce a topic by explaining in the learners’ home language, which supports the learning process and assists the learners in developing proficiency in the language of teaching and learning. The researcher agrees with this view because when code-switching is employed to introduce mathematical concepts, learners understand and remember better (Setati & Adler, 2001).

The researcher, during her time as a teacher, observed this taking place in the classroom. Learners were comfortable engaging in discussions during the lessons in Xitsonga (L1). Their participation in L2 was considerrably less as soon as they were required to communicate in English. Allowed to code-switch, the learners became involved in the lessons and even shared their ideas and knowledge relating to the subject matter. Nomlomo and Mbekwa (2013), in this context, confirm the significance and the relevance of code-switching as they observed learners participate better once they code-switch. Uys (2010) states that code-switching is relevant because it supports learning as a good educational practice that enables teachers to explain the subject matter to the learners, who then understand it. Sepeng (2013) found code-switching relevant in classrooms as a strategy that clarified concepts that were deemed complex during the lessons. The learners, according to Sepeng (2013), cross-check amongst themselves if they have understood the concept. Those learners who understood better were used as resources to explain some concepts through the language of their choice to those who did not understand the concepts taught. In situations where learners catch what the teacher is teaching, the teacher's task of explaining the content and concepts to the learners in English is simplified by the enthusiasm with which those learners explain the content and the concepts to their peers. Those who understand quickly do so because of their proficiency in the second language. Chikiwa and Schäfer (2016) concerned themselves in the study with teachers' code-switching practices between isiXhosa and English. Their proposal signifying their approval of code-switching is demonstrated by their statement, which says code-switching should be done consistently and with precision to support learners from diverse backgrounds.

Jegede (2011), in the study in Nigeria, acknowledges that learners encounter problems where mathematics is taught in English which is not their home language. Therefore, he states that code-switching, in this instance, becomes very relevant as its employment leads to a better understanding of the content taught. Jegede (2011) explains that when teachers code-switch in mathematics classrooms, educational benefits are evident when learners understand the subject matter they are taught. Modupeola (2013) argues in favour of code-switching, saying that it should not be viewed as an impediment to proper teaching and learning but as a helpful strategy in classroom interaction where clarity is required and the transference of knowledge to learners is a must. Ajibade, Omolola and Adetomi (2017), dealing with code-switching as a widespread phenomenon in bilingual communities like Nigeria, where the speakers use their first language L1 (native language) and their acquired language called the second language (L2) in different settings, state that code-switching should be seen and treated as a rich and a veritable communicative tool because of its role in the process of communication. Jegede (2011) supports the employment of code-switching stating that it leads to a better understanding of the contents being taught.

Clarkson (2007), also preferring code-switching in teaching and learning, states that the practice is helpful in the processing of a problem within the total solution strategy. Muthusamy, Muniandy, Kandasamy and Farashaiyan (2020) point out that code-switching in international classrooms results from a lack of competence in the second language. They, too, favour the use of code-switching in teaching and learning environment, stating that the lack of English proficiency also results in code-switching. Selamat (2014), in a study conducted in Malaysia, stated that where teachers and learners shared the same first language, code-switching had relevance in the teaching and learning by facilitating instruction and the learning process for learners especially those with low proficiency in English. Selamat (2014) concluded that teachers and learners had positive views about the practice of code-switching in English Second Language classrooms, perceiving as a valuable teaching and learning resource in the classroom. Nierche (2009) states that code-switching enhances learners' understanding particularly those who come from rural areas.

The literature used above demonstrates that code-switching is employed the world over and is relevant for teaching and learning mathematics. It is also clear that code-switching is widely accepted because of its contribution in the mathematics classrooms as it has various functions, some of which are promoting a good understanding of the subject matter, facilitating teaching and learning process, an effective strategy for classroom management, clarification of concepts and difficult tasks as well as simplifying learning for the learners whose proficiency in English is insufficient. The effectiveness of code-switching in the teaching and learning of mathematics is discussed next.

3.9 THE EFFECTIVENESS OF CODE-SWITCHING IN TEACHING AND LEARNING MATHEMATICS

This section is discussed under two sub-topics: the literature on the effectiveness of code-switching in the teaching and learning of mathematics and an example of a lesson presentation where code-switching was effectively used during the teaching and learning of mathematics.

3.9.1 The Effectiveness of Code-Switching in the Teaching and Learning of Mathematics

The success of code-switching, as a strategy that enhances the quality of teaching and learning in mathematics, is demonstrated by its effectiveness in the classrooms.

Code-switching is effective when the speakers of one language are exposed to another language consistently over a sustained period because the speakers become more proficient in the other language thereby becoming bilingual albeit to different degrees (Lin & Li, 2012). The effectiveness of code-switching is highlighted by its alleviation of the teaching and learning process, its assistance in the explanation of the subject matter, in its building of the learners' understanding of what transpires in the classroom and its assistance to both teachers and learners' inefficient communication during mathematics teaching and learning (Uys, 2010). Baker (1993) confirms this view and states that code-switching is relevant when introducing a new concept, when the need to praise someone arises, to emphasise a point or to reprimand a learner who misbehaves in class. According to Sepeng (2013) and Yusob *et al.* (2018), code-switching is effective because it enhances the quality of mathematical interactions in mathematics classrooms. The practice of code-switching is an effective strategy by learners who use it to make their intended meaning explicit and to transmit valuable information to the other learners in their classroom interactions (Muthusamy *et al.*, 2020).

Pollard (2002) conducted a study on the role of code-switching (using Spanish and English within the same discourse) in bilingual and immersion settings. The finding of the study was that the subject matter could be discussed more effectively in a classroom which allowed and encouraged code-switching because of the freedom given to the use of the language in the classroom. In another case, the effectiveness of code-switching between Malay and English second language classrooms is evident in how it addresses the potential communicative and comprehension problems emanating from the learners' limited language proficiency and the individual learner's linguistic background (Selamat, 2014).

3.9.2 An Example of a Lesson Presentation where a Teacher Effectively used Code-Switching during the Teaching and Learning of Mathematics

To demonstrate the effectiveness of code-switching, two examples are given:

Example 1: Lesson on Borrowing and interest

When teaching about borrowing in finances, learners may not understand the term borrowing in the context of mathematics. The teacher then indicates that:

Borrowing means *ku lomba*.

The teacher then further explains that:

> When you go to *machonisa* (loan shark) and borrow some money, interest is payable. *Loko u ya ka machonisa u fika u lomba mali u ta yi vuyisa hi swintsongo ntsongo yi ri na interest (ntswalo in Xitsonga)*.

The immediate mention of the word *machonisa*, a loan shark, tells the learners about the person (loan shark) they know who lends money to people and charges interest on the money lent. The learners, upon hearing the name of *machonisa* being mentioned, understand the concept of borrowing very quickly. In light of this example, the learners understand better the concepts of bank, interest and borrowing. This is an example that they know because it happens in their community so they can understand the concept of borrowing and interest better.

Example 2: Lesson on equations (x+x=2x)

> The learner asks:
>
> What is <u>x</u> in this lesson? (<u>x</u>) *i yini eka dyondzo leyi ya maths*?
>
> Teacher (explains in Xitsonga):
>
> *<u>x</u> hi yi tirhisa ku va yi yimela xan'wanchumu lexi xi nga va ku movha kumbe swin'wana*. [*x* is used to represent something which may be a car or other things.
>
> For example, loko movha wun'we (*x*) wu hlanganisiwa na movha wun'wana (*x*) hi ta va na mimovha mimbirhi (2*x*). [When you add one car to another car you will have two cars represented by 2x.]

In this example <u>x</u> represents one car 2<u>x</u> represents <u>two cars</u>.

Through code-switching from English to the learners' home language, understanding of the mathematical concepts is facilitated (Maluleke, 2019). Code-switching is particularly relevant when teachers introduce a new concept, as given in the example. Initially, the introduction of the new concept (content) was done in English but the learners failed to understand. However, when the teacher employed code-switching, the learners immediately understood which is a clear indication of the effectiveness of code-switching in the teaching and learning of mathematics.

As previously reported, Pollard (2002) observed communication in a bilingual classroom where Spanish and English were used. Learners were asked questions in English and they could not respond. She approached the learners and spoke to them in Spanish explaining the terms and concepts, and then repeated the questions in English. The learners immediately responded and interacted effectively and were relaxed and comfortable as soon as code-switching was employed. Research supports the use of code-switching in the classroom as a valuable strategy (Pollard, 2002) to employ during teaching and learning and to allow learners to communicate more effectively and enhance the learning process. Code-switching thus comes with benefits but also the challenges, which are both discussed in the next section.

3.10 THE BENEFITS AND CHALLENGES OF CODE-SWITCHING IN THE TEACHING AND LEARNING OF MATHEMATICS

This section deals with the benefits and challenges of code-switching in the teaching and learning of mathematics.

3.10.1 The Benefits of Code-Switching in Teaching and Learning Mathematics

Learners who have the advantage of using code-switching in their classrooms are successful and are able to convey their knowledge of the subject matter to their fellow learners and teachers (Pollard, 2002). In immersion classrooms where code-switching is prohibited or not understood, learners often stop halfway through the sentence or indicate that they do not know the answer to the question, or where they know the answer, they lack the vocabulary to interact in English appropriately. Learners within the bilingual classrooms and those with bilingual tutoring lessons and code-switching are permitted to communicate freely, are relaxed and effective. They, without hesitation, join the conversation and enjoy the lesson in contrast to learners within immersion settings where code-switching is not allowed and learners are hesitant to participate in classroom discussions.

Maluleke (2019) and Pollard (2002) have demonstrated that code-switching is a valuable strategy in the teaching and learning process as a communicative strategy (Setati, 1998), in clarifying concepts and efficiently transferring knowledge to the learners (Muthusamy *et al*., 2020). In addition, the teacher is better able to maintain discipline in the learners' home language (Nurhamidah *et al.,* 2018:80).

The practice of code-switching builds a good relationship between teachers and their learners and boosts learner confidence, and enables them to participate easily, freely, and effectively in classroom activities and discussions (Abad, 2010). In addition, code-switching assists the learners in understanding the difficult aspects of the lesson and in addition, they are able to understand and follow the teachers' instructions, (Memory *et al.,* 2018) and understand the meaning of difficult words and improve their English (Ahmad & Jusoff, 2009). Code-switching in a bilingual classroom serves a beneficial purpose in that it explains abstract concepts and defines complex terms to the learners, it enables learners to understand lesson content and seek clarification of concepts where necessary and it bridges communication gaps in the classroom (Aljoundi, 2013).

Code-switching is a socio-linguistic strategy that allows teachers and learners to build English vocabulary and make the meaning of problematic mathematical terms. The acquisition of vocabulary in mathematics ultimately enhances the learners' pedagogical knowledge of mathematics (Maluleke, 2019) and in addition, develops the learners' knowledge of the two languages. When learners engage in group work where the medium of instruction is not their home language (Adler, 2001), code-switching promotes discussion and questioning, enhancing their thinking and problem-solving (Simasiku, Kasanda & Smit, 2015) which ultimately has an effect on learners' long-term mathematics performance (Clarkson, 2007).

To sum up, code-switching performs the following functions in the classroom: clarification, reiteration or repetition, explanation, asking, translation, checking for understanding, developing vocabulary, aiding memorisation, class management and general communication (Fachriyah, 2017). The literature discussed in this section endorses the significance of code-switching as a communicative strategy enhancing quality in teaching and learning mathematics highlighting the benefits of its use.

3.10.2 The Challenges of Code-Switching in the Teaching and Learning of Mathematics

Researchers, through the years, have looked at the challenges facing code-switching. Some have referred to the phenomenon of code-switching as language interference while others who are against code-switching, argue that code-switching is harmful in that learners will not be able to communicate effectively in the language of teaching and learning. They describe code-switching as a linguistic deficit that reveals the lack of incompetence of the speaker in the second language (Muthusamy, 2020). Setati (1998) noted a prevailing perception that code-switching disturbs the smooth running of lessons and derails learners from acquiring English proficiency, the LOLT.

Palmer (2009) cited by Maluleke (2019) observed that some teachers in the United States of America (USA) regard code-switching as a sign of linguistic weakness and that it should not be encouraged as learners need to acquire proficiency in English which is regarded as the language of power. However, the situation in South Africa differs to that in US as learners in South Africa struggle to acquire the average level of proficiency in English to enable them to interact with their teachers. Therefore, when learners switch from their first language (L1) to L2, it helps them improve their performance (Palmer 2009 in cited in Maluleke, 2019)

Mokgwathi and Webb (2013) argue that code-switching is counterproductive in the teaching and learning situation as it does not develop learners' proficiency in the language of teaching and learning and of course assessment, which is English. Sert (2005) asserts that using a learner's home language alongside English, causes some learners to lose interest in the lesson, and stop listening to the medium of instruction and await the teacher' translation which negatively affects their mathematics performance. However, Ahmad and Jusoff (2009) observed that the learners who are opposed to the use of code-switching during teaching and learning are those who have proficiency in the medium of instruction.

Learners whose home language is not English, may experience challenges during mathematics assessment and find that their performance has been compromised by language rather than mathematical ability as they had failed to understand the terms used in their question papers. In a South African study conducted by Songxaba, Coetzer and Molepo (2017), it was discovered that learners who were taught by teachers who code-switched during Afrikaans Second Language lessons, experienced problems during Afrikaans assessment as the assessment was in the target language only. When the learners' mother tongue is not used during the assessment, it contributes to inequalities and challenges in not understanding the questions. Lim and Presmeg (2011) in their research, reported that teachers found it time consuming to code-switch between English and Mandarin to support low-performing learners in translating mathematical concepts. Ahmad and Yusoff (2009) found that low-performing learners approved the practice of code-switching, but most learners were opposed to code-switching because it did not improve their proficiency in the medium of instruction.

According to Songxaba *et al.* (2017), the Department of Basic Education does not officially recognise code-switching. However, Pollard (2002), Clarkson (2007) and Malueke (2019) in the researcher's view, argue convincingly that code-switching in important resource for the teaching and learning process (Nurhamidah *et al.,* 2018).

To sum up what has been discussed in the literature review, the functions of code-switching are presented in Table 3.6 offering valid points relating to code-switching as a communicative strategy enhancing the teaching and learning of mathematics.

Table 3.7: The functions of code-switching in teaching and learning mathematics

CATEGORY	FUNCTION	ILLUSTRATION
Curriculum Access	Delivering the lesson content in the second language	Explaining difficult mathematical concepts in the classroom using the learners' first language.
Classroom Management	Regulating learners' behaviour in mathematics classrooms.	Reprimanding learners for bad behaviour or commending them for good behaviour in the classroom.
Interpersonal Relations	Maintaining and negotiating social relationships between teachers and learners.	Encouragement, compliment, commanding learners by teachers. Learners' asking questions for clarity during the teaching and learning of mathematics.
Pedagogic content and communicative functions	Translating and checking learners' understanding of mathematical concepts.	Explaining the lesson content to facilitating the learning process.

Table 3.7 offers a summary of code-switching as a communicative strategy that enhances the quality of mathematics teaching and learning.

Table 3.8: Using code-switching as a communicative strategy to enhance the

CATEGORY	FUNCTION IN THE MATHEMATICS CLASSROOM
The relevance of code-switching	It leads to a better understanding of the subject matter by clarifying difficult concepts, facilitating the learning process and being an effective classroom management strategy.
The effectiveness of code-switching	It contributes to speakers becoming bilingual, alleviates the teaching and learning process, enhances the quality of mathematical interactions in the classrooms, and promotes the freedom for the use of the first language where the second language is used as the medium of instruction.
The benefits of code-switching	Code-switching enables the learners to convey their knowledge of the subject matter to their peers and teachers, gives the learners confidence during the class discussion, is a valuable resource to convey meaning, improves communication, assists teachers to explain difficult concepts, and defines difficult mathematical terms to the learners.
The challenges of code-switching	Code-switching may prevent the learners from acquiring proficiency in the language of teaching and learning, it disturbs the smooth running of lessons, it affects the learners' communication in the language of teaching and learning, and may cause some learners to lose interest in the lesson.

3.9 CHAPTER SUMMARY

Literature was reviewed in this chapter to discuss how code-switching as a communicative strategy, could enhance teaching and learning mathematics in secondary schools. Mathematics performance was discussed to establish whether performance in this subject was affected by the language of teaching and learning in the classes where the learners do not speak the LOLT. Mathematics performance was dealt with through the literature of large-scale studies such as Annual National Assessments (South African), SACMEQ, TIMSS and PISA. These studies revealed that mathematics performance in South Africa is a cause for concern when the learners perform below the benchmark set for participating countries.

English First Additional Language, the language of learning and teaching of mathematics, which is not the learners' home language, was discussed and literature revealed that the language of instruction was not necessarily a challenge to all bilingual learners but to those whose first language is not English. It was discovered that teaching mathematics to learners whose mother tongue is not the LOLT has been characterised by instances where teachers code-switched between the medium of instruction and the learners' home language to bridge the gap for the learners to understand the subject matter.

A detailed discussion of code-switching in the teaching and learning of mathematics classrooms was given. The relevance of code-switching, its effectiveness, benefits, and challenges in teaching and learning mathematics to native learners was also presented. The need for code-switching from the second language to the first language in teaching and learning mathematics remains important because of the various functions it has in the classrooms it serves. The next chapter (Chapter 4) deals with the research design and methodology used to conduct this study.

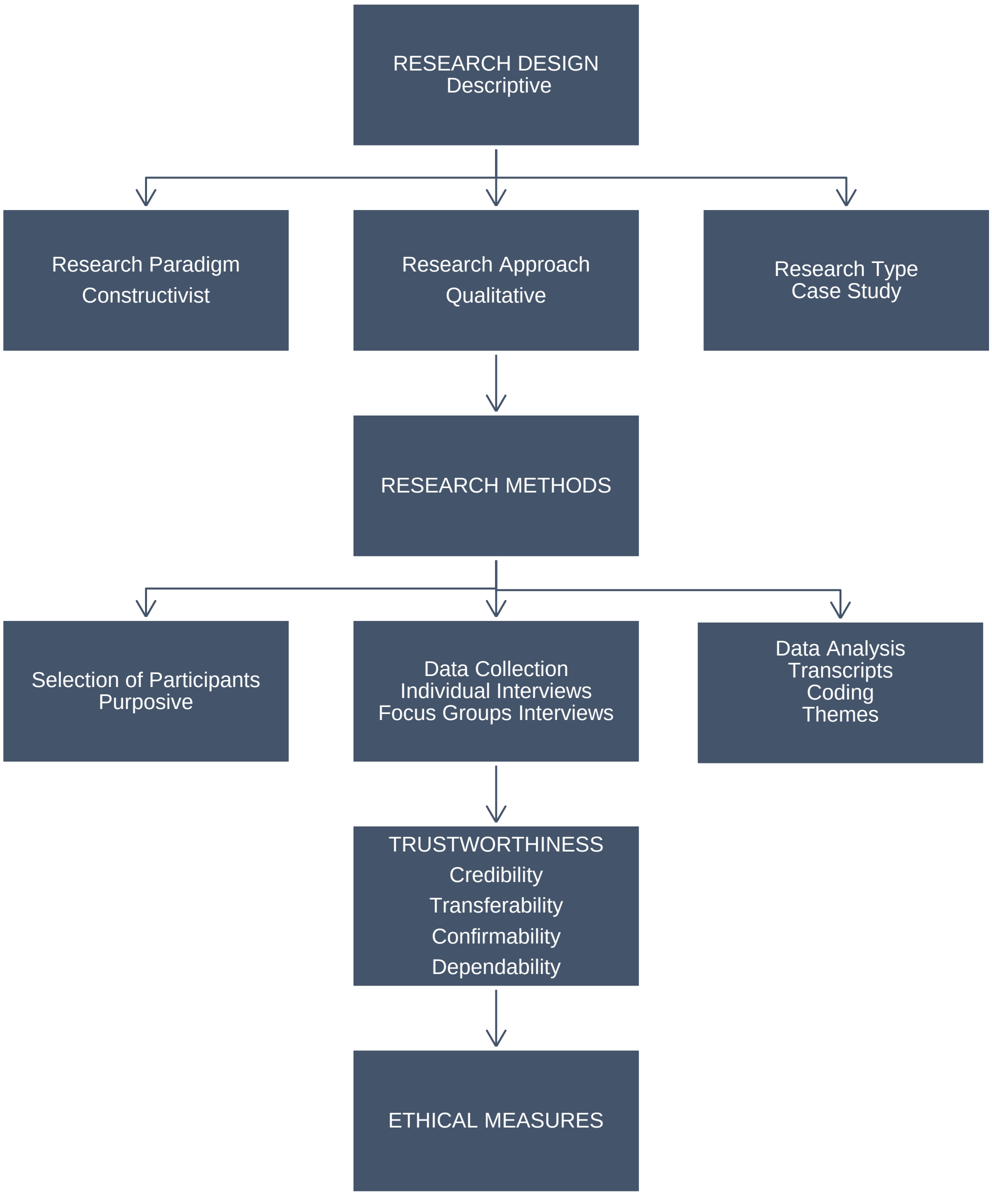
CHAPTER 4

RESEARCH DESIGN AND METHODOLOGY

4.1 INTRODUCTION

In Chapter 3, the literature on code-switching as a communicative strategy that enhances the quality of teaching and learning in mathematics with specific reference to its relevance, effectiveness, challenges, and benefits in mathematics classrooms, was reviewed. Mathematics performance and the language of teaching and learning used for mathematics teaching and learning were also discussed to give insight into the practice of code-switching. Chapter 3 explained what code-switching is, where it takes place, how it takes place, and its benefits. In sum, the previous chapter demonstrated that code-switching is a communicative strategy that enhances the teaching and learning of mathematics. To further understand its value, a qualitative approach was used to conduct the study to establish an in-depth and detailed understanding of code-switching in mathematics classrooms (Cohen, Manion & Morrison, 2018). The qualitative approach helped to study the phenomenon of code-switching in mathematics classrooms and make sense of and interpret this practice in terms of the meanings mathematics teachers and learners gave (Denzin & Lincoln, 2005).

Chapter four presents an analysis of the methodological options available for this study and the motivation for their selection as informed by the main research question. The following sections are discussed in this chapter: the rationale for empirical research, the research design methods used, including sampling and data collection and analysis. The chapter ends off with a discussion on the trustworthiness of the research as well as ethical measures. Figure 4.1 below serves as an overview of Chapter 4.



Source: Researcher's own work

Figure 4.8: Overview of Chapter 4

As the nature of the research question and the subject being studied determine the research methodology (Denzin & Lincoln, 2005), the research question and the sub-research questions that guided the study are highlighted in the next section.

4.2 THE RESEARCH QUESTIONS

In Chapter 1, the main research question: *How do mathematics teachers use code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in Grade 11?* was presented.

The following sub-research questions were formulated:

1. What does the scholarly literature say about code-switching as a communicative strategy to enhance mathematics teaching and learning quality in Grade 11?
2. How is code-switching relevant in teaching and learning mathematics of Grade 11 learners?
3. How effective is code-switching as a communicative strategy in enhancing quality in mathematics teaching and learning?
4. What are the challenges and benefits of code-switching in teaching and learning mathematics for Grade 11 learners?
5. What framework could be employed to enhance the quality in mathematics teaching and learning?

The next section presents the rationale for conducting this study.

4.3 RATIONALE FOR EMPIRICAL INQUIRY

Empirical research concerns how people directly or indirectly gain knowledge through observations and experiences (Pathan, 2012). The knowledge gathered is referred to as empirical evidence that can be analysed quantitatively or qualitatively. According to Bouchrika (2020), empirical research seeks to create new knowledge relating to how the world works. Quantitative research is an approach where variables are quantified and analysed to obtain results defined by the use of numbers and closed-ended questions (Creswell, 2014). This means that in quantitative research, numerical data are utilised and analysed using specific statistical techniques to answer closed questions such as who, how much, what, where, how many and how (Apuke, 2017; Creswell, 2014). In contrast, qualitative research is defined by language and open-ended inquiries (Creswell, 2014), which helps researchers explore and understand the meaning that individuals or groups attribute to a social or human problem.

After paying due regard to quantitative and qualitative approaches, a qualitative approach was deemed best suited for this study because of the knowledge and understanding of how participants (mathematics teachers and learners), through the use of code-switching, expressed themselves in sharing their views and experiences. The findings of the study would demonstrate if code-switching as a communicative strategy would enhance teaching and learning mathematics. If so, the study results would then guide how code-switching should be employed in teaching and learning of mathematics. This study has been prompted by the ongoing debate on whether code-switching in teaching and learning should be used when learners are taught mathematics in a foreign language. Effective teaching and learning have been the concern of some scholars who, over the years, have emphasised that classroom interaction becomes a great resource for successful lessons (Yusob *et al.,* 2018). Vorster (2008), as a result, saw an urgent need to find ways and means to assist multilingual learners to cope with the subject matter especially where English is used as a medium of instruction and where English is not the home language of the learners who often exhibit different levels of English proficiency.

The debate has demonstrated that code-switching is an important strategy to be employed for teaching and learning many subjects such as code-switching in teaching and learning science (Msimanga & Lelliot, 2013), code-switching as a technique in teaching literature in a secondary school ESL classroom (Moodley, 2001) and code-switching as a useful foreign language teaching tool for EFL Classrooms (Bhatti *et al.* (2018) where the medium of instruction is a barrier to effective teaching and learning (Maluleke, 2019; Pollard, 2002).

The researcher argues that when teaching and learning occur in an atmosphere where there is a challenge of communication as a result of the language of teaching, which is not the learners' first language, effective teaching and learning ceases to exist. In this situation, code-switching becomes an important strategy. Educational research is conducted to explore school problems and empower the educational actors (role players). The research, therefore, involves the community of teachers and learners to explore the beneficial output of education needed for social cohesion and economic prosperity (Poni, 2014).

4.4 RESEARCH DESIGN

Research design, which is the complete scheme or programme of the research, is the embodiment of the work to be done and how the work is to be done employing different research methodologies to best align with the paradigms (Kivunja & Kuyini, 2017). The research design relates to the transformation of a research idea into a research project or plans to be carried out in practice by a researcher or research team (Given, 2008).

Akhtar (2016) sees research design as a structure of research regarded as the *glue* that holds the elements in a research project together, but providing guidelines for various research activities, inter alia, selection of research approach and designing of sampling plan (Grover, 2015; Panthan, 2012) as well as the procedure followed by the researcher when data is collected, analysed, interpreted and reported (Grey, 2009). The research design gives the methods of collecting and analysing the data and enables the researcher to establish how all this will answer the research question. Kothari (2004) holds the view that research design is needed because of the help it offers to make research efficient, yielding maximal information with minimal expenditure of effort, time and money.

Cropley (2019) highlights the following six fundamental dimensions of research regardless of the orientation:

1. design which may be experimental, quasi-experimental, *ex-post-facto*, or non-experimental.
2. the setting which can either be in the laboratory or real-life.
3. data collection procedures that involve specific techniques for collecting data, namely, special apparatus, tests, questionnaires, observation schedules, and interviews.
4. the kind of data which can be ratio/interval, ordinal, nominal, non-numerical data, or narratives.
5. data analysis type which can either be done through statistical analysis or meaning-based analysis; and
6. the strategies for generalising findings which can either be hypothesis testing or hypothesis generation (Cropley, 2019:22-23).

Creswell (2014:42) regards research designs as types of inquiry within qualitative, quantitative and mixed methods approaches that provide specific direction for procedures. However, there are differences between and implications for each of these approaches, as indicated in Table 4.1 below.

Table 4.9: The difference between quantitative and qualitative approaches

DIMENSION	QUANTITATIVE APPROACH	QUALITATIVE APPROACH	IMPLICATIONS FOR THIS STUDY
Design	Experimental	Non-experimental	Case study design - non-experimental
Setting	Laboratory	Field	At schools
Data Collection	Instruments - electronic/ mechanical devices, tests, questionnaires	Collection of narratives which can be either existing diaries, or newly conducted interviews	Interviews - focus groups, f to-face and teleph interviews
Data Type	Numerical - ratio, interval, ordinal	Descriptive, for instance interview protocols, written records, or videos	Descriptive interviews
Analysis	Descriptive and analytic statistics	The analysis is aimed at revealing the meaning	Inductive analysis according to the themes
Generalisation	Focus on testing hypotheses	Focus is on generating hypotheses	The focus was on generalising findings similar studies

Source: adapted from Cropley (2019:22-23)

In this study, the researcher obtained qualitative data grounded in interpretivism. The sociological case study as the qualitative strategy for this study, was used for the study whilst ontology, epistemology, methodology and methods are the components of the paradigm which underpinned this research. The discussion hereunder focuses on the research paradigm, research approach and the research type that informed this study, based on beliefs and worldviews that guided this study.

4.4.1 Research Paradigm

The term paradigm comes from the Greek word *paradeiknya,* which means to show side by side. It denotes the idea of a mental picture or pattern or thought (Klein & Myers, 1999). Thomas Kuhn first used the term when he introduced it as an overall historical framework (Crotty, 1998). This term, over the years, has received different attention from various scholars (Boru, 2018; Guba & Lincoln, 1994; Kivunja & Kuyini, 2017; Rehman & Alharthi, 2016; Riyami, 2015). Clear and precise research is guided by a good understanding of the philosophical underpinnings that inform a researcher's choice of research questions, methodology and methods (Grix, 2004). According to Guba and Lincoln (1994), a paradigm can best be defined once one has had regard to three questions that are (i) ontological - what is the form and nature of reality and, therefore, what is there that can be known about it? (ii) epistemological - what is the nature of the relationship between the knower or would-be knower and what can be known? and (iii) methodological - how can the inquirer/would-be knower go about finding out whatever he or she believes can be known? The researcher's intentions, goals, and philosophical assumptions are inseparably linked with their research because one's view of reality and knowledge affect the research (Riyami, 2015).

A paradigm is thus a belief system and theoretical framework with assumptions encompassing ontology, epistemology, methodology and methods which assists in studying and understanding the reality of the world (Rehman & Alharthi, 2015). Classification of all educational research into a few paradigms is a very difficult exercise, particularly where research textbooks employ the terms quantitative and qualitative in describing the types of research. What has to be born in mind is that the main difference in research is at the level of ontological and epistemological assumptions (Crotty, 1998).

Although researchers have proposed a large number of paradigms, Candy (1989), who is held in high esteem as one of the leaders in the field, says that these paradigms can be grouped into three main taxonomies, namely positivist, interpretivism or critical paradigms. Tashakkori and Teddlie (2003a; 2003b) propose a fourth paradigm that borrows elements from the positivist, interpretivism or critical paradigm which they call pragmatic paradigm. Researchers should use the philosophical/methodological approach best suited to the problem investigated (Tashakkori & Teddlie, 1998). Different paradigms supporting educational research are thus positivism, interpretivism or constructivist, critical theory or transformative and pragmatism (Kivunja & Kuyini, 2017), each of which are discussed below.

4.4.1.1 Positivist paradigm

The positivist paradigm was first proposed by French philosopher Augustine Comte (1798-1857) (Kivunja & Kuyini, 2017). Comte (1856), after assuming that experiments, observations and reasons based on experience ought to be the basis of understanding human behaviour, held the view that these should be the only legitimate means to extend knowledge and human understanding. According to the positivist view, the phenomenon is that reality exists independently of humans and is dependent upon immutable laws. The ontological position of positivists is realism which relates to the quantification in research based on objectivity. Language and symbols are used to "describe phenomena in their real form, as they exist, without any interference whatsoever" (Rehman & Alharthi, 2016:53). Positivist researchers mainly conduct experiments because they believe that truths are facts that can either be proven or disproven (Ryan, 2018). Grover (2015) states that positivism is most suited to physical sciences where the matter dealt with is not subject to change with time and context and where physical parameters remain the same.

In terms of the positivist paradigm, its epistemology is seen as objectivist, its ontology naïve realism, its methodology experimental, and its axiology beneficence (Kivunja & Kuyini, 2017). Research methodologies suited to the positivist paradigm include experimental methodology, quasi-experimental methodology, correlational methodology, causal-comparative methodology, randomised control trials methodology and survey research methodology (Kivunja & Kuyini, 2017).

4.4.1.2 Critical or transformative paradigm

According to Kivunja and Kuyini (2017), the critical or transformative paradigm bases its research on social justice issues. It aims to address the political, social and economic issues which create social oppression, conflict, struggle and power structures. It is sometimes referred to as a transformative paradigm and this is so because it aims to change politics to confront social oppression and improve social justice. The paradigm assumes a transactional epistemology where the researcher interacts with participants, with the ontology of historical realism related to oppression, a dialogic methodology and axiology that respects cultural norms (Kivunja & Kuyini, 2017). The critical paradigm assumes that reality exists and has been shaped by cultural, political, ethnic, gender and religious factors that interact with each other to create a social system (Rehman & Alharthi, 2016). Epistemologically, according to the critical paradigm, is the assumption that no object is researched without being affected by the researcher as its approach is subjective. Educational researchers aim to change society and not merely to explain or understand it. The critical educational researcher confronts those in power and exposes the oppressive structures that subjugate people resulting in inequality.

Critical methodology engages the subjects in dialogue to bring about change in their outlook on social systems that keep them deprived of intellectual and social needs. The methodology is, therefore, dialogic and dialectical (Rehman & Alharthi, 2016). Methodologies suited for use in the critical paradigm are Neo-Marxist, Feminist theories, Cultural studies, Critical race theory, Freirean Studies, Participatory emancipation, Postcolonial/indigenous methodology, Queer theory, Disability theories, and Action research (Kivunja & Kuyini, 2017).

4.4.1.3 Pragmatic paradigm

Pragmatism is also a research paradigm with its methods based on historical contributions of the philosophy of pragmatism (Maxcy, 2003). The pragmatic paradigm is often associated with mixed or multiple methods where the focus is on the consequences of research and the research questions and not the methods themselves. It may engage both formal or informal rhetoric (Biesta, 2010; Creswell & Clark, 2011; Johnson & Onwuegbuzie, 2004; Maxcy, 2003; Morgan, 2014a; Teddlie & Tashakkori, 2009).

This paradigm came into being among philosophers who believed that it was impossible to access the truth about the real world based on a single scientific method such as advocated by the positivist paradigm. It was also not possible to determine social reality as the interpretivist paradigm did. What was required was a worldview that provided research methods most appropriate for studying the phenomenon at hand (Alise & Teddlie, 2010; Biesta, 2010; Tashakkori & Teddlie, 2003a, 2003b; Patton,1990). These theorists needed approaches to research that were practical and pluralistic and allowed a combination of methods that could shed light on the behaviour of participants and their beliefs behind those behaviours and the consequences that resulted from the different behaviours.

The need gave birth to a pragmatic paradigm that advocates a relational epistemology, a non-singular relational ontology and a mixed-methods methodology as well as value-laden axiology. Pragmatism came about to put an end to the two opposed positions of the positivist (and postpositivist) and the interpretivists. This, according to the theorists, would end the paradigm wars (Gage, 1989). The research methodologies suited for use in this paradigm are naturalist, narrative inquiry, case study, phenomenology, ethnography, action research, experimental, quasi-experimental and causal comparative.

4.4.1.4 Constructivist or interpretive paradigm

Constructivism, in the main, is associated with qualitative methods, literary and informal rhetoric where the researcher, as much as possible, relies on the participants' views and thereafter develops subjective meanings of the phenomenon (Creswell, 2014; Kaushik & Walsh, 2019). According to Creswell and Clark (2011), constructivist research proceeds from the bottom up, which means from individual perspectives to broad patterns and finally to broad understandings. The focus of the interpretivist paradigm is on understanding the subjective world of human experience (Guba & Lincoln, 1989). The approach seeks to concentrate on the subjects being studied to understand and interpret their thoughts or their meaning of the context. The aim is to understand the viewpoint of the subject being observed and not the viewpoint of the observer. The key tenet of the interpretivist paradigm is that reality is socially constructed (Bogdan & Biklen, 1998). This is the reason why this paradigm has been referred to as the constructivist paradigm.

A constructivist paradigm does not precede research - it is grounded on the data generated by the research act. Data, in this paradigm, are gathered and analysed consistent with the grounded theory (Strauss & Corbin, 1990). Most importantly, the paradigm assumes a subjectivist epistemology, a relativist ontology, a naturalist methodology and balanced axiology as its elements (Kivunja & Kuyini, 2017). In a subjectivist epistemology, researchers give meaning to the data through their thinking and cognitive processing as informed by their interactions with participants (Punch, 2005; Rehman & Alharthi, 2016; Ryan, 2018). The assumption of relativist ontology proceeds from the belief that the situation studied has multiple realities which can be explored and meaning made of them or reconstructed through human interactions between the researcher and the subject of the research and among the research participants (Creswell, 2014; Chalmers *et al.,* 2005; Rehman & Alharthi, 2016). Carr and Kemmis (1986) explain that where a naturalist methodology is assumed, the researcher uses data gathered through interviews, discourses, text messages and reflective sessions where the researcher is the participant-observer. According to Kivunja and Kuyini (2017), balanced axiology assumes that the result of the research will show the values of the researcher who attempts to present a balanced report of the findings. Conducting this study demonstrates, highlights and confirms the characteristics that are exhibited within the interpretivist paradigm, as set out by Lincoln and Guba (1985) and Morgan (2007) when they deal with the interpretivist paradigm.

This study is based on an interpretive paradigm that seeks to understand the phenomenon of code-switching in mathematics classrooms through close interaction with the participants in their natural settings at their respective schools. The teachers of mathematics and Grade 11 mathematics learners as the participants in this study, were able to share their experiences while code-switching in their classrooms. It is noteworthy that the researcher's personal opinions are also key in this knowledge construction with her worldview and her view of how knowledge is constructed is emphasised within the constructivist/interpretivist paradigm.

4.4.2 Ontological Assumptions

Scotland (2012) describes ontology as a branch of philosophy that deals with people's assumptions to sustain the belief that something makes sense or is real or the very nature or essence of the social phenomenon under investigation. The ontological assumption of this study refers to the experiences of mathematics teachers and their Grade 11 learners of the practice of code-switching which cannot be understood from one angle but the subjective narrative of mathematics teachers and their learners. As Kivunja and Kuyini (2017) put it, it is the philosophical study of nature or reality, of being or becoming, and the basic categories of things that exist as well as their relations. Ontology helps the researcher conceptualise the form and nature of reality and what one believes can be known about this reality. The nature of reality in this study lies in understanding the mathematics teachers' practice of code-switching. Philosophical assumptions about the nature of reality play an enormous role in understanding how meaning is made of the data that has been gathered. Richards (2003:33) and Riyami (2015) aptly describe ontology as the nature of our beliefs about reality. According to Guba and Lincoln (1994) and Rehman and Alharthi (2016), researchers have assumptions that in certain instances, these beliefs about reality are implicit, how it exists, and what is there that can be known about it.

The researcher, in this study, views reality about teaching and learning of mathematics in the fact that mathematics is taught in English First Additional Language, a foreign language, and thereby necessitating the practice of code-switching in the mathematics classrooms. It becomes an ontological question that immediately springs to mind to ascertain what kind of reality exists in the context, although embracing the idea of multiple realities when conducting qualitative research (Creswell, 2013).

4.4.3 Epistemological Assumptions

Epistemology originates from Greek, where the word *epistime* means knowledge. Kivunja and Kuyini (2017) explain that epistemology shows how people come to know something and how they come to know the truth or reality. Cooksey and McDonald (2011) look at epistemology as what counts as knowledge within the world. It relates to the basis of knowledge, its nature, and forms and how it can be acquired and communicated to other human beings. Through the assistance of Grade 11 mathematics teachers and learners as participants of the study, the researcher brings out the nature of knowledge and justification as interaction with the participants contributed to answering the research question. The responses of the participants further assisted the researcher in answering the question of whether reality should be perceived objectively or subjectively.

4.4.4 Methodological Assumptions

Cohen, Manion and Morrison (2018) state that qualitative research must be conducted in natural, uncontrived, real-world settings where there is minimal interference on the researcher's part. Data must be systematically collected, inductively and abductively analysed with constructs and findings being derived from the data during the research. Influenced by the researcher’s values. The research must have value depicted by the researcher’s choice of focus of the research, its framing and bounding, a method of working and data collection, analysing and reporting of the findings (Cohen *et al.*, 2018). The methodology seen as a broad term by Keeves (1997), refers to the research design, methods, approaches and procedures used in an investigation that is well planned to find out something. The researcher used a qualitative approach to collect and analyse the data gathered from mathematics teachers and their learners in their natural settings (classrooms) through the use of various data collection methods.

4.4.5 Axiological Assumptions

Kivunja and Kuyini (2017) argue that many ethical issues have to be borne in mind when research is conducted. The factors, in the main, relate to wrong and good behaviour that must be observed and respected when conducting the research. The value placed on the different aspects of the research, the participants and the audience that will receive the research results, are central to the research process and therefore need to be evaluated and understood. Regard has to be given to human values of those who are part of the research and participate (Finnis, 1980). Kivunja and Kuyini (2017) state that axiology refers to the ethical issues that need to be considered and that the consideration is founded on the understanding that human beings have a dignity that must be respected and that they, in the final analysis, have a fundamental human right to make choices which the researcher must respect. In this research, the participants were accorded the respect they deserved.

4.4.6 Research Approach

Every good thing that is done is preceded by good planning. The same thing applies to research work which is the search for knowledge and truth. Creswell (2010) sums up the business of research work. Research work, according to Creswell (2010), concerns five aspects namely (i) the research paradigm (the research methodologies) ;(ii) the knowledge of the research which is ontology; (iii) the way the research knowledge is driven which is epistemology; (iv) the value of the research knowledge which is axiology; and (v) how research knowledge is written. This is the rhetoric that refers to coherence between the five aspects. This then leads to the discussion on research approaches. Creswell (2014) defines research approaches as plans and procedures followed in research work starting from broad assumptions to detailed methods. Important decisions have to be taken during the planning. The decision regarding the approach to be followed plays an important role in the study. The philosophical assumptions the researcher employs such as procedures of inquiry (research designs) and specific research methods, data collection, analysis and interpretation are instrumental in the choice of the approach that the researcher intends to employ. The nature also informs the research approach of the research problem or issue being addressed, the researcher's personal experiences, and the study's audiences (Creswell, 2014).

Gaskell (2000) asserts that the choice of empirical research methods come from applying observation and experience to a research question and are not grounded in theory alone. Askarzai and Unhelkar (2017) explain that volumes of published studies guide the researchers on the choice of research methodology; however, there has been debate on the three platforms comprising quantitative, qualitative and mixed methods, where quantitative and qualitative methods are conciliated.

As the approach followed in this study is qualitative, quantitative and mixed methods approaches are briefly outlined and the qualitative approach is discussed in more detail.

4.4.6.1 Quantitative approach

Quantitative research is an approach for testing objective theories by examining the relationship among variables (Creswell, 2014). Askarzai and Unhelkar (2017) state that quantitative methodologists regard the quantitative approach as a valid research approach because they believe that reality (truth) can be measured or quantified. They further argue that phenomenon can be explained through quantification as they consider the quantitative method superior to the qualitative method. McLeod (2019), dealing with quantitative data information, explains that information is about quantities and therefore relates to numbers. The information is concerned with discovering facts about social phenomena, and it assumes a fixed and measurable reality. Therefore, it is important to note that the data obtained is collected through measuring things and thereafter analysed through numerical comparisons and statistical inferences. Bouchrika (2020) states that quantitative research methods are used to gather information via numerical data. This could measure behaviour, personal views, preferences and other variables. The data that has been gathered are analysed to address the research questions. The variables, could, in turn, be measured on instruments for data to be analysed using statistical procedures.

Research has strengths and limitations. Quantitative research findings are based on random sample selection and can, as a result, be generalised to a larger population. The findings are accurate and reliable as they are based on precise and quantitative data. The research findings can also be used to make quantitative predictions. Quantitative research is useful to study a large population and can analyse a large quantity of data, the collection of which is relatively quick (Askarzai & Unhelkar, 2017).

The analysis of quantitative data is not complicated, data is verifiable, and the statistical software makes the analysis relatively quick and lastly, the research is objective and the researcher independent (Askarzai & Unhelkar, 2017). However, quantitative research also has its limitations in that the research on human phenomena features such as motivation and perception, may provide limited results (Askarzai & Unhelkar, 2017). In addition, data collection is labour intensive with data analysis requiring data cleaning and the researcher requires more time to analyse as the sample size is large and requires knowledge of statistics and statistical software.

4.4.6.2 Mixed methods approach

Creswell (2014) explains that mixed methods research involves collecting both quantitative and qualitative data, integrating them and using distinct designs that may involve philosophical assumptions and theoretical frameworks. Therefore, a view is held that the combination of qualitative and quantitative approaches provides a deeper understanding of a research problem unlike where the two approaches are employed independently. Askarzai and Unhelkar (2017) define a mixed methods approach as a method where the researcher combines the different taxonomies of the qualitative and quantitative methods and regard mixed methods research as novel and vibrant research that is gaining momentum as the third option of research methodology.

The advantages of mixed method research are that the application of this method gives insight that a mono method cannot offer, it can enhance the validity of results, theory building, hypothesis testing and generalisations. It also provides a complete picture of research and its effects are less biased. It facilitates different dimensions of thinking for the researcher and has the added advantage of benefiting from the counterbalance of qualitative research's advantages and disadvantages. Apart from allowing a novice to take advantage of the experience of both methods, it gives room for presenting a greater range of different views resulting in better and stronger conclusions (Askarzai & Unhelkar, 2017). Limitations of mixed methods research is the knowledge of both qualitative and quantitative methods; however, it is time-consuming and may cost more than mono research. Its research findings may be contradictory, resulting from both quantitative and qualitative findings (Askarzai & Unhelkar, 2017).

Based on the discussion about quantitative and mixed methods approaches above, after careful consideration and being influenced and informed by the research question, a qualitative approach was deemed appropriate for the study and is fully discussed below.

4.4.6.3 The qualitative approach

Empirical research methods, in this instance, are qualitative as experience and observation are located in the consciousness of the research where the researcher's subjects are unique to the time and the individual. According to Gaskell (2000), qualitative research provides rich and valuable information sources that bring about new ways of inquiry because the research subjects provide the researcher with unexpected perspectives on the research question. Johnson and Christensen (2014) confirm that in the qualitative approach, knowledge comes from experience. The choice of qualitative approach to guide this study and the interest in such a method have been informed and motivated by the recognition that teaching and learning in a second language is complex. To unearth the complexity and have a more in-depth examination and understanding of individual learners and their teachers, their behaviours and their experiences, one needs to have proper regard for how teaching and learning takes place and the factors that affect the process (Nassaji, 2015).

Aspects of qualitative research involve answering a research question that cannot be quantified, properly dealing with the research question that is primarily concerned with opinions and beliefs of individuals and the investigator's desire to have a clear and detailed understanding of the complex and vexed issue (Jameel & Majid, 2018:2). The information sought would also determine what needed to be emphasised as well as the effectiveness, accuracy and validity of the study. The qualitative approach, which is subjective and aimed at understanding a social phenomenon, is used to understand human behavioural factors (Askarzai & Unhelkar, 2017; Bouchrika, 2020; Creswell, 2014).

Albert Einstein's famous quote "not everything that counts can be counted, and not everything that can be counted counts" forms Askarzai and Unhelkar's (2017) basis in their argument in favour of qualitative research. Dadich and Fitzgerald (2011) affirm that qualitative research has no universal definition, which Hennink, Hutter and Bailey (2020) confirm that qualitative research is a broad umbrella term covering a wide range of techniques and philosophies. However, they argue that qualitative research is an approach that enables one to examine people’s experiences in detail by using a specific set of research methods, inter alia, in-depth interviews, focus group discussions, observation, content analysis, visual methods and life histories or biographies. It is much more than just the application of qualitative methods. They argue that the simple application of the methods does not automatically make one a qualitative researcher.

According to Hennink *et al.* (2020), one of the most distinctive features of qualitative research is that the approach allows one to identify issues from the perspective of one’s study participants and understand the meanings and interpretations that they give to behaviour, events or objects to obtain an insight into the interpretations about a phenomenon that cannot be possible with quantitative research (Askarzai & Unhelkar, 2017). This means that qualitative research methods assist in gathering non-numerical data and determining the underlying reasons, views or meanings from study participants or subjects (Bouchrika, 2020).

Creswell (2014) regards qualitative research as an approach followed when exploring and understanding the meaning individuals or groups ascribe to a social or human problem or exploring and seeking to explain how and why a particular phenomenon or behaviour operates as it does in a particular context. McLeod (2019) confirms that the qualitative approach concerns understanding human behaviour from the informant’s perspective, which assumes a dynamic and negotiated reality.

Creswell (2014) explains that the characteristics of qualitative research are that it occurs in natural settings, which is where participants experience the problem under study, the researcher is a key role player as he/she collects data through examining documents, observing behaviour, or conducting interviews. The research process is flexible rather than fixed and involves multiple sources of data obtained through observations, interviews, documents, and audio-visual information, it uses inductive and deductive data analysis allowing the researcher to build patterns, categories and themes from the bottom-up, organising data into more abstract units of information. In qualitative research, participants’ meanings are more significant and highly esteemed above those of the researcher and in addition, qualitative approach is reflexive and gives a holistic account of the research. McLeod (2019) states that the direct and close involvement by the researcher enables the researcher to have an insider's view of the field, which has an added advantage in that the researcher can find issues that are often missed (such as subtleties and complexities) by the scientific, more positivist inquiries.

The main strengths of qualitative research are that it provides complex textual descriptions of how people experience phenomena. It can be used to explore sensitive topics and culturally defined experiences providing valuable insight into a phenomenon, people's behaviour, perception, and experience. Qualitative research provides a deep understanding of a complex phenomenon, it is useful to study a case and the data set is generally small, convenient and cost-effective to create (Askarzai & Unhelkar, 2017).

The major criticism of this approach is the lack of adequate validity or reliability. Limitations of qualitative designs do not generally draw samples from large-scale data sets because of the time costs involved. The subjective nature of qualitative data and its origin in single contexts makes it challenging to apply conventional standards of reliability and validity (Askarzai & Unhelkar, 2017; McLeod, 2019).

As informed by the research question, this study adopted a qualitative approach to explore how teachers and mathematics learners engage in their classrooms using English First Additional Language and code-switching to the learners' home language (Xitsonga) to enhance their learning and teaching of mathematics. The researcher was aware that this approach focuses on the personal, subjective, and experiential basis of knowledge (Kielmann, Cataldo & Seely, 2012) and as such teachers, learners, and the researcher were involved in constructing meaning involving code-switching as the communicative strategy that enhances the teaching and learning of mathematics. The interaction took place in the natural setting of their schools (Creswell, 2014) and rich data were collected through the use of face-to-face individual and focus group interviews. This resulted in a deeper understanding of code-switching as a communicative strategy in the teaching and learning of mathematics (Nassaji, 2015).

Kielmann *et al.* (2012) argue that qualitative research, in general, does not always adhere to a constructivist view of the world, which suggests that reality is in the eye of the beholder. This simply means that there is no single reality for a given phenomenon but multiple, relative dimensions of reality which can only be partially captured using subjective and naturalistic methods. Kielmann *et al*. (2012) argue that qualitative research, which focuses on the personal, subjective and experiential basis of knowledge, is humanistic, is holistically situated in the meaning of particular behaviours and ways of doing things in a given context in contradiction to isolating these as quantitative researchers would. Qualitative researchers aim more often to explain rather than merely describe, as they are constantly trying to make sense of what they see and hear in a specific context (Kielmann *et al.,* 2012), a view that aligns with this study's aim.

4.4.7 Research Strategy

Askarzai and Unhelkar (2017) identify four areas (strategies) of qualitative research which are case study, ethnography study, phenomenological study, grounded theory study while Bhawna and Gobind (2015) add content analysis. According to Bhawna and Gobind (2015), the strategies represent research built upon inductive reasoning and associated methodologies. It must be remembered that the aim of qualitative research is to gain a deep understanding of a specific organisation or event and not a surface description of a large sample of a population (Bhawna & Gobind, 2015; Yin, 2003). Its further aim is to provide an explicit rendering of the structure, order and broad patterns found among a group of participants which they call ethnomethodology or field research.

In this study, the researcher explored code-switching as a communicative strategy that enhances the teaching and learning of mathematics in Grade 11. The exploration was based on the researcher's intention to answer the questions related to the employment of code-switching in mathematics classes and how it can enhance the quality of teaching and learning in these classrooms (Baxter & Jack, 2008; Bhawna & Gobind, 2015). The researcher, therefore, chose the case study design that was framed within the qualitative approach and is discussed in the following section.

4.4.7.1 Case Study

Yin (2003) views a case study as a research strategy and an all-encompassing method that covers the logic of design, data collection techniques and specific approaches to data analysis. As a research strategy, Yin (2003) explains that a case study contributes to knowledge of the individual, group, organisational, social, political and related phenomena. A case study is used in many situations and enables investigators to retain the holistic and meaningful characteristics of real-life events inter alia, individual life cycles, organisational and managerial processes, neighbourhood change, international relations and the maturation of industries (Yin, 2003). The case study chosen for this study enabled the researcher to retain the characteristics of real-life events of code-switching holistically and meaningfully in the teaching and learning of mathematics in Grade 11 within the classroom environment and understand the employment and the implications of code-switching in the teaching and learning of mathematics in Grade 11 classrooms in Mopani District, Limpopo Province, South Africa.

Cherry (2021) defines a case as an in-depth study of a person, group or event where nearly every aspect of the subject's life and history is analysed in search of patterns and behavioural causes. Case studies are usable in different fields such as psychology, medicine, education, anthropology, political science and social work (Cherry, 2021). Yin (2009) discusses the four main case study designs which are a single-case design with its focus on a critical case that has never been researched, the embedded single case wherein more than one unit of analysis is incorporated, multiple case designs where two case studies are compared and the embedded multiple-case design in which different subunits are involved using a range of instruments.

Various researchers have classified types of case study research. An ethnographic case study focuses inter alia, on the culture of a school or a group of students or classroom behaviour, a historical case study deals with the descriptions of institutions, programmes and practices as they evolved in time where historical organizational case study is common and a sociological case study focuses on the constructs of the society and socialisation in studying the educational phenomena (Merriam, 1998). Cohen *et al.* (2018:377) cite Merriam (1998) who classifies the types of case study in terms of their outcomes namely as being exploratory (can be to generate hypotheses that are tested on a larger scale), descriptive (provides narrative accounts) and explanatory (used to test theories). Cohen *et al*. (2018:377) also cite Yin (2009) who categorises the types of case study according to the intent of the study as descriptive, interpretive (developing conceptual categories inductively to determine initial assumptions) and evaluative (involves description, explanation, and judgment). Cohen *et al.* (2018:378) further cite Stake (1994, 1995, 2005) whose identification of the three types of case study is as follows: intrinsic case studies which are followed to understand the particular case in question, instrumental case studies which examine a particular case in to gain insight into an issue or theory and the multiple/collective case studies which consist of groups of individual studies that are undertaken to gain a fuller or more general picture broadly related to teaching and learning.

The researcher, informed by the types of case studies, preferred the descriptive case study (Merriam, 1998) because it focuses on the constructs of Grade 11 mathematics teachers and their learners and how they employ code-switching during teaching and learning. The descriptive case study was deemed the best choice as it is central to the general arena of education (Merriam,1998). The case study is also instrumental as it seeks to understand the practice of code-switching in Grade 11 mathematics classrooms in Mopani District, Limpopo Province where the study was conducted. The preferred case study exposed the researcher a great deal of information and facilitated the gathering of data about the employment of code-switching (Cherry, 2021). However, there are limitations to the use the case study which are, inter alia, that the case study cannot necessarily be generalised to the larger population, cannot demonstrate cause and effect, may not scientifically be rigorous, and can lead to bias (Cherry, 2021) but the benefits far outweighed their advantages.

The researcher, in conducting this case study, considered the steps that are relevant for the conduction of the case study as outlined by Creswell (2013:121-122):
In identifying the specific case for this study, the researcher identified mathematics teachers and Grade 11learners in rural areas of Mopani District in Limpopo Province, South Africa as participants for the case study because they were perceived as the right people who could provide the case with rich data that in turn, would assist in providing answers to the research question.

1. The researcher identified code-switching as a communicative strategy to enhance quality in the teaching and learning of mathematics as the intent and issue that required attention.

2. Selecting the data source helped the researcher access information which would resolve the issue of code-switching which necessitated this case study was through the identification of mathematics teachers and their Grade 11 learners (the study participants).
3. Qualitative data collection instruments that were used for gathering data in this case study included semi-structured interviews and focus group interviews.
4. The collected data were analysed and interpreted in the context of the case, which involved the employment of code-switching in the teaching and learning of mathematics in Grade 11. Data were analysed and the emerging of themes contributed to the understanding of the investigated case.

4.5 RESEARCH METHODS

Igwenagu (2016) states that research methods are the means or modes of data collection, or sometimes referred to as an explanation of how a specific result is to be determined. Research methods are processes of systematic resolution of the research problem and are a combination of all those methods or techniques used in the conduction of research (Kothari, 2004). Research methods, in other words, constitute a scientific study of conducting research when solving a research problem. Johnson and Christensen (2014:869) simply regard research methods as instruments used to identify, study and justify research problems. The research methods selected for this study were informed by the research question (Maxwell, 2012). These methods provided triangulation required for the conduction of qualitative research in that various data collection methods were employed to develop a comprehensive understanding of the practice of code-switching in mathematics classrooms.

The sub-sequent sections present an overview of the study population, the sampling methods employed, data collection strategies and data analysis.

4.5.1 Study Population

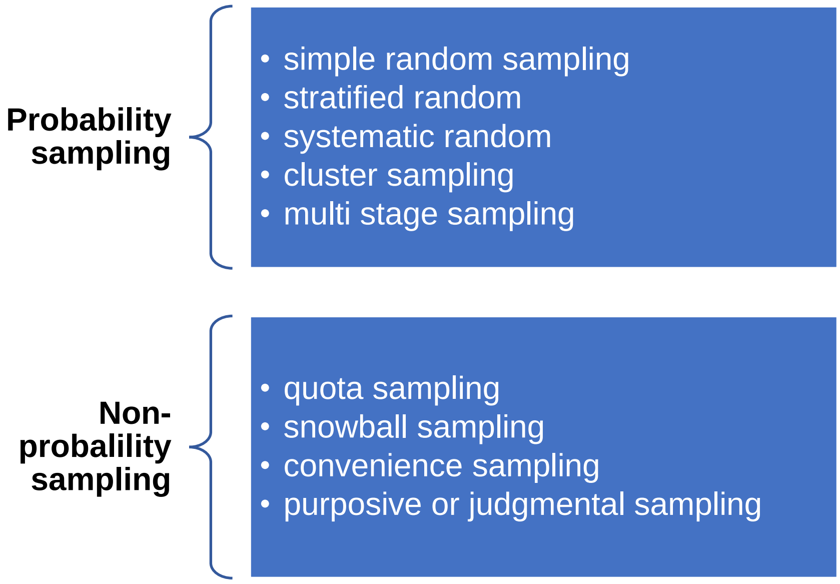
Johnson and Christensen (2014) regard population as a larger group to which a researcher wants to generalise the sample results referred to as a complete set of cases. Datta (2018) defines population as all members who meet a set of specifications or a specified criterion. Educational research aims to access people (participants) who are essential for providing data by answering the necessary research questions. The mathematics teachers and Grade 11 mathematics learners in Limpopo Province were eligible for selection because they met the requirements for the study and were situated within rural settings.

The population of the study was considered to identify prospective participants for sample from which the researcher would collect the data. According to Johnson and Christensen (2014), a sample is a set of elements or cases taken from a larger population and may consist of either probability or non-probability sampling. The total population of this study involved one hundred and fourty three (143) high schools, one hundred and fourty three (143) Grade 11 mathematics teachers and ten thousand six hundred and fourty nine (10 649) Grade 11 mathematics learners.

4.5.2 Sampling Process

Given (2008) defines a sample as a set of data sources drawn from a larger population with potential sources of information relevant to the study or the process of choosing actual data sources from a larger set of possibilities. Scholars seem to be unanimous in their definition of sampling, which applies different principles in identifying people who become participants in a study (Cropley, 2019; Showkat & Parveen, 2017). Therefore, selecting a sample from the population relates to the sampling process and involves identifying people and carefully selecting them for participation in a study that involves different principles in both quantitative and qualitative research (Cropley, 2019).

The diagram below (Figure 4.2) illustrates the two main research sampling techniques, probability and non-probability sampling, and their types:



Source: adapted from Taherdoost (2016:20)

Figure 4.9: Sampling Techniques

The use of probability and non-probability sampling depends on the research approach. Probability sampling methods are used in quantitative research while non-probability sampling methods are used in qualitative research (Cropley, 2019; Given, 2008; Showkat & Parveen, 2017). Informed by the research question, the researcher, in conducting this study, opted for the use of non-probability sampling techniques with the number of participants in the study being influenced by the time required to analyse the data and the availability of financial resources for this study (Cohen *et al.,* 2008). Table 4.2 below highlights the strengths and limitations of probability and non-probability sampling adapted from the different scholars indicated.

Table 4.10: Strengths of probability and non-probability sampling

STRENGTHS OF PROBABILITY AND NON-PROBABILITY SAMPLING:		
STRENGTHS	**PROBABILITY [RANDOM SAMPLING]**	**NON-PROBABILITY [NON-RANDOM SAMPLING]**
Strengths	The sample is representative of the population. They are much more accurate. Has less risk of bias. Findings are generalisable to the population.	Is a useful convenient selection method. Less complicated to set up. Less expensive to implement. The technique requires less time to complete.

Source: adapted from Alvi (2016); Datta (2018)' Cohen *et al*. (2018); Showkat & Parveen (2017)

Table 4.3: Limitations of probability and non-probability sampling

LIMITATIONS OF PROBABILITY AND NON-PROBABILITY SAMPLING:		
LIMITATIONS	**PROBABILITY [RANDOM SAMPLING]**	**NON-PROBABILITY [NON-RANDOM SAMPLING]**
Limitations	They require more work to implement. They are time-consuming. They are costly.	Findings lack generalisability. May demonstrate bias. The sample is not representative of the population.

Source: adapted from Alvi (2016); Datta (2018)' Cohen *et al*. (2018); Showkat & Parveen (2017)

4.5.3 Non-Probability Sampling

The researcher employed non-probability sampling for this study. The advantages tabulated in Table 4.2 above informed the data collection technique, which for the careful selection of participants for the study (Given, 2008). Using non-probability sampling, the researcher selected teachers who taught mathematics to Grade 11 learners (Given, 2008). The participants were perceived as relevant as they could share their experiences of the use of code-switching in mathematics classrooms which would offer more insight into the phenomenon and explain how the practice of code-switching could be used as a communicative strategy that enhances the teaching and learning process. Non-probability sampling, according to Datta (2018), enabled the researcher to develop a good understanding of the population and was deemed most suited for this study.

There are four types of non-probability sampling as discussed below:

1. *Quota sampling* is where the participants are chosen based on predetermined characteristics so that the total sample will have the same distribution of characteristics as the wider population.
2. *Snowball sampling* uses a few cases to help encourage other cases to take part in the study, thereby increasing the sample size.

3. *Purposive or judgemental sampling* is a strategy in which particular settings, persons, or events are deliberately selected to provide important information that cannot be obtained from other choices.
4. *Convenience sampling* is where participants are selected because they can easily be found and are readily available (Taherdoost, 2018:22).

For this study, the researcher chose purposive sampling which is discussed hereunder.

4.5.3.1 Purposive sampling

According to Crossman (2020), purposive sampling is a research technique of non-probability sampling that selects a sample based on its characteristics and the study aim. It is known as judgemental, selective or subjective sampling. There are seven types of purposive sampling: heterogeneous, homogeneous, typical case, deviant case, critical case, total population and expert. Etikan and Bala (2017) state that judgemental or purposive sampling is based on the researcher's judgement as to who could provide the best information to meet the aims and objectives of the study and would be willing to share the information (Etikan & Bala, 2017). In purposive sampling, the researcher specifies the characteristics of the population of interest and locates individuals within the group with those characteristics, thus deliberately enabling the researcher to obtain information that could not easily be obtained or is not readily accessible from other choices (Maxwell, 2012).

Informed by Etikan and Bala, mathematics teachers and Grade 11 learners as participants were selected for the research as they could best share their experiences of code-switching because they employed the practice in their classrooms. This study employed the total population sampling technique because the sample was derived from all the teachers who taught mathematics in Grade 11 and their learners. The sampling process in this study started with the identification of ten high schools that offered mathematics as one of their teaching subjects and were located in the rural areas of Mopani East District in Limpopo Province. The researcher, having been a teacher in schools situated in the rural setting, regarded these schools as ideal for conducting this study and because of the practice of code-switching. Male and female teachers as well as learners sampled were carefully selected and had rich data that was required for the study.

After obtaining the approvals to research from the Ethics Research Committee of the University of South Africa (Appendix A) and the Limpopo Department of Education (Appendix C), the researcher then met the three circuit managers of the sampled schools seeking permissions to conduct the research in the sampled schools (Appendices D-I). Thereafter, the researcher visited the ten sampled schools to discuss the proposed research with the principals and then met with mathematics teachers and learners to discuss the proposed research and the logistics of conducting the interviews. Fourteen mathematics teachers agreed to participate in face-to-face interviews. The sampled teachers were all qualified to teach mathematics in Grade 11 in that they possessed a teachers' qualification, some teachers had first degrees while others had post-graduate qualifications.

Learners from high schools were further sampled to participate in focus group interviews comprising six members per group. The learners' focus group interviews were organised to understand the learners' views regarding the practice of code-switching to confirm what their teachers shared. Six schools participated in focus group interviews with six members whilst in the sixth school one learner failed to participate as planned, bringing the total number of learner participants to thirty-five. Each participating school had one class of Grade 11 mathematics and the participants were drawn from these classes. The participating focus groups consisted of average, below average, and above-average performers in their classes. Their teachers were very helpful in the selection of the learners to participate in these focus groups. It is important to note that all participating learners were at schools situated in the rural areas of Mopani East District, Limpopo Province within a thirty-kilometre radius of the researcher's residence. This was designed to enable the researcher to travel to the research sites with ease since the interviews were conducted during the fourth term when the learners were preparing for their final examinations. All the learners who participated in the study were aged between sixteen and eighteen years and the teachers were between thirty-five and fifty-eight years. The interview guides that were used for face-to-face interviews and focus group interviews are attached herein (Appendices R and S).

Table 4.3 below, a summary for the sample of the study, depicts the schools, teachers, and learners.

Table 4.4: Summary for the study sample size

PARTICIPANTS	SAMPLING METHOD	NUMBER	DATA GATHERING INSTRUMENT
Schools	Purposive	10	Not applicable
Teachers	Purposive	13	Face-to-face individual interviews
Learners	Purposive	35 (6 groups)	Focus group interviews
Total		**48**	

4.5.4 Data Collection

In conducting any research data collection is vital as the collected data enables the researcher to answer the research questions. Kabir (2016) confirms this stating that all data collection aims to capture quality evidence that translates to rich data analysis and allows the building of a convincing and credible answer to questions posed.

Qualitative data collection methods that the researcher considered for this study were open-ended and less structured (Kabir, 2016) and primarily relied on interactive interviews, which ensure to ensure the credibility of the findings. The research interview aimed at obtaining relevant information on code-switching in mathematics classrooms from the mathematics teachers and Grade 11 learners. Interview presupposes that a specialised form of communication between people for a specific purpose associated with a specific subject matter is conducted (Anderson, 1990). The interview in this regard, would serve as a rich source of valuable information relating to the participants' experiences and understanding of the practice (Dilshad & Latif, 2013).

4.5.4.1 Semi-structured interviews

Interview are one of the main methods of collecting data in qualitative research (Kielmann *et al.,* 2012). Interviewing has a variety of forms that include individual, face-to-face interviews and face-to-face group interviews (Kabir, 2016). Interviews can be structured, semi-structured, or unstructured. Face-to-face interviews are advantageous because detailed questions can be asked and probing can be done to provide rich data; however, the asking and answering of questions can be achieved and mediated by the telephone or other electronic devices. argue that Interviews can be conducted in various settings to collect information on a specific theme or topic. In conducting interviews, Kielmann *et al*. (2012) state that one has to think about the context of the research and adapt the interviewing style accordingly. They further explain that an interview needs to be conducted in a private place to avoid people overhearing the discussion, especially where the interview involves sensitive topics.

Interviews contain a mix of open-ended and close-ended questions and cover fairly specific topics or themes (Kielmann *et al.,* 2012). Individual face-to-face interviews relate to interactions between the researcher and the individual interviewee. Individual interviews in this study enabled the researcher to obtain detailed information about the understanding of code-switching in mathematics classrooms. Individual were conducted in the form of face-to-face interviews (Mathers *et al.,* 2009) and telephonic interviews for follow up interviews, if required. Telephonic and video interviews are similar in that they enable the researcher to interact with the participants from an unlimited geographical area where the face-to-face interview is impractical; however, this presupposes that the participants have access to telephones (Saarijarvi & Bratt, 2021; Ryan *et al.,* 2009). The researcher employed telephone interviews with mathematics teachers when it became a challenge to hold face-to-face follow-up interviews because of restrictions with the Covid-19 pandemic. The challenge with telephonic interviews is that the participants may be reluctant to answer the call. This might have been the position when one of the teachers could not be found in a follow-up telephonic interview. Another challenge regarding telephone interviews could be that the participant may not be reached due to network problems which could have been the problem when the researcher could not access the teacher (participant) during the study

The interviewer should work with a loosely structured topic guide or checklist with topics to be covered. This guide may include some questions that are more structured than others. The questions may be followed up by less structured ‘probes’ which enable the interviewer to follow up on a topic for purposes of getting more information.

Unstructured interviews that resemble an ordinary conversation may also be helpful as the participants are least constrained to respond to the questions. In this study, as per Given (2008, the researcher developed an interview schedule to guide interview mathematics teachers' face-to-face interviews (*cf*. Appendix S). The interview schedules contained questions that were carefully framed to address the sub-research questions and were determined by the nature of the research aims and objectives of the study. The researcher, therefore, asked the questions which answered the research questions and used follow-up probing questions to gather more valuable information during the interviews and clarify specific points.

According to Gundumogula (2021), it is encumbered upon the researcher to ensure that the interview session is accessible and convenient to the participants and the researcher. This research was duly informed by Gundumogula (2021) and Ryan *et al.* (2009) in the planning and in conducting of the interview sessions as follows. The planning for the interviews was done in advance to ensure that the settings where the interviews were to be held were conducive to engaging in interviews would be free from interruptions or impediments.

The focus group interviews in this study promoted interaction with spontaneity among the participants (Grade 11 mathematics learners). This is in line with the assertion of Thomas *et al.* (1995) cited by Gundumogula (2021).

4.5.4.2 Focus group interviews

Focus group interviews, a qualitative technique for data collection, are conducted with individuals with specific attributes that deal with a given issue or topic (Anderson, 1990). Denscombe (2007) states that a focus group has between six and nine participants who work together when providing the researcher with the information about the study. It was essential to involve the learners in the study to supplement information from the teachers and elicit the learners' perspective on code-switching as an important communicative strategy for teaching and learning in mathematics.

The researcher held six focus group interviews with Grade 11 learners studying mathematics to triangulate the mathematics teachers' understanding of code-switching (Gundumogula, 2021). Six focus group participants of six members were informed about the interview date, time, and venue in advance, which was a Grade 11 classroom with enough light and ventilation where circular seating was used, as represented in Figure 4.3. The researcher provided refreshments since the interviews were held in the afternoon after the school day had ended. Focus group interviews in the six schools lasted for fourty minutes.

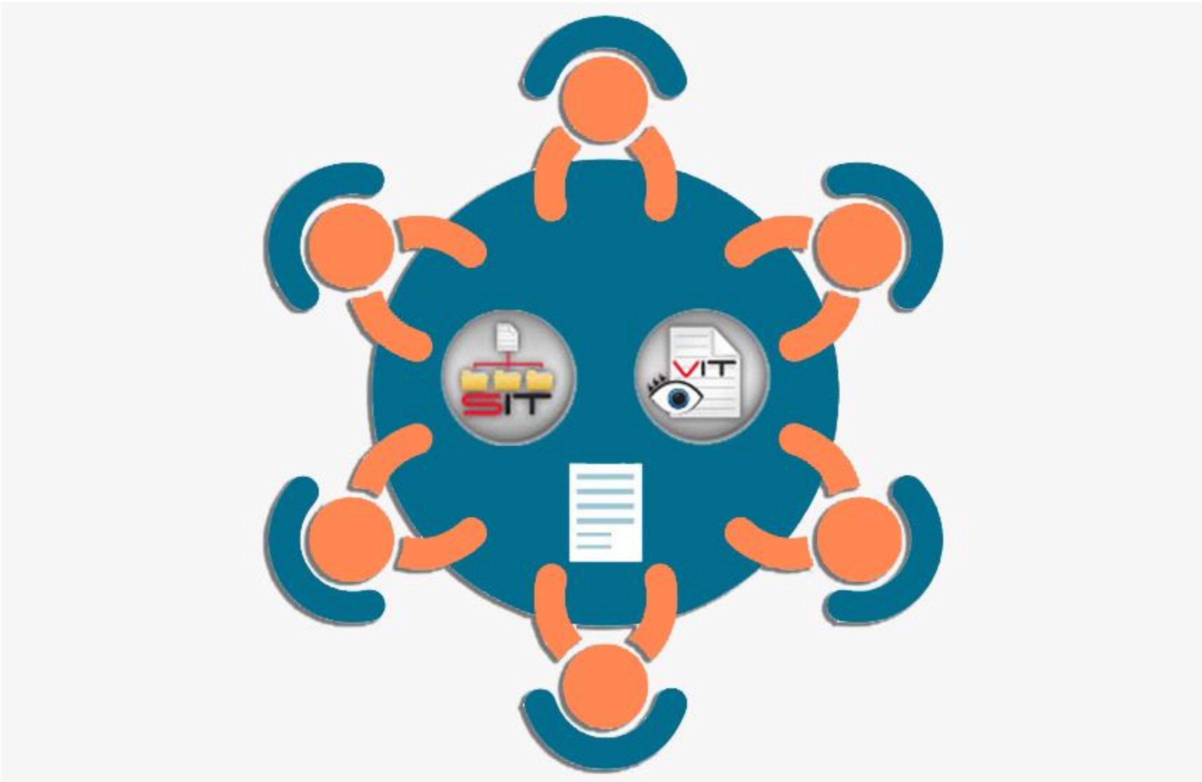


Figure 4.10: Representation of focus group interviews

Source: https://images.app.goo.gl/bnbzBG6wDfiMFTV56

4.5.4.3 Summary of data collection instruments

Data collection techniques applicable to this study were face-to-face interviews with telephonic interviews as a follow-up interview, if required and focus group interviews. The researcher conducted face-to-face interviews with mathematics teachers as well as focus group interviews with Grade 11 mathematics learners during 2019 before the outbreak of the Covid-19 pandemic whilst the telephonic interviews with mathematics teachers were conducted as a follow-up to the first interviews. The teacher’s interviews lasted for thirty minutes.

Table 4.4 is a summary of qualitative data collection techniques, their advantages as well as their disadvantages used in this study, based on the works of Creswell (2013), Kabir (2016) and Kielmann *et al*. (2012).

Table 4.5: Qualitative data collection types, advantages, and disadvantages

DATA COLLECTION TYPE	ADVANTAGES	DISADVANTAGES
Face-to-face Interviews	Useful when participants cannot be directly observed Detailed questions can be asked Further probing can be done Direct and without delays due to technical interruptions	Provision of indirect information filtered through the views of interviewees They are more costly They are also time-consuming They may also be unsafe due to travel
Telephonic Interviews	Provides free flowing of data Ensures anonymity and privacy of participants They are cheaper and faster to conduct Allows clarification of issues	Data are gathered in a designated place and not a natural setting Only accessible for people with telephones Inappropriate for exploration of sensitive issues Facial expressions, body language, and other verbal signals are not observed.
Focus-group Interviews	Offers an opportunity for gathering information about shared understandings of real-life situations Provides an understanding of the participants’ reactions as they interact Contributes to the deeper and richer data than those from one-to-one interviews	The researcher’s presence may contribute to bias The researcher does not have control over the groups It may be a challenge to organise these groups It is difficult to analyse and interpret focus group data

DATA COLLECTION TYPE	ADVANTAGES	DISADVANTAGES
	Complement other methods of data collection for in-depth information in a short time	

Source: adapted from Creswell (2014:241-242); Gundumogula (2021); Kabir (2016:211); Kielmann *et al*. (2012); Saarijarvi & Bratt (2021)

4.6 Data Analysis

After the interview session, the researcher transcribed the audio recordings, and the verbatim transcriptions were safely stored in preparation for data analysis. Audio recordings were saved on a flash drive which was locked away for safekeeping at the researcher's residence together with the recording device. An example of the transcribed interview is attached as Appendix Y, whilst the voice recordings and the soft copy of the transcripts were saved on a flash disc submitted to the supervisor. Data transcription enables the researcher to familiarise herself with the collected data (Caulfied, 2019; Maguire & Delahunt, 2017).

Flick (2013:3) defines qualitative data analysis as the classification and interpretation of linguistic (or visual) material to make statements about implicit and explicit dimensions and structures of meaning-making in the material and what is represented. Creswell (2013) explains that absolute care must be taken when data are analysed because not all the information is usable in a qualitative study. Flick (2013) regards data analysis as a central step in qualitative research as it produces the research outcomes. Table 4.5 is the researcher’s summary of the advantages and disadvantages of qualitative data analysis.

Table 4.6: Advantages and disadvantages of qualitative data analysis

ADVANTAGES AND DISADVANTAGES OF QUALITATIVE DATA ANALYSIS	
ADVANTAGES	**DISADVANTAGES**
In-depth analysis provides researchers with a detailed analysis of subject matter Assists researchers in understanding the mindset of participants	Time-consuming Not easy to generate Dependent on the researcher’s skills

Gathered data may assist the researcher to conduct further research in future	

Source: Researcher's own summary

Qualitative data analysis in this study aimed to explain, through the gathered data, how code-switching as a communicative strategy can be used to enhance the teaching and learning of Grade 11 mathematics in the Mopani District of Limpopo Province.

4.6.1 Qualitative Data Analysis

The word data describes valid information that helps the researcher answer his/her research question(s) (O'Connor & Gibson, 2003). Data comes from notes, observations, interview tapes, transcripts, newspaper clips, personal journals and any other relevant and related sources. O'Connor and Gibson (2003) suggest that once data has been collected, it should be organised and properly thought about as it is concerned with meaning.

4.6.2 Data Analysis Process

Qualitative data can be analysed manually or through the use of computer programmes that are referred to as QDA (Qualitative Data Analysis) software or CAQDAS (Computer-Aided Qualitative Data Analysis Software) (Flick, 2013). However, this study analysed data manually in line with the qualitative content analysis process that incorporated Maguire and Delahunt's (2017) analysis process, presented in Table 4.6 hereunder.

Table 4.7: Data analysis process

DATA ANALYSING AND REPRESENTATION	CASE STUDY	THE PROCEDURE FOR THIS STUDY
Familiarise yourself with the data	Reading the transcripts	After the data transcription, the researcher read and re-read the data to familiarise herself with it.
Generating initial codes	Organising data in a meaningful and systematic way	The researcher read the data whilst initialising codes using highlighters of different colours.

DATA ANALYSING AND REPRESENTATION	CASE STUDY	THE PROCEDURE FOR THIS STUDY
Search for themes	Develop patterns that capture relevant information	The researcher examined the codes created and identified patterns that fit the themes.
Review the themes	Gather data that is relevant to each theme	The researcher ensured that developed themes were valuable and accurate representatives of the data.
Define themes	Define the themes	The researcher formulated the meaning of the themes to understand the data.
Write-up	Write the report	A detailed written report of the information gathered explained how the analysis answered the research question.

Source: adapted from Maguire and Delahunt (2017: 3351-3352)

The emergent themes and categories for this study are reported and discussed in Chapter 5.

4.7 TRUSTWORTHINESS OF THE RESEARCH

In qualitative research, it is the researcher's responsibility to analyse the data meticulously and rigorously do so concerning the elements of credibility, dependability and transferability. This gives the research the trustworthiness it deserves (Jamieson, 2016). In other words, trustworthiness denotes that qualitative researcher pay due regard to transferability, credibility, dependability, and confirmability which must be evident in their research (Creswell, 2014). One must ensure that transcripts are free from obvious mistakes made during transcription and that the definition of codes and meaning remain intact during the coding process. Given (2008) explains that trustworthiness provides the researcher with the tools to demonstrate the worth of their project outside the qualitative parameters that are often ill-fitting. As informed by Jamieson (2016) and Creswell (2014), the researcher ensured that the data analysis of this study complies with the trustworthiness of qualitative research in the manner discussed below.

4.7.1 Credibility

Jamieson (2016) regards credibility as akin to the concept of internal validity and may be aided by the process of member checking where participants are required to confirm the authenticity of transcriptions and/or derived themes. Jamieson (2016) sees the alternative as peer review, where coding decisions are justified to experienced researchers. Given (2008) defines credibility in research as a situation where the researcher has accurately and richly described the phenomenon in question. To ensure credibility in this study, the researcher used member checking as a strategy where the teacher participants were asked to read and confirm whether the analysed data represented their shared experiences of the use of code-switching in their mathematics classrooms. The teacher participants reported that transcriptions reflected their shared experiences of code-switching.

4.7.2 Transferability

Houghton, Casey, Shaw, and Murphy (2013) and Polit and Beck (2012) explain that transferability means that research findings can be applied to other settings or groups. If the results of a qualitative study have meaning to individuals not involved in the study and where the readers can associate the results with their own experiences then, and in that event, a qualitative study complies with transferability. To enable the reader to assess the findings' capability of being fit or transferable, it is incumbent upon the researchers to provide sufficient information on the participants and research context. Sandelowski (1986) in this regard, states that the aim of qualitative research determines the criterion of transferability and may only be relevant if the research intends to make generalisations about the subject or phenomenon. The findings of qualitative research, which is done on a small scale, cannot be generalised. Although they may be more or less transferable to, or applicable in other contexts, the researcher has to decide to provide clear descriptions of his/her methodology and his/her decision-making process during coding (Jamieson, 2016). The researcher managed to fully describe the context of the research to enable other researchers interested in exploring code-switching in the teaching and learning situation to relate to this study as well. The employment of purposive sampling for participating teachers and learners ensured that the study complied with transferability.

4.7.3 Confirmability

Polit and Beck (2012) and Tobin and Begley (2004) state that the researcher must have the ability to demonstrate that the analysed data represents the participants' responses and not his/her bias or viewpoints. Describing how conclusions and interpretations were reached and giving examples that disclose that the findings were derived directly from the data, is one way of demonstrating confirmability (Cope, 2014). One can successfully demonstrate how qualitative research was done by referring to rich quotes emanating from the participants that introduce each emerging theme. Given (2008) proffers a simple definition of confirmability, which relates to the researcher's duty to make sure that the interpretations and findings have the attributes of the data. The researcher, in this study, transcribed the audio recorded interviews which were used to analyse the data. The analysis was based on everything the participants said and not the researchers' views. The interpretations and findings truly are representative of the data.

4.7.4 Dependability

Cope (2014 cites Polit & Beck, 2012 and Tobin & Begley, 2004) whose definition of dependability is that data should remain constant over similar conditions. This happens when another researcher agrees with the decision trails at every stage of the research process. In other words, a study would be deemed dependable if its findings were replicated with similar participants in similar conditions. This is achieved by the researcher's process and descriptions (Koch, 2006). Jamieson (2016) states that dependability is akin to reliability in quantitative research and achieved in qualitative research by the measures such as the use of an interview schedule, clear examples of codes and reflexivity, which relates to an instance where a researcher is open about his or her influence on the research or vice versa. In this study, the researcher complied with dependability through the employment of an audit inquiry. Therefore, the researcher asked her supervisors to critically examine this research and how data were analysed to determine the dependability of her research findings.

4.8 ETHICAL MEASURES

Ethics play an important role with researchers being guided and assisted by ethical issues when they conduct research (Johnson & Christensen, 2014). Ethics, amongst others, would require that privacy be considered whenever research is conducted. The participants need assurance that their participation remains protected for them to freely participate in the research. Israel and Hay (2006) confirm this and add that researchers need to protect their research participants, develop trust with them, promote the integrity of the research, guard against misconduct and impropriety that might reflect on their organisations or institutions and cope with new, challenging problems. Johnson and Christensen (2014) define ethics as the principles and guidelines that help in the upholding of the things that are valued.

1. Bogdan and Biklen (1992) confirm the privacy and the freedom that must always be observed when conducting qualitative research. They, as a result, list the following ethical issues:

2. the participants should feel free in their participation which is achieved by the researcher avoiding research sites where the participants may feel obliged to participate in the study;
3. the privacy of the participants is key and must be respected;
4. the researcher must clarify his or her expectations from the participants and their expectations of him or her;
5. the researcher must protect the identity of the participant to avoid embarrassment and harm unless if the permission was granted to do so;
6. upon seeking permission to conduct the study, the terms of the agreement should be clear and adhered to; and
7. it is incumbent upon the researcher to be truthful when the report is written up and findings reported.

Prior to the start of the research, the researcher, informed by Kielmann *et al*. (2012) and the other scholars, took into consideration informed consent, privacy and confidentiality as well as honesty. Potential participants should freely agree to participate in the study. They need to understand the research activities as well as the risks and benefits attached thereto. No reference should be made to their names, location and other personal details in protecting the participants. Confidentiality has to be observed at all costs. The information participants give the researcher must equally be respected and protected. Field notes, tapes, interview guides, and related information being private information must be stored in safe and secure locations. In conducting the research, participants put their trust in the researcher who has to present accurate information from the participants. Researchers are prohibited from manipulating and 'cherry-picking' data to suit their needs. Research work requires honesty at its best from the researcher. It is noteworthy that the participants are given feedback about the study's findings, and where applicable, benefit from the study themselves.

Before the researcher began this study, an application for ethical clearance from the University of South African Ethics Committee for permission to conduct this study (*cf*. Appendix A) was made. Further permission to research rural high schools in Mopani East District, Limpopo Province was sought and found from the Limpopo Department of Education (*cf*. Appendices B and C). The approval by the Limpopo Department of Education is attached (*cf*. Appendix C). Permission was also sought and found from the three Circuit Managers whose schools were sampled for participation (*cf*. Appendices D-I). The researcher then visited the schools with information letters to which the District Director's and the Circuit Managers permission letters were attached. This was done so that the principals of the respective schools were taken on board concerning what was about to happen at their schools as this study involved them. After informing the principals, the researcher consulted with the mathematics teachers and the learners informing them of the researcher's intention to conduct this study (*cf*. Appendices J, K, and L). After the information sessions, the participants freely and voluntarily agreed to sign the consent forms and to participate in the research. Learners under the age of eighteen were given the consent forms to give their parents who would read and sign on their behalf (c*f*. Appendices M, N and O). The researcher's contact details were given to all the participants who were informed that they had the right to withdraw their participation if they so wished.

The researcher did not disrupt any of the teachers' and learners' activities because the interviews were held outside of their official contact time, as per the terms and conditions of the permission from the Limpopo Department of Education. The researcher allowed the participants to share their views freely and voluntarily. The researcher also explained that it was necessary to audio record the interviews because the recorded information needed to be transcribed for purposes of analysis of the data. The participants were given pseudonyms that would be used for reporting purposes. All the participants were satisfied with the explanation and reported that they were free to participate in the study.

4.9 CHAPTER SUMMARY

Chapter four was a detailed discussion of the research design, research paradigm, and the research methodology used to gather data from the participants. This research underpinned by an interpretive paradigm was qualitative in nature and guided by a bounded descriptive case study. This chapter described the population and explained how the participants were purposively and conveniently sampled to provide rich data on the use of code-switching in mathematics classrooms. Research data was obtained from ten high schools in the Mopani District of Limpopo Province. Through the use of a qualitative approach, it was explained how it became possible to interact with the participants using Semi-structured interviews, telephonic interviews and focus group interviews. Using the methods above, a significant amount of information relating to the use of code-switching as a strategy enhancing teaching and learning mathematics in Grade 11 was collected.

The chapter concluded with the discussion of the measures that were put in place to ensure that the study's trustworthiness was realised and the ethical considerations that came into play to protect the participants in the study.

Chapter five focuses on the presentation of the research findings.

CHAPTER 5

ANALYSIS, FINDINGS AND DISCUSSION

5.1 INTRODUCTION

In the previous chapter, the researcher discussed the research design and the methods used to conduct the empirical study to realise the aim of this study. Chapter five presents the study's findings obtained from mathematics teachers and Grade 11 learners through face-to-face interviews, telephone interviews and focus group interviews to answer the main research question: *How do mathematics teachers use code-switching as a communicative strategy to enhance quality in mathematics teaching and learning in Grade 11?*

In this chapter, the findings emerging from the analysis are presented through the lens of the theoretical framework (social justice, behaviourism, Piaget's cognitive learning theory and social constructivism, discussed in Chapter 2) and supported by the reviewed literature (*cf.* Chapters 2 and 3). The chapter begins with the profiles of mathematics teachers who participated in the study.

5.2 THE PROFILE OF MATHEMATICS PARTICIPATING TEACHERS

Research ethics require that any research participant (in this case, mathematics teachers and their Grade 11 learners) give their informed consent to participate in the study. The participants from ten Quintile 2 schools situated in rural area of the Mopani District of Limpopo province participated freely in the study by providing the necessary consent. The teachers participated in face-to-face interviews at their respective schools (held before restrictions of the Covid-19 pandemic) and telephonic interviews which were follow-up interviews. Fourteen mathematics teachers initially agreed to take part in the interviews. However, the M@1 teacher, due to unforeseen circumstances, did not participate, so thirteen teachers ended up participating and are referred to as M@2-M@14.

Table 5.1. below presents the profiles of the mathematics teachers who participated in the interviews.

Table 5.11: The profiles of the participating mathematics teachers

TEACHER'S PSEUDONYM	SUBJECTS TAUGHT	TEACHING EXPERIENCE	TEACHER WORKLOAD (PERIODS) PER WEEK
M@2	Mathematics, Physical Science	26 years	21
M@3	Mathematics	26 years	30
M@4	Mathematics, Geography	27 years	32
M@5	Mathematics and Natural Science	6 years	42
M@6	Mathematics and Natural Science	14 years	36
M@7	Mathematics, English (FAL)	20 years	36
M@8	Mathematics	10 years	36
M@9	Mathematics and Life Sciences	36 years	18
M@10	Mathematics	29 years	35
M@11	Mathematics and Physical Sciences	25 years	30
M@12	Mathematics and Physical Sciences	26 years	30
M@13	Mathematics	28 years	36
M@14	Mathematics	25 years	30

The experience of the thirteen participating mathematics teachers ranged from six to thirty-six years. Mathematics teachers with many years of experience shared valuable information gathered over the years they had taught the subject relating code-switching to a communicative strategy in teaching and learning mathematics. Table 5.1 also highlights other CAPS subjects these teachers offer and their workload evident from the periods they teach per week.

Semi-structured interviews (face-to-face and telephonic) were used as data collection instruments. Each instrument was reported separately to answer the research sub-questions and to ensure that data analysed, through the use of emergent themes and categories, led to the credibility of this study.

5.3 QUALITATIVE ANALYSIS OF INTERVIEW DATA

Not all collected data is used (Creswell, 2013) because only data regarded as answering the sub-research questions should be considered. The researcher analysed the collected data informed by O'Connor and Gibson (2003), Flick (2013) as well as Maguire and Delahunt (2017). The data collected were classified and interpreted to give meaning to how mathematics teachers and learners use code-switching as a communicative strategy enhancing quality in teaching and learning mathematics. Also informed by Creswell (2013), the collected data was aggregated into fewer themes and categories and used as the basis for interpretation. The process of data analysis is outlined in Table 4.6. To answer the sub-research questions, collected the data, using different instruments, were reported separately using themes and categories to reflect on the trustworthiness of the research instrument. Six themes were identified as well as twenty-seven categories. Table 5.2 below is the reflection of the identified themes and categories.

Table 5.12: Emergent themes and categories from participating mathematics

NO	RESEARCH QUESTION	THEME	CATEGORY
1	What does scholarly literature say about code-switching as a communicative strategy to enhance mathematics teaching and learning quality in Grade 11?	Scholarly literature on code-switching as a communicative strategy enhancing mathematics teaching and learning quality in Grade 11	1. The teachers' explanation of code-switching 2. The reasons for code-switching 1. Explaining concepts 1. Bridging the learning process 1. Serves as a solution to the language barrier 3. Code-switching is an important communicative strategy 1. This leads to a better comprehension of the subject matter 2. Encourages learner participation

NO	RESEARCH QUESTION	THEME	CATEGORY
2	How is code-switching relevant in the teaching and learning of mathematics Grade 11 learners?	The relevance of code-switching during teaching and learning of mathematics of Grade 11 learners.	2.1 The use of code-switching to explain and clarify concepts 2.1.1 Clarifying concepts through code-switching 2.2.1 Assists learners to ask questions 2.2 Promotion of learners' understanding and performance in mathematics. 2.2.1 Introducing new concepts 2.2.2 Subject matter becomes more meaningful
3	How effective is code-switching as a communicative strategy in enhancing quality in mathematics teaching and learning?	The effectiveness of code-switching as a communicative strategy to enhancing quality in mathematics teaching and learning.	3.1 Code-switching and good performance. 3.2 Code-switching and learners' confidence 3.2.1 Creates a friendly environment for communication 3.2.2 Is useful for group work 3.3 Code-switching and classroom management.
4	What are the benefits and challenges of code-switching in teaching and learning mathematics in Grade 11 learners?	.1 Benefits of code- Switching	4.1.1 Contributes to better understanding 4.1.2 Makes learners reinforce learned content
		.2 Challenges of code-switching	4.2.1 Teachers' challenges 4.2.2 Learners' challenges 4.2.3 Language challenges for mathematics assessment 4.2.4 Providing a glossary for mathematics during assessment
5	What framework could be employed to enhance	The framework to be employed to enhance	5.1 Inclusion of home language terminologies when

NO	RESEARCH QUESTION	THEME	CATEGORY
	quality in mathematics teaching and learning?	quality in mathematics teaching and learning	designing mathematics lesson plans 5.2 Considering learners' home language during mathematics assessment.

The discussions of the identified themes and categories, presented in the next sections, regarding code-switching as a communicative strategy to enhance quality in teaching and learning mathematics in Grade 11, is supported by extracts from teacher participant interviews serving as confirmation of this discussion (*cf*. Appendix T).

5.4 PRESENTATION OF EMERGENT THEMES AND CATEGORIES FROM THE ANALYSIS OF THE INTERVIEW DATA

The first theme to be discussed in the next section relates to code-switching as a communicative strategy enhancing quality in mathematics teaching and learning. This theme has three categories.

5.4.1 Theme 1: Code-switching as a communicative strategy enhancing quality in teaching and learning mathematics in Grade 11

Theme 1 reflects the teachers' understanding of the concept of code-switching, the reasons for code-switching in mathematics classrooms and code-switching as an essential communicative strategy in the teaching and learning of mathematics. The teachers' understanding of code-switching as a communicative strategy is in line with the observations of Ajibade *et al.* (2017). The categories below, namely, teachers' explanation of code-switching, the reasons for code-switching, and code-switching as an important communicative strategy, represent the interview data from the teachers' face-to-face and telephonic interviews and are presented in the next section.

Category 1.1: The teachers' explanation of code-switching

The teachers' explanation of the concept of code-switching is a reflection of how and why they employ the practice. Asked to define code-switching, the mathematics teachers' responses demonstrated that they understand what code-switching is as indicated by the Department of Education (2010). The following excerpts are an illustration of what code-switching means to these teachers:

> *Code-switching is a switch from one language to another, particularly from English to the learners' mother tongue. If they are Venda speakers, it refers to moving from English to Venda. Suppose they are Xitsonga speakers and primarily teaching learners who are Xitsonga speaking, code-switching as a switch from English to Xitsonga to make learners understand complex mathematical concepts*. (M@2)

> *Code-switching is the use of the learners' mother tongue in this case the learner's mother tongue (Xitsonga) alongside English during teaching and learning*. (M@6)

Another participant also mentioned this, sharing the same understanding of code-switching:

> *According to my memory from the years of teaching, code-switching is when one switches from one language to another in the same scenario or the same sentence trying to communicate. This could be from the medium of instruction to a home language where learners learn their subject in a foreign language.* (M@10)

The teachers' definitions of code-switching indicate that they have the correct explanation of code-switching and its importance in teaching and learning mathematics. The teacher moves from one language, the LOLT, to the learner's native language (Xitsonga) to create a higher understanding. Jegede (2011) asserts that it is challenging to teach mathematics in English when English is not the learners' home language. Mathematics teachers know that English poses a significant challenge to learners' understanding of mathematics during teaching and learning since English is not their home language. The challenge motivates the teachers to code-switch to ensure learners understand the subject content. Code-switching is adequately defined by the teachers who, consequently, provide reasons for code-switching as it appears in the next category.

Category 1.2: The reasons for code-switching

This category provides the mathematics teachers' reasons for code-switching. The mathematics teachers confirmed that they practice code-switching in their classrooms, as indicated in examples from their responses below.

Yes, I do, ma'am. I do code-switch. (M@4)

Mmm, yes, of course, I code-switch. (M@6)

Yes, definitely I do that. (M@7)

Very much so. Yes, I do code-switch when I am teaching mathematics in my class. (M@10)

The teachers confirmed that they used the communicative strategy of code-switching when teaching and gave reasons for using code-switching in their mathematics classrooms, which are discussed below.

Category 1.2.1: Explaining concepts

Mathematics, being taught in English, a foreign language to most teachers and the learners in this study, compels the teachers to practise code-switching during lesson presentations. Low (2016) stated that code-switching could be a communicative resource to classroom teaching. Teacher M@3 aligns with Low (2016), as the excerpt below reveals:

The reason for code-switching is that, at times one is compelled to code-switch in order to explain complex mathematics concepts to the learners where it appears, they are unable to comprehend what is being communicated to them in the medium of instruction which is not their home language. (M@3)

Nierche (2009) asserts that home languages should be perceived as important resources in teaching and learning mathematics where instruction is different from home languages. Code-switching enables mathematics teachers to explain complicated mathematical concepts to their learners. The teachers' statements below confirm this:

Those problematic concepts which are unfamiliar to the learners compel one to code-switch into their vernacular. (M@12)

The reason I code-switch is that some of the mathematical concepts are not easily understood by the learners when English is used as a medium of instruction. Code-switching allows me to give better explanation of such concepts for the learners to understand. M@11)

In the excerpts above, the teachers' responses confirm what Uys (2010) observed when teachers code-switched. Code-switching enabled the teachers to efficiently and adequately explain the subject matter to their learners to ensure better understanding.

Category 1.2.2: Bridging the learning process

Chikiwa and Schäfer (2014) assert that learning mathematics in English by learners whose first language is not English, gives rise to challenges for the teachers who are required to code-switch from English to their native language to enhance conceptual understanding of mathematics. Ustunel (2016), Ahmad and Jusoff (2009) as well as Nurhamidah *et al*. (2018) also agree that code-switching bridges the teaching and learning process. What follows hereunder reveals how teachers see code-switching as bridging the learning process in mathematics classrooms:

> *The reason why I code-switch is that code-switching bridges the teaching and learning process. It becomes clear during the lesson when one asks questions that the learners didn't understand during teaching and learning*. (M@6)
>
> *Moving from English to Xitsonga, explaining complex terms, becomes easy. However, for those learners who understand English explaining the complex concepts to them in English does not create problems because they understand the language. Geometry has terms and theorems such as an angle at the centre, double at the circumference, code-switching makes the learners understand the meanings of circumference, the angle at the centre, the double angle at the circumference, and subtended angle.* (M@11)

It is noteworthy to indicate that teacher M@11 even explains how he employs code-switching to make learners understand those concepts that are difficult to them using their mother tongue in the lesson on theorems. Selamat (2014) explains that code-switching is a useful resource to implement during teaching and learning because it facilitates the learning process for those learners with low English proficiency.

Category 1.2.3: Code-switching serves as a solution to a language barrier

The language of teaching and learning (LOLT) may become a barrier to good performance in mathematics if it is not the learners' mother tongue, which is the case with the learners in this study. Mathematics teachers practise code-switching because they perceive the practice as the solution to the language barrier. Van der Berg *et al.* (2011) observed that language could hinder good performance in mathematics. The excerpts below attest to this:

> *I code-switch because I realise that in most cases, language is a barrier to comprehending the learning content. Sometimes the medium of instruction that we use to explain complex mathematical concepts to the learners makes it difficult for the learners to comprehend what is being communicated to them. Code-switching, in this instance, as a solution to the problem, is employed.* (M@2)

> *The reason that learners have a language barrier is that many terminologies are found in mathematics. To make them understand better, we code-switch so that they know what is happening in mathematics. Where we code-switch, learners find out that know the terminology also exists in their mother tongue*. (M@13)

Teacher M@11, below, explains that mathematics classrooms are comprised of learners who understand English (the medium of instruction) and those that do not. The language barrier caused by the medium of instruction where the learners do not understand English, impels mathematics teachers to code-switch. Teacher M@11 puts it as follows:

> *Two reasons make me code-switch. Number one, we have learners who understand and speak English fluently. Secondly, some hear but cannot speak, and the other group does not understand what you are saying when you speak in English. When we teach in English, those who do not understand will be left behind*. (M@11)

Danesi (1996) stated that learners who are taught in a language other than their home language often do not do well academically due to the language problem.

Category 1.3: Code-switching as an important communicative strategy

In this category, mathematics teachers perceive code-switching as an essential communicative strategy during teaching and learning mathematics. Aljoundi (2013) believes that code-switching bridges communication gaps in the classroom. The learners, consequently, can communicate easily and freely as soon as their mother tongue is employed. This is borne out by the illustration below:

> *The reason behind code-switching is that the learners' mother tongue makes it easy for them to communicate, unlike using English as a medium of instruction throughout the lesson*. (M@9)

It is clear from Webb *et al*. (2007) that language plays a vital role in teaching and learning ensuring effective and meaningful teaching and learning in the classroom. However, effective teaching and learning cannot successfully occur when the learners are not proficient in the medium of instruction used in the classroom, as reported by Aljoundy (2013), Howie (2003) as well as Botes and Mji (2010).

Category 1.3.1: Code-switching leads to better comprehension of subject matter

Learners should be proficient in the medium of instruction to comprehend mathematical tasks as mathematical abstractions depend on the understanding of the language used as the medium of instruction (Halai, 2009). This is highlighted below:

> *Because learners understand their home language precisely, code-switching enables them to easily associate their home language with the language of teaching and learning, thereby understanding the subject matter very well*. *Yes, I do. I do think that code-switching is an important communicative strategy. Because as I've said it that anyone would learn better if you are learning in your mother tongue. So, you find that you have a scenario where you are forced to learn other things, not in your mother tongue. Code-switching becomes essential in some instances where you may want to clarify, where you want to connect the learning material to real-life situations or matching what the learners are learning to their own culture. Code-switching therefore becomes essential as a communicative strategy to help learners understand the subject they learn*. (M@10)

> *One of the reasons is that mathematics is being learned in English, and the learners do not understand the concepts in English because they have to learn the second language simultaneously. Similarly, we use code-switching to*

> *explain a concept. Code-switching improves learners' understanding of mathematical concepts.* (M@14)

The teachers, well aware that the Department of Basic Education does not encourage the use of the learners' mother tongue, have seen the need to code-switch because of the problems brought about by English, which is the medium of instruction and not their home language. Adler and Sfard (2016) and Selamat (2014) stress that English as a medium of instruction in South African multilingual classrooms is always an impediment to proper teaching and learning of mathematics. Setati (2008, 2005), confirms that code-switching is a tool that enhances better understanding and comprehension of the subject matter. Jegede (2011) and Aljoundi (2014) hold the same view.

Category 1.3.2: Code-switching encourages learner participation

Learners have been found to participate freely and actively where they understand the language used to teach them. Teacher M@7 explained that she code-switched as soon as she realised that active and free participation by her learners was lacking in her classroom. The minute she did that, her learners began to participate again. She responded as follows:

> *Learners face challenges when I illustrate to them difficult mathematical concepts using English. Realising the problem, I immediately switch from English to Xitsonga explaining the concepts and this brings back their active participation to their classroom.* (M@7)

Other mathematics teachers' statements confirm this:

> *Yes, I think so. It is suitable for enhancing the quality of teaching and learning mathematics. Mathematics is a subject that most learners fear. Hence, if we continuously use this jargon for strong mathematics words that learners do not understand, it sometimes becomes tedious. Therefore, if you code-switch at times, it makes them even participate during the lesson, making them understand better*. (M@3)

> *Yes, the use of English as a language of learning and teaching act as a barrier to learners of mathematics concepts. However, code-switching is used to ease*

> *understanding during teaching and learning. When I code-switch, they catch what I'm trying to illustrate as a concept to them. You will see them participating very well, and then you know that the lesson is flowing, and then they write or respond to you when you ask them questions. The response is positive because I code-switch to them while explaining the concepts*. (M@7)
>
> *I think it is very relevant because the learners participate very well when I am code-switching. Sometimes, when I don't code-switch, they become stagnant because they don't understand what I am teaching, but their participation increases as soon as I code-switch*. (M@4)
>
> *Yes, it is helping a lot on my side because if you don't do that, you will be talking to yourself inside the classroom with learners will be looking at you and only two or three will be participating. Some learners fail tests where lessons are only presented in English. However, they perform better in their tests when code-switching is practice. It helps a lot*. (M@11)

Nomlomo and Mbekwa (2013) also explored code-switching and found that the practice enables the learners to participate freely, actively and effectively, enhancing the relevant teaching and learning of mathematics in Grade 11.

5.4.2 Theme 2: The relevance of code-switching during teaching and learning of mathematics

This theme focused on the relevance of code-switching during teaching and learning mathematics in Grade 11 classes. The participants were asked about code-switching as an important communicative strategy to enhance teaching and learning mathematics. The teachers explained that code-switching was relevant and essential as a communicative strategy in teaching and learning mathematics in their classrooms.

The mathematics teachers highlighted what drove them to code-switch during their lesson presentations. The use of code-switching was prompted by the use of English (which was not the learners' home language) as a medium of instruction. They found the medium of instruction as a drawback to the learners' understanding during mathematics teaching and learning to those learners whose English proficiency was low. The teachers contended that code-switching helped them clarify concepts that appeared difficult to their learners. Sepeng (2013) confirms that concepts that were deemed complex during the lessons were clarified when the teacher code-switched.

Category 2.1: The use of code-switching to explain and clarify concepts

According to Muthusamy *et al*. (2020), Sepeng (2014) and Modupeola (2013), code-switching is an effective strategy that is relevant to clarify complex concepts during teaching and learning.

Category 2.1.1: Clarifying concepts through code-switching

This study bolsters the fact that code-switching helps explain complex mathematical concepts and clarifies them to the learners. The responses from mathematics teachers below are instructive:

> *Yes, I do because when I realise that my learners do not understand the meaning, I have to code-switch to clarify the meaning of concepts in their home language because mathematics itself is a language. It needs to be associated with a home language so that learners can get the meaning. Mathematics as a language, has rules that must be followed. For example, when you say what you do on the left-hand side must be done on the right-hand side, learners must understand the meaning. When I say on the other side, they might think I am talking about the hand itself. Therefore, there is a need to clarify this using the home language.* (M@5)

> *When I use code-switching, I clarify certain concepts that seem to be difficult for the learners to understand. So, if I code-switch, it makes it easy for them to grasp the content that I will be teaching*. (M@9)

> *Yes, it is relevant because it means when I want to clarify concepts, I use code-switching* (M@6)

The responses above demonstrate that mathematics teachers code-switch to explain and clarify mathematical concepts, as confirmed by Lin and Li (2012) when they said that code-switching assists in explaining the subject matter. In the excerpt below, the teacher explained how code-switching is relevant to the teaching and learning of mathematics and gave an example of the frequently used concepts when code-switching arises:

> *Other concepts need to be explained in the learners' mother tongue for them to understand better. For example, in mathematics, we have concepts like* ***x*** *and* ***y*** *and so on. Let us say I am teaching like terms and unlike terms, I indicate that like terms can be added together but unlike terms cannot be added together. We have a basket with oranges and avocadoes and bananas. Can you add a banana and an avocado? The answer is simply no. 3x+3y which which are unlike terms, cannot be added together while 2x+3x can be added because they are like terms.*
>
> *Hi teka timanga hi ti katsa na tindluwa ku ta va timanga na tindluwa kambe loko hi lava ku katsa timanga ka tibaskiti timbirhi swa koteka ku ti katsa hi thlela hi ti hlayela hi ku ta fana kambe hi nge katsi timanga na tindluwa hi thlela hi kota ku ti hlayela hi ku a swi fani. [If we mix peanuts and Bambara groundnuts, we shall have peanuts and groundnuts. We can place peanuts in two baskets as this is possible, and we can easily count them simply because they are the same, but we cannot mix peanuts and Bambara groundnuts and easily count them because they are different]. I practice code-switching for learners to understand and relate the lesson to real-life situations and make it interesting*. (M@14)

To go back to the example of Teacher M@14, $3x$ and $3y$ represent peanuts and Bambara groundnuts respectively. $3x+3y$ remain $3x+3y$ whereas $2x+3x$ representing two baskets with peanuts will give us 5x because they are all peanuts.

In general, mathematics teachers agree that the use of code-switching assists them in clarifying concepts. The excerpt above demonstrates that code-switching is used to help learners understand and relate the lesson to the real-life situation, thus making the lesson interesting. Adler (2001) supports the observation that code-switching as a communicative strategy helps mathematics teachers clarify concepts for knowledge acquisition.

Category 2.1.2: Code-switching assists learners in asking questions

Mathematics lessons are best presented where the atmosphere in a class is conducive to allowing learners to participate freely. Once that happens, learners are free to ask questions relating to the subject matter presented to them. If not, the learners remain passive. This aligns with Nomlomo and Mbekwa (2013) who reported on the cognitive benefits of using the home language in mathematics classrooms. Teacher M@8, in the excerpt below, refers to this:

> *Because it helps learners who want to ask questions in the classroom*. (M@8)

This means that learners will not be hindered by lack of language proficiency to ask questions to facilitate their understanding of difficult and complex concepts.

Category 2.2: Promotion of learners' understanding and performance in mathematics

The mathematics teachers' perceptions of how code-switching as a relevant strategy in teaching and learning mathematics is supported by literature which has highlighted the functions of code-switching in teaching and learning of the subject. Understanding the value and functions of code-switching, teachers are better equipped to implement the practice to benefit learners, especially those disadvantaged by lack of the proficiency in the medium of instruction (English), which is not their home language.

Mathematics teachers reported on how code-switching promoted the learners' understanding and their performance in mathematics. The verbatim responses of the teachers are found in the following excerpts:

> *Yes, it increases performance because when I code-switch, learners tend to understand the subject matter very well than when I don't code-switch. After all, when I code-switch in their language, they understand better and perform better*. (M@4)

> *When I teach learners in their home language, you find that a learner knows the answer. However, he or she fails to answer questions that I ask because of their low English proficiency where I only use English. Employing code-se-*

switching, the learners too code-switch, and this results in their better understanding, participation and performance in mathematics. (M@5)

Yes, code-switching has always proved fruitful when I realise that some learners struggle to understand. For example, after giving them the assessment in English, I found that many learners did not understand and consequently failed to perform well because of English which was a barrier to such understanding. During feedback, I discovered that they had performed poorly because of the language barrier. I gave them the same assessment, but this time explained to them in their mother tongue and the learners improved their performance in the same assessment. (M@6)

Because code-switching enables learners to understand the content taught to them, unlike teaching them in only the language of teaching and learning. Code-switching leads to better performance, as evident in the assessment that is usually given to them. (M@9)

The findings reveal that code-switching is important and very relevant to the teaching and learning of mathematics as it has a vital role in promoting the learners' performance in the subject. Literature significantly supports the confirmation and views that code-switching as a communicative strategy increases learner performance (Clarkson, 2007; Simasiku *et al*., 2015).

Category 2.2.1: Introducing new concepts

The participating teachers acknowledged the relevance and significance of code-switching as a communicative strategy in teaching and learning mathematics and verbalised this in different ways. The excerpt below from the interview specifically dealt with his use of code-switching when he introduced new concepts:

You know when you are teaching mathematics, at times you are breaking new ground. When you introduce new mathematical concepts, it is such a challenge when it does not relate to learners' everyday experiences. The better way is to connect this to learners' everyday experiences for them to understand those concepts through code-switch. (M@2)

The research that Maluleke (2019) conducted reveals that code-switching was successfully used to introduce the lesson where learners struggled to understand the new mathematical concepts. Ahmad (2009) also attests to this.

Category 2.2.2: Subject matter becomes more meaningful

Uys (2010) and Nurhamidah *et al*. (2018) acknowledge the effectiveness of code-switching during the teaching and learning process. According to mathematics teachers who participated in this study, code-switching makes mathematics content more meaningful.

Teacher M@13 and Teacher M@11 explained the need to code-switch during teaching and learning mathematics in their classrooms. Code-switching to both teachers results in the learners understanding the subject matter as the lesson is presented. They note the same result, which is that code-switching plays a significant role during teaching and learning, mainly if the LoLT is not their home language. Teacher M@11 gives an excellent example of code-switching to explain what circumference and angle mean:

> *Let me come back to the same theorem. When we talk about the theorem at the centre, doubled angle at circumference we explain this in English, there is no need to say this is a circumference. It is unnecessary to tell them that this is subtended arch because they understand what we mean. But a learner who has low English proficiency may not understand these words. They have to take that new word and put it in their imagination to understand what you are talking about. The lesson may come to an end while they are still thinking about the word subtended and they might be left behind. So, I code-switch in the following manner.*
>
> *"hi Xitsonga loko u hlamusela ku loko hi vulavula hi <u>subtended</u> hi vulavula hi ntila kumbe layini leyi masayiti mambirhi ma nga hlangana eka yona. Loko hi vulavula hi <u>circumference</u> hi vulavula hi layini leyi nga endla <u>circle</u>. So va kota ku swi twisisa ku okay loko hi vulavula hi <u>circumference we are talking about the line that makes the circle and</u> loko hi vulavula hi <u>center or angle</u> leyi nga ka <u>center</u> hi vulavula hi tilayini timbirhi leti sukaku ka <u>center</u> ti ya ka <u>circumference and then</u> la xikarhi hi kona ku nga <u>angle</u> laha <u>angle</u> leyin'wani yi nga yi davulaka*

circumference le henhla".[… in Xitsonga when you explain that when we talk of subtended we talk of a line where two sides meet. When we talk of circumference, we speak of a line which forms a circle. They then understand that when we speak of circumference… when we speak of a centre or circle in the centre, we refer to two lines that move from the centre to the circumference and the centre part forms the angle where the other line can cut the circumference at the top]. So, it becomes easier for them to understand what the theorem is all about. (M@11)

Teacher M@11's example of code-switching between Xitsonga and English simplifies what he was trying to explain to the learners to understand the concepts of circumference and angle. His code-switching embodies different types of intersentential and intrasentential code-switching. As it appears in these excerpts, code-switching plays a significant role in explaining mathematical concepts during lesson presentation (Garegae, 2002), facilitating their learning and their teachers teaching.

> *Yes, at times, we feel code-switching is good because learners fail to understand English as LOLT. Then you try to explain to them using the language that they know. So, we sometimes think that we have to use code-switching for learners to understand mathematics concepts.* (M@13)

The third theme below presents the effectiveness of code-switching as a communicative strategy enhancing quality in mathematics teaching and learning.

5.4.3 Theme 3: The effectiveness of code-switching as a communicative strategy enhancing the quality of mathematics teaching and learning

This theme deals with the effectiveness of code-switching as a communicative strategy which enhances mathematics teaching and learning quality. The identified categories are code-switching and good performance, code-switching and learners' confidence and code-switching and classroom management.

Category 3.1: Code-switching and good performance

Participating teachers discussed how their learners performed before they started to code-switch in the presentations of their lessons, explaining that performance was poor:

> *Before I realised that these learners had a problem with the language, the performance of my learners was so poor, and after I realised that I engaged in code-switching. Somehow, I saw things differently in terms of the performance of the learners which had become better*. (M@2)

When the participant was probed to explain what he meant, he said:

> *I saw the performance starting to improve and that made me conclude that language was one of the aspects that could harm the learners' performance.* (M@2)

> *It was bad madam, it was bad. Learners were performing poorly until I realised that I was talking to myself, I then decided to code-switch. I started by putting in one or two words when code-switching. I immediately noted that the learners were beginning to participate better and improve in answering questions in their tests*. (M@3)

> *It was very bad; it was poor before I started to practise code-switching. And after I began to code-switch, I realised that they started performing well*. (M@6)

> *When I code-switch, I want learners to understand better and I do this by giving examples and then reinforce them with English. During my first years performance was bad because I was not code-switching. For me, code-switching is more important*. (M@13)

As articulated by the above participants, code-switching indeed plays a very important role in improving learners' performance in mathematics classrooms, particularly as poor performance results from language proficiency in understanding the content. Simasiku *et al*. (2015) observed that code-switching to the learners' home language promotes discussion and questioning which enhances their thinking and develops their problem-solving skills.

Category 3.2: Code-switching and learners' confidence

The use of code-switching in the mathematics classroom improves learners' confidence to communicate during teaching and learning in this category. Teachers' responses showed that code-switching offers learners the opportunity to communicate freely with their teachers and peers during the teaching and learning of mathematics. This is in line with Abad (2010), who affirms that code-switching builds the learners' confidence as they can freely communicate with their teachers and participate in group work and activities in the mathematics classrooms using their home language.

Category 3.2.1: Code-switching creates a friendly environment for communication

Sepeng (2013) and Yusob *et al*. (2018) highlight that code-switching enhances the quality of communication in mathematics classrooms while Uys (2010) asserts that code-switching assists both the teachers and the learners to communicate efficiently during teaching and learning of mathematics. The teachers affirm this through the following responses:

> *I realised that learners do occasionally wish to speak with their teachers during teaching and learning. However, most of them keep their thoughts or questions to themselves. Some learners were unable to express their personal experiences concerning the lesson taught. Failure to communicate in English resulted in a hostile environment.* (M@2)
>
> *Yes, it improves it. It even creates a friendly atmosphere in the class. In using English, the learners do not feel comfortable and do not participate, but once they code-switch, even those who do not usually talk or respond feel comfortable in their class and become active*. (M@3)
>
> *Yes, there are many benefits because when you teach mathematics through code-switching, the learners' minds are easily provoked. That encourages creativity and maximum participation, and code-switching enables learners to communicate freely in the classroom*. (M@9)

The teachers in the above excerpts show that code-switching is effective, meaningful and resourceful in the teaching and learning of mathematics because it creates a friendly environment conducive to open communication in the learners' home language, which aligns with Lin and Li's (2012) view of the importance of providing a platform for open communication to facilitate learning.

Category 3.2.2: Code-switching is useful for group work

Teachers indicated that code-switching assists the learners to engage in group work and enables them to discuss what they did not understand during the teaching and learning process. The following excerpts represent what they said.

> *It also helps them to engage in groups and teamwork when they are busy discussing, they can use code-switching so that a learner who did not understand in the class can apprehend during the discussion*. (M@8)

> C*ode-switching does assist in building the learners' confidence during communication while in class because I engage them in group work. Sometimes you find out that some of the learners do not participate when English is used but when I give them the freedom to communicate in their mother tongue you find that everyone participates*. (M@6)

The above responses indicate that code-switching helps in many ways as an effective communicative strategy in teaching and learning mathematics. The employment of code-switching in the learners' group discussions reveals the effectiveness of this practice in communication in a language in which they are proficient. This is confirmed by Adler (2017) that using the learners' home language is sometimes necessary to help learners understand and enjoy mathematics, as they would in a learner-centred activity.

Category 3.3: Code-switching and classroom management

One of the functions of code-switching is its effectiveness in reprimanding the learners who misbehave during mathematics teaching and learning. The participating mathematics teachers emphasised that they used the learners' home language to maintain discipline in their classrooms, as evident in the following excerpts:

> *I think it assists me in the sense that sometimes when learners are out of control in class when I speak to them in their language, I use idiomatic expressions in*

their mother tongue and quickly get their attention. When using English, they often do not understand what you are saying. (M@2)

When asked to give an example of the above, M@2 responded:

> *Let's take the example of learners who do not want to do their work, the learners may fail to understand you when you instruct them in English but switching to their home language using idiomatic expressions, the learners understand you quickly respond. For example, I can say: "u ta tshovela leswi u swi byalaka" which means you will reap what you sow. This effectively reprimands the learners.*
>
> *It assists a lot, especially when reprimanding learners who make noise or distract others if you use their home language. They quickly get the instruction and stop whatever they are doing, unlike in a situation where you try to use English to stop them whatever they are doing*. (M@3)

When probed to give an example on how code-switching is used to reprimand the learners, Teacher M@3 indicated that she addressed them in Xitsonga when they make noise during teaching and learning and the learners responded immediately, keeping quiet:

> *Yes, yes, I use code-switching to manage learners during teaching and learning*. (M@6)

The findings reveal that teachers view code-switching as a very effective tool when discipline is to be maintained in their classrooms as many learners are not proficient in English and would not understand the reprimand or instruction. Memory *et al.* (2018) observed this.

5.4.4 Theme 4: The benefits and challenges of code-switching

During the interviews and using their teaching experiences, the teachers were able to pinpoint the benefits and challenges of code-switching during the teaching and learning of Grade 11 mathematics. The sub-themes identified include the general benefits of code-switching and the difficulties faced by the teachers and the learners.

Sub-theme 4.1: Benefits of code-switching

As revealed in the literature, code-switching has been found to benefit teaching and learning mathematics. In this category, the findings reveal code-switching and its contribution to learners' better understanding of mathematics and how it enables them to reinforce learned content.

Category 4.1.1: Contributes to a better understanding

Benefits in the employment of the use of code-switching in the teaching and learning of mathematics were reported by teachers:

> *Code-switching benefits learners' understanding during lesson presentations. Failing to code-switch makes it difficult for learners to understand the subject content taught.* (M@2)

> *Yes, there are benefits. After all, the learners understand better because some of the concepts are very difficult but when we code-switch it becomes better for the learners to understand*. (M@4)

> *Exactly, as I have said, learners understand what you are teaching more than if you are just going to be strict and rigid to the medium of communication expected in the classroom. So, I feel that there are more benefits than disadvantages*. (M@10)

> *Learners will try to understand better let's say I give them an example they will go beyond my example because they understand exactly what I am talking about when I am teaching in the class*…(M@5)

Scholars such as Memory *et al*. (2018); Jegede (2011); Ahmad and Jusoff (2009); and Setati (1998) (*c.f*. 3.8.2) share and support the above mathematics teachers' views on the benefits of code-switching in the teaching and learning of the subject. They assert that code-switching helps learners understand the subject and follow instructions, and that it is a valuable communicative strategy in the classroom.

Category 4.1.2: Makes learners reinforce learned content

It is important to point out that some learners are proficient in English so that they immediately understand the mathematics content. On the other hand, some learners follow what the teacher is communicating to them but are not sure if their understanding is correct as their language proficiency is not adequate to cope at

Grade 11 level. This is what Teachers M@7 and M@13 emphasised in their responses below:

> *Yes, learners easily understand the subject matter presented. By using the learner's mother tongue, the teacher can easily reach out to those who struggle with certain subject content. The explanation given to learners using their home languages makes it easy for them to recall the content taught.* (M@7)

> *Another reason is that learners should internalise the knowledge that they are learning, they should not take it - it is just there to be memorised without understanding. The most important thing is to internalise the knowledge. Code-switching makes learners understand*. (M@13)

Code-switching by the teachers, in this instance, enables these learners to confirm their understanding and learning becomes more meaningful. Code-switching to the learners' home language reinforces their understanding in mathematics classrooms and allows them to internalise the information.

Sub-theme 4.2: The challenges of code-switching

The findings revealed that teachers faced challenges in their classrooms when code-switching. The excerpts below reveal the teachers' perceptions of the challenges of code-switching that they face in mathematics classrooms.

Category 4.2.1: Teachers' challenges

Three challenges of code-switching were recognised by the mathematics teachers who took part in the study: Switching codes takes time, there are no criteria from the Department of Basic Education that must be followed during and throughout the implementation, and some teachers are unfamiliar with the learners' home languages. The difficulties faced by the teachers are detailed underneath.

> *To me one challenge would be that it might be time-consuming. It is just like when for example, there is a session, we have got a speaker and an interpreter; the time it takes to complete the session becomes longer because of the interpretation. So, it applies when you code-switch because you are trying to*

explain concepts in Xitsonga. Code-switching takes a lot of time and the periods are short. (M@2)

My challenge is that it is time-consuming because changing from English to Xitsonga takes time. Again, the moment you give the learners a chance to use their home language everyone will want to say something that is why I say it is time-consuming. (M@3)

Code-switching may be time-consuming because translating may require more time, and remember we got the allocated periods, so it takes time and the content to be covered is more. (M@6)

The above excerpts indicate that some mathematics teachers perceive code-switching to be time-consuming. They argue that using two languages and repeating everything that is said in English in Xitsonga, takes time. It may result in not having enough time in the allocated lesson to complete the work and activities. Lim and Presmeg's (2011) study align with this as they found it time-consuming to code-switch between English and Mandarin to support low-performing learners which then compromised other learners.

The second challenge concerns guidelines from the Department of Basic Education on the practice of code-switching that should inform the teachers on how to code-switch.

When you look at our CAPS document and the ATP there is no clear information on how to implement code-switching in the teaching and learning of mathematics. I suggest that there be some guidelines to tell us how and when to code-switch. (M@4)

To explain what ATP and CAPS meant, Teacher M@4 clarified that:

ATPs are the subject-based Annual Teaching Plans that the Department of Basic Education provides to teachers. They are intended to give us guidelines on how to teach the learners and topics to be taught. However, there is no clear information or direction on how to code-switch during teaching and learning. (M@4)

Teacher M@4 accepts the fact that code-switching is practised during the teaching and learning of mathematics. However, her challenge lies in the fact that there are no guidelines from the Department of Basic Education through the Curriculum Assessment Policy Statements and Annual Teaching Plans to assist the teachers when they have to code-switch. In their study conducted in Limpopo province, Kretzer and Kaschula (2019) found that a flexible teaching and language policy would create a meaningful learning environment for to a multilingual and diverse class.

The third and last challenge of code-switching, according to Teacher M@10, is that the teacher may not share the same home language as the learners. The teacher responded in the manner following:

> *Alright, the disadvantage on the part of the teacher is that you may not know all the languages, if a teacher does not use code-switching properly it may also cause harm instead rather than benefits*. (M@10)

Teacher M@10 also acknowledges that code-switching is practiced in mathematics classrooms. He, however, points out that on the one hand the teacher may not know the learners' home language whilst on the other, the teacher who code-switches may not do so correctly. Teacher M@10 stated that when the teacher is proficient in the learner's home language, it is beneficial. However, it could be a challenge not only to the teacher but all the learners if the teacher is not proficient in the learners' home language.

Category 4.2.2: Learners' challenges

It seems that learners too face challenges with the use of code-switching in their mathematics lessons. The quotations hereunder confirm this:

> *Learners might not have enough time to master the language of learning and teaching, that is English. Question papers are set in English during the examination, which could be a disadvantage since there is no translation from English to the learners' native language. Code-switching in such instance, can be seen as a setback and may result in learners' poor performance.* (M@2)

According to some of the teachers, the main challenge faced by mathematics learners during teaching and learning where code-switching is employed, is that it contributes to learners not mastering the language of teaching and learning which might compromise their performance during mathematics assessments as these are conducted in English. Mokgwathi and Webb (2013) highlight that the perception that prevailed, which was code-switching, was counterproductive. Learners were not becoming proficient in the medium of instruction, which is vital for performance and achievement.

> *Learners from former model C schools, who are proficient in English, do not prefer code-switching while those who are not proficient in English are more comfortable with the employment of the practice.* (M@4)

Teacher M@4 introduced an important aspect relating to a challenge faced by a learner from a former model C school (mostly Quintile 4 or 5) where the learners' home language is English. Former model C school learners are invariably proficient in English and if code-switching is employed, they may lose interest in the lesson which could affect their performance. However, the main idea of code-switching is to ensure that all the learners in the mathematics classrooms benefit from the lesson presentation. This finding is confirmed by Sert (2005) who indicated that using a learner's home language alongside English could cause some learners to lose interest in the lesson, which would negatively affect their mathematics performance. In contrast, learners could stop listening to the teacher when using the medium of instruction and await the teacher's translation in the home language.

Category 4.2.3: Language challenges during mathematics assessment

As assessments and examinations are done in English, the findings revealed that learners may experience problems when English only is used.

> *The challenge of code-switching is that it is not employed in the examination and institutions of higher learning.* (M@3)

> *Code-switching is a challenge to the learners because examinations are written in English only as code-switching is not allowed.* (M@5)

> C*ode-switching creates challenges for the learners because tests are only set in English and not the learners' mother tongue.* (M@7

…but another challenge is that the Xitsonga words such as ku hlanganisa (to add) are not used in the question papers. (M@8)

Teachers M@3, M@5, and M@7 seem to fear that code-switching may negatively affect the learners' examinations and assessments as there will be no one to explain the questions or the concepts in their home languages. While such fear may exist, it may not necessarily mean that all the learners who benefitted from code-switching during the lesson presentations will have problems in their examinations and assessments. Teacher M@3 also highlighted that code-switching is not practised at institutions of higher learning. However, some of the learners who become proficient in English as a result of code-switching during the mathematics lessons, may not necessarily experience the challenge.

Identifying the challenges of code-switching in mathematics raises the issue of a glossary for mathematics assessments that would assist the learners in understanding the questions.

Category 4.2.4: The provision of a glossary for mathematics during the assessment

Officially, code-switching is not allowed to be used in classrooms which would then apply to the teaching and learning of mathematics. Kretzer and Kaschula (2019) stated that code-switching is not allowed in most South African classrooms. However, it is practised in mathematics classrooms because of the need to code-switch as some learners fail to comprehend mathematical concepts and the subject matter. The teachers, after using code-switching to explain complex concepts or introduce new topics, realised that the learners progressed well but the problem arises during assessment and examinations which are in English, as the learners would find difficulty in understanding as they had relied heavily on the support of code-switching during lessons.

The teachers explained that learners are disadvantaged if their home language is not used during mathematics assessment. The teachers interviewed hold the view that it would be better to provide the learners with a glossary in English and an African Language (Xitsonga) during mathematics assessment to ensure that language proficiency does not impede the learners' performance in mathematics. However, no such glossary is in existence for mathematics in English and Xitsonga, as confirmed by Teachers M@2, M@4, M@5 and M@6.

Teacher M@4 explained that glossaries are used in other subjects, indicating that there is a glossary in Afrikaans and English in Geography assessments that assist the learners in understanding the questions. Teachers feel that such a glossary is needed in mathematics assessment to support learners.

Teacher M@3 agreed that providing a glossary during mathematics assessment would add value to learners whose home language is not the medium of mathematics instruction. Teacher M@7 below supports the argument:

> *The provision of a glossary assists learners to understand complex mathematical concepts. Dealing with scaling, for example, conversions are done from one unit to another. In the process words such original size, actual or real-life situation are used. These words convey the same meaning. The presence of a glossary properly explains this to the learners who then understand that the three words mean the same thing.*
>
> *If there was a glossary to explain that the word real or original size or actual size means vukulu kumbe swilo leswi hanyaka leswi nga kona swi nga drowiwangiki (size or normal living things which are not drawn) I think n'wana (learner) would understand better than ku va n'wana a nyikiwa (than when the learner is given) these three terms in different versions ku ve va va va kha va vulavula hi (meanwhile they are talking about) the same one thing*. (M@7).

Teachers M@2, M@3, M@5, M@7, and M@9 also explained that by not providing a glossary to learners is a disadvantage to them, particularly if there are many words used in English (synonyms) for the same term.

> *The medium of instruction might have made it difficult for learners to comprehend the content. Obviously, it will be a disadvantage if a glossary is not available for the learners during assessment* (M@2)
>
> *Yes, it disadvantages them because the absence of a glossary makes it difficult for the learners to recall the concepts that were used interchangeably during teaching and learning.* (M@7)

The disadvantage is that the learners will not understand a glossary is not provided for them. M@3)

Without a glossary, learner will struggle to understand the meaning of the new concepts used during assessment. (M@5)

Yes, err, it's going to disadvantage them because they will experience difficulty during assessment. If there was a glossary of some kind, they would easily understand. (M@9)

The findings indicate that participating teachers view the use of the learners' home language during assessment as beneficial as learners can appropriately and adequately understand the questions and concepts used in the assessments. It bears mentioning that some of the learners improve their proficiency in English during code-switching and that they, nevertheless, require to be provided with the glossary which becomes an added advantage to their comprehension of mathematical concepts.

5.4.5 Theme 5: The framework to be employed to enhance teaching and learning mathematics

Mathematics teachers were asked if they included home language (Xitsonga) terminologies as part of code-switching in their lesson plans which could assist them in their employment of code-switching as well as what guidelines they would suggest improving the employment of this practice. Two categories comprising the inclusion of home language terminology when designing lesson plans and considering learners' home language during mathematics assessment are discussed.

Category 5.1: Inclusion of home language terminology when designing mathematics lesson plans

As previously indicated, code-switching is not actually allowed in classrooms (Kretzer & Kaschula, 2019), which means that mathematics teachers do not include home language terminology when they prepare their lesson plans. This was evident in their responses below:

I don't, I don't include that. (M@3)

No, I don't include home language because it is for my benefit I have to code-switch when I teach but not when I write my lesson plans as I have to do it in English. (M@4)

We do not do that. We don't indicate those words when we plan our lessons. The fact that we don't include them is because the DBE does not allow us to teach these learners using our mother tongue. (M@7)

Being not allowed to use the learners' home language in my lesson planning, I, however, from time to time come across concepts where I feel it is necessary for me to code-switch for the benefit of the learners. (M@2)

Teachers M@3, M@4, M@7 and M@2 explained that they were not allowed to use the learners' home language in their lesson planning. However, the shared feeling was that the inclusion of the learners' home language would be of much assistance.

Teachers articulated that including the learners' home language when designing mathematics lesson plans would benefit the teaching and learning of mathematics. Teachers M@6 and M@10 responded as follows:

Yes, yes, yes, this one may improve the teaching and learning of mathematics because if there is no home language terminology it limits us. (M@6)

If the policy is in place that would be very good and helpful during lesson preparation. Then I will know which concepts to code-switch during lesson presentation. (M@10)

The interviews generated a discussion around the practice of code-switching. As Teachers M@6 and M@10 stated, code-switching is not part of any official policy even though it is practised in several mathematics classrooms in Limpopo province due to the learners' lack of English proficiency. Mathematics teachers hold the view that it would be very helpful if teachers in the preparation of their mathematics lesson plans could include the use of home language terminology to supplement the teaching in English to ensure that important and difficult mathematical terminology and concepts are understood and internalised. Because of this need, Teachers M@6 and M@10 feel that the Department of Basic Education should be approached in this regard.

Teacher M@7 confirmed that code-switching is practised in the Mopani District rural schools. She justifies the practice of code-switching by giving an example where learners rote learns. This type of learning is brought about by the medium of instruction which is not the learners' home language. Experience, according to her, has taught her that learners who are supported with code-switching, do not forget what they have learned. It seems that where learners are taught in the medium of instruction, which is not their home language, they understand, internalise and remember what they have been taught. She asserts that a lesson that does not include code-switching makes it difficult for learners to understand new concepts, subject content and new information.

Of all the interviewed mathematics teachers, only Teacher M@3 proffered a different viewpoint. Teacher M@3 felt that providing learners with a glossary would send a wrong message to the learners who might think that code-switching implies that they would write their examinations in their home language. However, Teacher M@3 acknowledges that she does code-switch when the need arises.

Category 5.2: Considering learners' home language during mathematics assessment

During mathematics assessment, learners write in the language of teaching and learning which is English. As per the language policy, the findings reveal that learners are not allowed to code-switch and write in their home language.

> *Ah no, not at all*. (M@10)
>
> *No, learners are not allowed to code-switch answering questions*. (M@2)
>
> *No, they are not allowed. They have to write in English. It won't be right when they write in their home language.* (M@4)

However, it has been reported that learners, whose home language is not English, struggle to perform well in assessments due to a lack of English language proficiency, in contrast to learners for whom English is their home language.

The findings indicate that not allowing learners to use code-switching in completing assessments and examinations is an example of inequality in the teaching and learning process (Songxaba *et al.,* 2017). Teacher M@2 is concerned that even though the learners' home language plays a significant role in the teaching and learning process, it is not considered during mathematics assessment:

No, learners are not allowed to code-switch when answering questions. My suggestion would be that learners' language be considered just as mathematics in some schools is done either in English or in Afrikaans. (M@2)

The general perception of mathematics teachers is that including a glossary containing complex mathematical concepts in the learners' mother tongue alongside English would assist the learners in answering questions correctly during mathematics assessment. Some teachers suggested that the Department of Basic Education should be approached with a request that a common mathematical concepts register be compiled for learners in all home languages:

I think the DBE should ask mathematics teachers to compile the list of words that seems difficult for the learners and try to establish an English Xitsonga mathematics dictionary for grades 10-12 which can be included in the CAPS document. (M@6)

I can suggest to the Department of Education that they develop some complex mathematical concepts for Grades 10 to 11 and include them in the ATP and CAPS so that the teachers and the learners can understand them and include them in the question papers. (M@4)

I think DBE can ask teachers to compile a list of terminologies deemed difficult in all grades. Then, the glossary must be in the CAPS so that learners can have access to them. The glossary should also be included in the question papers. (M@8)

Teacher M@7 suggested that the learners, during mathematics assessment, should be allowed to give their answers in their mother tongue:

The learners must also be allowed to illustrate their points in their mother tongue while writing. If the learners have answered the questions in their mother tongue and the answers are correct, they must be marked as correct irrespective of the language used. (M@7)

Teacher M@9 discussed assessment in mother tongue in specific cases:

> *Yes, it depends. When I'm assessing them orally yes, they can answer me in their home language but when coming to formal assessment, one cannot answer questions in the home language.* (M@9)

However, it is recommended that the Department of Basic Education consider all issues and develop a policy that has the learners' best interests at heart. Teachers pointed out that learners' achievement is poor because of their lack of English proficiency:

> *They are bound to answer these questions in English and for that reason, the language becomes a barrier. Some of the learners are failing not because they do not know the answer but because they do not understand some of the instructions in English. I suggest that the Department of Basic Education formulate a clear policy on code-switching. There must be a glossary on the question paper that will assist them in understanding some of the questions in the question paper or should be posed in English and Xitsonga.* (M@9)

5.5 PRESENTATION OF EMERGENT THEMES AND CATEGORIES FROM ANALYSIS OF GRADE 11 MATHEMATICS LEARNERS' FOCUS GROUP INTERVIEWS

This section presents the finding emerging from the focus group interviews conducted with Grade 11 mathematics learners. The focus group interviews were conducted to elicit the learners' perceptions of code-switching as a communicative strategy in the teaching and learning of mathematics. Table 5.3 presents the profile of participating learners.

Table 5.13: Profile of the participating Grade 11 mathematics learners

<table>
<tr><th>NO</th><th>SCHOOL PSEUDONYM</th><th>QUINTILE</th><th>PARTICIPANTS</th><th>GENDER</th><th>AGES</th><th>OTHER SUBJECTS LEARNED</th></tr>
<tr><td>1</td><td>School A</td><td>2</td><td>Learners A- F</td><td>M & F</td><td>16-17</td><td rowspan="6">Xitsonga Home Language
English First Additional Language
Physical Sciences</td></tr>
<tr><td>2</td><td>School B</td><td>2</td><td>Learners A- F</td><td>M & F</td><td>16-17</td></tr>
<tr><td>3</td><td>School C</td><td>2</td><td>Learners A- F</td><td>M & F</td><td>16-17</td></tr>
<tr><td>4</td><td>School D</td><td>2</td><td>Learners A- F</td><td>M & F</td><td>16-18</td></tr>
<tr><td>5</td><td>School E</td><td>2</td><td>Learners A- F</td><td>M & F</td><td>16-17</td></tr>
<tr><td>6</td><td>School F</td><td>2</td><td>Learners A- F</td><td>M & F</td><td>16-18</td></tr>
</table>

NO	SCHOOL PSEUDONYM	QUINTILE	PARTICIPANTS	GENDER	AGES	OTHER SUBJECTS LEARNED
						Geography Life Sciences Life Orientation

Thirty-six learners, six from each of the six schools, were sampled to participate in focus group interviews. Participants were Grade 11 mathematics learners whose ages ranged from sixteen to eighteen years. One learner dropped out and resulted in one group having five learners while five schools had six learners. In five schools, the learners who participated in focus group interviews were referred to as Learner A, B, C, D, E, and F from Schools A, B, C, D, and E, while in School F, learners were referred to as A, B, C, D, and E. All the learners were doing seven subjects, including mathematics, as the table in the last column demonstrates.

The emergent themes and categories identified during the learners' focus group interviews are presented in Table 5.4 below.

Table 5.4: Emergent themes and categories from Grade 11 mathematics learners' focus group interviews

NO	INTERVIEW QUESTIONS	THEME	CATEGORY
1	What is the medium of instruction for the teaching and learning of mathematics in Grade 11?	The medium of instruction for the teaching and learning of mathematics	1.1 Learners' perception of the medium of teaching and learning in mathematics 1. Mother tongue and mathematics teaching and learning

NO	INTERVIEW QUESTIONS	THEME	CATEGORY
			1.2.1 Explain complex concepts 1. Contributes to learners' understanding 2. Makes learners comfortable during the lesson
2	What do you think are the factors which compel teachers to code-switch during the teaching and learning of mathematics?	Factors that compel teachers to code-switch during the teaching and learning of mathematics	2.1 Clarification of concepts 2.2 Makes lesson to be productive 2.3 Some teachers are not proficient in English 2.4 To accommodate all learners
3	Do you think code-switching is good or bad in the teaching and learning of mathematics?	3.1 The benefits of code-switching in the teaching and learning of mathematics	3.1.1 Assist learners to remember during examination 3.1.2 Helps during the writing of homework 3.1.3 Is good for revising previous question papers
		3.2 The challenges of code-switching	3.2.1 It is not good for learning the medium of instruction 3.2.2 Is not good if the teacher does not know the learners' mother tongue 3.2.3 It is a challenge when writing examination

5.5.1 Theme 1: The medium of instruction for the teaching and learning of mathematics in Grade 11

Theme 1 relates to Grade 11 learners' views regarding the medium of instruction for teaching and learning in mathematics and includes the following categories: learners' perception of the medium of teaching and learning in mathematics, mother tongue and the teaching and learning of mathematics, which are discussed next.

Category 1.1: Learners' perception of the medium of teaching and learning in mathematics

The finding revealed that learners agreed that the medium of instruction used in the teaching and learning of mathematics is English:

> *The medium of instruction in the teaching of mathematics in Grade 11 is English*. (Learner D School C)

> *The medium of instruction is English*. (Learner B School D)

Other learners stated that English and Xitsonga were both used as the media of instruction:

> *English is the medium of instruction, but mathematics is primarily taught in Xitsonga. (Learner E School A)*

> *Va hi dyondzisa hi English mara loko va fika ka marito lama hi nga ma twisiseki va dyondzisa hi Xitsonga, so swa hi pfuna swinene hi ku hi kota ku twisisa ku lahaya va vulavula hi yini*. *[They teach us in English but when we do not understand certain terminology they explain in Xitsonga and it helps us a lot as we then are in a position to understand what the teachers are teaching us about.]* (Learner D School D)

As per policy, English is the medium of instruction or LOLT used in the school. However, serious consideration must be given to what Learner E School A and Learner D School D said concerning the medium of instruction. It is evident that code-switching plays a major role in their mathematics classrooms and confirm the lack of language proficiency of learners in the language of instruction (Howie, 2003). This, according to Alordiah *et al*. (2015), is a result of the fact that English, which is the language of assessment, is not widely spoken in rural areas. Mlachila and Moeletsi (2019), Howie (2003) and Visser *et al.* (2015) have identified poor command of English among Black South African learners which is the medium of instruction, which necessitates the use of code-switching in mathematics lessons.

Category 1.2: Code-switching and the teaching and learning of mathematics

Divergent views emerged during the learners' focus group interviews. Some learners preferred to be taught in English whilst most of the learners preferred code-switching to Xitsonga by their teachers during teaching and learning mathematics. The low proficiency in English of some learners impelled their teachers to find a way to assist them during teaching and learning. It appears there was only one solution: to code-switch from English to Xitsonga (learners' home language) and vice versa. Categories in this theme include explain complex concepts, contributes to learners' understanding and makes learners comfortable during the lesson.

Category 1.2.1: Explaining complex concepts

The learners who preferred code-switching practice argued that it was helpful in cases where difficult concepts had to be explained. Their arguments are embodied in their responses that follow below:

> *When I come across a concept that I do not understand in mathematics when the teacher explains in Xitsonga it becomes easier in my learning journey. Xitsonga is my mother tongue, and the teacher needs to add a little bit of Xitsonga when he teaches mathematics to understand it better*. (Learner D School A)
>
> *Loko va kha va hi dyondzisa mi kuma ku swin'wana a hi swi twisisi hi Xilungu lexiya, i vi va hi explainela swona hi Xitsonga. [As they are teaching us you find that some of the things we do not understand and then they explain these things in Xitsonga*. (Learner E School D)
>
> *Code-switching yi kahle eka mathematics because ku na marito man'wana ma <u>difficult</u> ku ma twisisa hi English so ya pfuna. [Code-switching is good in mathematics because some words are difficult to understand in English, so it helps.]* (Learner E School E)

The learners indicated that code-switching is an important communicative resource that enables the teachers to explain complex concepts. These learners affirm that even though the medium of instruction is English, some terms are difficult to understand and by code-switching, learning is facilitated. This finding aligns with

Chikiwa and Schäfer (2014) who found that learners, whose first language is not English, were challenged in learning mathematics in English which necessitated teachers code-switching from English to their native language to enhance conceptual understanding of mathematics.

Some learners held a different view of using the learners' home language mathematics teaching and learning as shown in the excerpt below:

> *If I learn in English, it makes it easier because the questions come in English. In Grades 1-3, I used English as a medium of instruction and it is easier for me to understand English than when I was taught in Xitsonga.* (Learner C School A)

The medium of instruction in Grades 1-3 in public schools, according to policy, is the learners' home language. Many schools use a bilingual approach at Foundation Phase level, which assists learners in the development of BICS and CALPS (Cummins, 1978), and ensures that they are proficient in the LOLT when they reach the FET phase. It appears that the above learner is proficient in English as she has been taught in English from the Foundation Phase and that her language proficiency had been developed. This learner thus has no challenge in learning mathematics in English. However, if code-switching is constantly used in mathematics class, learners proficient in English may lose interest in the lesson.

Category 1.2.2: Code-switching contributes to learners' understanding

Understanding the subject content of the lesson is key to effective teaching and learning of mathematics. As explained by mathematics teachers, code-switching is employed to ensure that mathematics learners understand. The participating learners in the excerpts that follow, also verbalise this:

> *The teacher sometimes observes that sometimes some don't understand, so they code-switch to make the learners understand*. (Learner F School D)
>
> *Some of our teachers teach us in Xitsonga to enable us to understand what we are learning in mathematics. Those that use English are not familiar with Xitsonga*. (Learner D School D)

> *Mina I think ku ri swi kanhle ku va hi dyondza hi English va pfa va hi hlamusela hi Xitsonga swi endla ku hi twisisa. [I think it is good when we learn in English and they sometimes explain to us in Xitsonga it makes us understand.]* (Learner B School D)

> *I think it helps me. Let's take we are in the classroom and we are doing mathematics and the teacher is introducing a new concept and, in the topic, there is jargon which we do not understand and the teacher needs to make us understand that word. You might find that it is challenging for them to make us understand in English*. (Learner D School F)

The findings from all the above participants indicate that code-switching is helpful when the teachers introduce new mathematical terminology and concepts especially those which are complex and abstract and thus difficult to understand. It seems that code-switching is used in specific instances and not the norm in teaching and learning mathematics. The literature confirms that code-switching is a good communicative technique that facilitates teaching and learning (Chikiwa & Schäfer, 2014; Jegede, 2011).

Category 1.2.3: Code-switching makes learners comfortable during the lesson

Effective teaching and learning take place in classrooms when the atmosphere prevailing is conducive. When learners are comfortable and safe, they can focus on what is happening in their class and can actively participate. Learners are not inhibited by their lack of language proficiency but are motivated to ask questions freely and participate as soon as code-switching is employed (Nurhamidah *et al*., 2018). Learner B School D and Learner D School F verbalised this in their responses below:

> *Some other learners cannot clearly understand the teacher's words because it is not all of us who understand English. They just put additional words in Xitsonga so that we may all feel comfortable in the lesson*. (Learner B School D)

> *Because some learners feel more comfortable when their mother tongue is used to explain concepts*. (Learner D School F)

Mi kuma ku nkarhi wunwana i n'wana wa xikolo a nga vutisa ku sir; ' rito leriya ri vula yini?' [You will find that sometimes the learner may ask: 'Sir, what does that word mean?'] Learner F School D

Language use is vital in the teaching and learning process. The use of English only in mathematics classrooms restricts the involvement of the learners as they are not as comfortable in only using English, as referred to in the excerpts above. This ensures a learner-centred approach with learners being actively involved rather than tense and not knowing how to put across what they do not understand during the lesson presentation.

5.5.2 Theme 2: Factors that compel teachers to code-switch during the teaching and learning of mathematics

Learners highlighted the following factors that compel teachers to code-switch during mathematics teaching and learning: clarification of concepts, making lesson productive, teachers are not proficient in English and accommodating all learners.

Category 2.1: Clarification of concepts

The learners agree that teachers are compelled to code-switch during the teaching and learning of mathematics because of the learners' low English proficiency.

I think va ehleketa ku ri nkarhi wunwana marito lawa va ma tirhisaka hi English hi nga ka hi nga ma twisisi. So loko va katsa na Xitsonga va endlela ku hi swi twisisa ku rito ra so ri vula yini. [I think sometimes they think that the English words they use are difficult for us to understand so when they code-switch, they ensure that we understand what the particular word means.] (Learner E School C)

Because there are some concepts that we do not understand, the teachers feel that if they use our mother tongue to clarify some concepts it will be easier for us because we use the language every day. (Learner B School C)

It is right to code-switch because mathematics concepts are clarified. (Learner F School D)

The learners above are well aware that English, which is their medium of instruction, is a barrier to their understanding of the mathematics lessons which their teachers present. They support the practice of code-switching used by their teachers which assists in clarifying old and new mathematical concepts and leads to greater understanding. Code-switching in this case contributes towards the productivity of mathematics lessons, as indicated below in the next category.

Category 2.2: Code-switching makes the lesson productive

The participating learners shared their understanding of the practice of code-switching in the following excerpts:

> *We have people who better understand Xitsonga and people who better understand English so all learners will be accommodated to make the lesson productive*. (Learner C School D)

> *I mhaka ya ku sometimes va hi vona ku sometimes loko va kha va dyondzisa a hi va twisisi, hi ku vanwana va good ka English, vanwana a va good se va swicha va suka ka English va ya ka Xitsonga. [It is because teachers observe that as they are teaching, we do not seem to understand as some us who are good in English while others are not so they switch from English to Xitsonga.]* (Learner B School D)

> *Va lava ku hi kota ku famba swin'we ni ku swi twisisa. [They want us to move with them and understand what they are teaching.]* Learner C School D

Learners indicated that mathematics lessons can never be productive unless everyone in the class understands the subject content and follows the teaching. Learners explained that the teacher ensures that learners understand what is being taught through the use of code-switching and that each lesson is productive. It is vital that all learners are able to understand the subject content, the concepts being taught so that these can be internalised and then applied to their learning.

Category 2.3: Teachers are not proficient in English

Learners indicated that some of their teachers are not that proficient in English. As a result, according to the learners, these teachers present their mathematics lessons in the learners' home language (Xitsonga).

> *Teachers do not know English very well.* (Learner D School D)

> *Most teachers teach in Xitsonga because they can't speak English*. (Learner D School B)

> *In most cases ya maths a va good hi English that is why loko va dyondzisa va katsa na Xitsonga*. *[In most cases when it comes to mathematics the teachers are not proficient in English that is why they code-switch from English to Xitsonga.]* (Learner D School C)

Lack of teachers' English proficiency results in very poor communication in the teaching and learning process, as the learners have articulated, and is a cause for concern. In order to ensure effective teaching and learning teachers need to be proficient in the medium of English, which is the language and learning and teaching in all schools.

However, once they code-switch to the home language, some teachers do not revert to teaching in the LoLT.

> *Some words are difficult in English so when they code-switch, they just continue teaching in Xitsonga until to the end of the lesson.* (Learner E School B)

The learners indicated that teachers code-switch in mathematics classrooms to ensure that every learner is properly accommodated during the lesson presentation.

Category 2.4: Code-switching accommodates all learners

When teaching and learning take place in English, learners whose mother tongue is not English are left behind (Choudhury & Bose, 2011). Learner B from School D pointed out that:

> *Loko va hi dyondzisa maths hi English, hi Matsonga hina, English a hi yi koti, ku na la hi fikaka kona hi twa Xilungu xi entile se hi yimisa mavoko hi va byela ku a hi swi twisisi, se va hi hlamusela hi Xitsonga va hi komba ku swi vula yini. [When they teach maths in English, we are Vatsonga, we do not know English, there are times when English is deep so we raise our hands and tell them we do not understand, so they explain in Xitsonga and show us what it means].* (Learner B from School D)

This learner's comment is a reflection of what the teachers have reported. A good and inviting environment and atmosphere contribute to the learners' teaching and learning.

They become comfortable and safe within an environment where learners can ask in their home language to facilitate their learning process, indicating the value of code-switching. When this happens, all the learners, particularly those whose English proficiency is not good, are accommodated (Halai, 2009).

> *Teachers code-switch from Xitsonga to English because they want to accommodate all learners.* (Learner C School D)

> *Va endlela ku ri lava nga twisisiki kahle English va kota ku twisisa. [They want those who do not understand English to be able to understand.]* (Learner E School E)

The findings emphasise and bolters the fact that code-switching is a communicative strategy that assists in the understanding of mathematics subject matter.

5.5.3 Theme 3: The benefits and challenges of code-switching

The third theme emerging from the data collected from the learners' focus group interviews resulted in the benefits of code-switching in the teaching and learning of mathematics and the challenges of code-switching in mathematics classrooms.

Category 3.1: The benefits of code-switching in the teaching and learning of mathematics

According to these learners, code-switching helps them remember what their teachers taught them in their examination, when they wrote their homework and when they went through the past mathematics question papers.

Category 3.1.1: Code-switching assists learners to remember during the examination

Code-switching, used in teaching and learning mathematics, has great value to learners whose English proficiency is low. Learner F School E states that code-switching is very helpful during examinations because they were able to remember very vividly what their teachers said to them during the explanation of mathematical concepts in their home language:

> *Loko va hi dyondzisa hi English na Xitsonga hi kota ku swi tsundzuka loko hi tsala xikambelo. [When they teach us in Xitsonga it helps us to remember as we write the examination.]* (Learner F School E)

Learners believe that the use of code-switching employed by their teachers during teaching and learning of mathematics enables them to understand the information (new knowledge and complex concepts) which they can draw on when they write their examinations.

Category 3.1.2: Code-switching helps during writing homework

Learners indicated that the same applies when they do their homework.

> *Swi pfuna loko se hi tsala tihomework ha twisisa. [It helps when we write our homework we understand.]* (Learner A School E).

Category 3.1.3: It is good for revising previous question papers

Learners also indicated that code-switching is very beneficial when they revise past mathematics question papers. They remember how the teacher used their home language to explain complex terminology and concepts or jargon.

> *Code-switching is good for revising previous question papers*. (Learner D School E)

Although learners were able to identify benefits, there are challenges in using of code-switching, according to Grade 11 mathematics learners.

Category 3.2: The challenges of code-switching

Challenges identified by Grade 11 learners included that code-switching did not assist them in improving their medium of instruction. Code-switching was not practicable where the language to be code-switched to was not the teacher's home language and code-switching is not allowed during mathematics examinations, which would present a problem.

Category 3.2.1: Code-switching is not good for learning the medium of instruction

Mogwathi and Webb (2013) hold the view that code-switching is counterproductive in the teaching and learning situation as it does not develop learners' proficiency in the language of teaching and learning. Regarding this view, the learners hereunder articulate their perceptions:

> *Mathematics loko hi lava ku dyondza eka televhixin a va hlamuseli hi Xitsonga. Na loko mi ya dyondza kun'wana la va nga tiveki Xitsonga a va nge hlamuseli hi ririmi ra manana. [When we want to learn mathematics on tv they do not explain in Xitsonga. Also, when you want to further your studies where they do not know Xitsonga, they will not use your mother tongue.]* (Learner E School E)

> *Code-switching a yi kahle a yi hi nyiki opportunity yo twisisa language ya mathematics. Hi fanele hi dyondza hi medium of instruction ku hi kota ku twisisa in the examination. [Code-switching is not good as it does not allow understanding maths language. We must learn through the medium of instruction so that we understand in the exam.]* (Learner B School E)

> *Mina ni vona o nge a yi fanele yi nga tirhisiwi because loko hi ri ka examination kumbe ka test ku va ku ri na marito manwana hi nga ma twisisiki, se swa hi tikela se ni vona ku yi nga tirhisiwi. [I feel code-switching must not be practiced because when we write our examination or test and come across difficult words, it becomes a challenge for us so it must not be used.]* (Learner D School D)

The learners suggested that code-switching should not be used during the teaching and learning process. They explain that English language proficiency is needed for following mathematics lessons and tutorials on television, which are presented in English. However, as the sampled schools are situated in rural areas, there may be no access to television. Learners also know that not learning the mathematical language in English might deprive them of the opportunity to develop English proficiency needed for further studies after leaving school.

Category 3.2.2: Code-switching is not good if the teacher does not know the learners' mother tongue

One of the challenges of code-switching is that the teacher may not know the learners' home language, which means that practising code-switching becomes impossible (Adler & Sfard (2017).

> *Code-switching does not help when we are taught by teachers who do not know our language we will not understand*. (Learner C School E)

This relates to mathematics classrooms situated in the rural areas in Limpopo province where most of the learners' home language is Xitsonga, but foreign nationals or teachers from other cultural groups may be employed to teach in these areas and are unable to speak and understand Xitsonga.

Category 3.2.3: Code-switching is a challenge when writing an examination

The general understanding of participating learners regarding the challenge of code-switching relates to mathematics assessments:

> *They teach in English and Xitsonga, but the question paper comes in English*. (Learner D School A)
>
> *Sometimes yona a yi kahle because loko ho va hi ri ka test a ku na loyi a nga ta ku hlamusela hi Xitsonga u ta fayisana na question paper u ri wexe. [Sometimes it is not good because when we are writing a test there won't be anyone to explain to you in Xitsonga, but you will face the question paper alone.]* (Learner B School D)
>
> *Challenge i ku loko hi ri ka examination kumbe hi tsala test ku na marito man'wani hi va hi nga ma twisisi hi ku hi nge hlamuseriwi. [The challenge is that when we are writing an examination or a test, we do not understand other words and they do not explain them to us.]* (Learner A School D)

Learners identified that a challenge with code-switching is that the question paper in the examination is in the medium of instruction (English) and not Xitsonga. In addition, no code-switching occurs where tests and examinations are written because there is no one to code-switch for the learner. Therefore, it is vital that code-switching does not compromise the learning of mathematics so that learners are fully prepared with the relevant knowledge and skills to perform well in tests and examinations where English is the test language.

5.8 A COMPARISON OF FINDINGS

Table 5.14: Teacher versus learner findings

THEME	TEACHERS	LEARNERS
The relevance of code-switching	1. Introducing new concepts	1. Mother tongue teaching and learning

THEME	TEACHERS	LEARNERS
	2. To explain subject matter 3. Clarifying concepts 4. Assists learners to ask questions and participate 5. Learning becomes more meaningful	2. Explaining complex concepts 3. Clarification of concepts
The effectiveness of code-switching	1. Promotion of learner understanding 2. Good performance. 3. learners' confidence 4. Creates a friendly environment for 5. communication 6. Is useful for group work 7. classroom management.	1. Contributes to learners' understanding 2. Makes learners comfortable during the lesson Makes lesson to be productive 3. To accommodate all learners
The benefits of code-switching	1. Contributes to a better understanding 2. It makes learners reinforce learned content	1. Assists to remember during the examination 2. Helps during the writing of homework 3. Is good when revising previous question papers
The challenges of code-switching	1. No standardised glossary for mathematics terminology and concepts for use during assessment	2. No code-switching when writing the examination 3. Does not promote English proficiency 4. Issue if the teacher does not know the learners' mother tongue
The framework to be employed to enhance quality in mathematics teaching and learning	1. Inclusion of home language terminology in designing mathematics lesson plans 2. Considering learners' home language during mathematics assessment	Section not applicable to the learners

The findings presented in Table 5.4 provide evidence that code-switching is indeed a communicative strategy that enhances the quality of mathematics teaching and learning in Grade11. The table relates to mathematics teachers’ interviews and Grade 11 learners’ responses during their focus group interviews. Although the interview schedule was not identical, the aim was to discover teachers' and learners' understanding of the practice of code-switching in mathematics classrooms. Teachers’ explanation of code-switching in teaching and learning reflects how both participants perceive code-switching in teaching and learning mathematics. Mathematics teachers and Grade 11 learners agree that code-switching is a communicative strategy relevant in mathematics classrooms because: it promotes mathematical content understanding, makes learners feel comfortable during teaching and learning mathematics and assists with clarifying complex mathematical concepts. However, mathematics teachers add that code-switching enables learners to ask relevant and good questions during lesson presentations: introduce new concepts and make mathematics learning meaningful.

In discussing the effectiveness of code-switching, both the teachers and learners agreed that it promoted learners’ understanding of the subject matter and created a friendly environment for communication in mathematics classrooms. The teachers also highlighted that code-switching leads to good mathematics performance, is a useful strategy promoting learners’ confidence, is important for use during groupwork activities and significant for classroom management during the teaching and learning process. Learners indicated that the effectiveness of code-switching lies in the fact that everyone in the class is accommodated during lesson presentations, regardless of the lack of proficiency in the language of teaching and learning.

The benefits of code-switching, as indicated by the teachers and learners, relate to its reinforcement of the learned content that assists learners to remember during the examinations. Mathematics learners explained and highlighted the following challenges of code-switching: code-switching is not used during the examination; it does not promote their English proficiency. It cannot be effectively employed if the teacher does not know the learners’ mother tongue. On the other hand, the teachers explained that code-switching contributed to the better understanding of complex mathematical concepts, while the learners indicated that code-switching assisted them when they completed their homework and during the revision of previous mathematics question papers. Mathematics teachers highlighted that code-switching also poses challenges. There was no standardised glossary for mathematics terminology and concepts in the class, especially during assessments.

In the last section of the table, a section that was only relevant to mathematics teachers, reported that home language mathematical terminology should be included during mathematics lesson plans and that the learners’ home language be considered during mathematics assessment.

5.9 CHAPTER SUMMARY

The researcher, in this chapter, presented the findings of the empirical study. The data collected from the semi-structure interviews with teachers and the focus group interviews with Grade 11 learners were analysed and interpreted to answer the study's research questions. The findings were reported as a narrative based on the emergent themes and categories while considering the research questions, the study objectives, and the participants' verbatim quotes with literature invoked to support the study findings.

The final chapter, Chapter 6, presents the summary of the literature review while synthesising the research findings. Lastly, limitations, conclusions, and recommendations based on the outcomes of this study are given.

CHAPTER 6

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

6.1 INTRODUCTION

In Chapter 1, the overview of the study was given with the main aims and objectives. This study aimed at exploring code-switching as a communicative strategy to enhance quality in mathematics teaching and learning in Grade 11, in Limpopo Province, South Africa.

To achieve the aim, the objectives of the study were:

1. to establish the scholarly literature regarding code-switching as a communicative strategy that enhances the quality of mathematics teaching and learning.
2. to evaluate the relevance of code-switching as a communicative strategy that enhances the quality of mathematics teaching and learning.
3. to examine the effectiveness of code-switching as a communicative strategy that enhances the quality of mathematics teaching and learning.
4. to assess the challenges and benefits of code-switching in the teaching and learning of mathematics of Grade 11 learners.
5. to propose a model for code-switching that can be employed as a communicative strategy enhancing quality in mathematics teaching and learning.

Chapter five presented the findings emerging from the analysis of semi-structured interview and focus group interview data. The findings were presented as emerging themes and categories.

This chapter begins with a reflection on the research methodology and a reflection on the theoretical framework underpinning the research. Thereafter, the research findings based on the research questions and objectives are presented. The proposed framework for code-switching as a communicative strategy enhancing quality in the teaching and learning mathematics at the research sites is given as a response to the final research question. In addition, future research on code-switching is recommended, the study's limitations are also presented by highlighting the challenges experienced in conducting the study. Recommendations, based on this study, are made to the Department of Basic Education and mathematics teachers.

6.2 REFLECTIONS ON THE RESEARCH METHODOLOGY

This empirical study aimed to understand code-switching as an important communicative strategy enhancing quality in teaching and learning mathematics The qualitative approach was used to gain more insight into the phenomenon under discussion (*cf*. 4.4.4.3). Through the use of a case study design, code-switching as an important strategy in teaching and learning mathematics in Grade 11 was explored (*cf*. 4.4.5.1). The research methods involved study population (*cf.* 4.5.1); sampling process (*cf*. 4.5.2); data collection methods which comprised semi-structured interviews (*cf*. 4.5.4.1) and focus group interviews (*cf.* 4.5.4.2). Data analysis (*cf*. 4.5) was done simultaneously with data collection from the respective schools where the research was conducted. Trustworthiness of the research (*cf*. 4.6) and ethical measures (*cf.* 4.7) that were adhered to during the data collection and analysis were discussed.

The chosen methodology was instrumental in the researcher gaining more insight relevant for conducting the study. The descriptive case study design within a qualitative approach enabled the researcher to interact with Grade 11 mathematics teachers and their learners in their natural settings. Face-to-face and telephone semi-structured and focus group interviews were conducted to collect in-depth data from the sample participants. The research methodology presented a proper platform for the researcher to interact with the participants while observing their feelings and gestures as they responded to the questions which gave more meaning and understanding of the phenomenon of code-switching (constructivist paradigm). Axiological assumptions allowed the participants to freely participate in the study through the applicable protocol of giving consent for their participation in the study. A qualitative approach collects samples from a small number of individuals, which presented a difficulty to the researcher during the study. The researcher wished she could have had more learners giving their views on the practice of code-switching.

The steps followed during the research enabled the researcher to conduct the study effectively. Non-probability sampling allowed the researcher to select the participants with rich data as they employed code-switching in mathematics classrooms. Semi-structured interviews were significant in that all the participants had to respond to the same questions. The open-ended nature of the questions allowed probing to occur wherever necessary. Telephone interviews were used. However, one needed to exercise patience as the participants constantly changed the agreed-upon time.

Network posed a serious challenge because of intermittent load shedding. Data collection for the qualitative approach became interesting because whenever the researcher finished an interview session, data had to be transcribed for the data analysis. According to the researcher, this presented another opportunity for the absorption of the participants' perceptions. If I were to once again conduct research, I would follow it again; however, I would. I would sample more learner participants for the focus groups.

6.3 REFLECTIONS ON THE THEORETICAL FRAMEWORK

In Chapter 2, the researcher presented the framework on which the study was based, which, among other things, included the social justice theory (*cf.* 2.2.2), behaviourist learning theory (*cf.* 2.3.1), constructivist learning theories (*cf.* 2.3.2), which are Piaget's cognitive constructivist learning theory (*cf*. 2.3.2.1) and social constructivist learning theory (*cf.* 2.3.2.2). Social justice theory supported this study because mathematics learners in rural areas, sampled for participation in this study, learn mathematics in a language that is not their home language, which is perceived as a barrier to their performance. The theory revealed that the Department of Education, also concerned about the state of these learners, has placed policies in place to ensure that equality is promoted. Code-switching as a communicative strategy becomes an important resource for realising social justice for mathematics learners, aligning with Skovsmose and Valero (2005). They articulate that social justice provides mathematics learners with new opportunities in mathematics learning.

Teaching and learning of mathematics occur in classrooms where a conducive atmosphere is required for effective teaching and learning to occur. Behaviourism is applicable where learner behaviour is managed in the classrooms. Any deviant behaviour in these classrooms is observable, easily correctable and manageable through the implementation of code-switching and the principles of behaviourism. Piaget's cognitive constructivist learning theory concerns how the learners can learn based on their intellectual development (McCain, 2013). Some of the South African curriculum principles outlined in the Department of Basic Education (2011) are based on this theory, as discussed (*cf.* 2.3.2.1) and, therefore, mathematics teachers need to be aware of the learners' developmental stage to support them to achieve in mathematics, which according to the study's findings, depends on how code-switching is practised to support teaching and learning.

A key principle of Vygotsky's social constructivism is that learners construct knowledge through social interaction where language plays a significant role (Adam, 2017). The learner is an active participant who first interacts with parents through language where culture is transferred and then with teachers and peers once they enter formal education. This means that learners interact and actively participate with their teachers and classmates in the classrooms. Active participation in mathematics classrooms enables learners to use their knowledge and skills in completing the set tasks. Working in the Zone of Proximal Development (*cf.* 2.3.2.4), learners are scaffolded to go from what they can do now to what they can do in the future, with the instructor or competent peers providing advice and encouragement.

A key finding from this section is that through scaffolding of code-switching from English to Xitsonga and vice versa, learners can effectively participate in the classroom through discussions, activities and group work because their understanding of the subject matter is facilitated. This means that code-switching is the vehicle for learners to work in the Zone of Proximal Development to reach their potential.

6.4 RESEARCH CONCLUSIONS

The conclusions for this study are presented according to each research question to answer the main research question: *How do mathematics teachers use code-switching as a communicative strategy to enhance quality in mathematics teaching and learning in Grade 11?*

6.4.1 RQ1: What does scholarly literature say regarding code-switching as a communicative strategy to enhance quality in mathematics teaching and learning in Grade 11?

Code-switching, which is anticipated of teachers and learners who share a shared first language (Aljoundy, 2013), is considered as a communicative method that has the potential to improve mathematics teaching and learning, especially when the medium of instruction is not the learners' first language. Chikiwa and Schäfer (2014) state that teaching mathematics in English to learners whose first language is not English compels teachers to code-switch from English to native languages to enhance conceptual understanding of mathematics.

Code-switching assists learners in developing a better understanding of new information, complex concepts or terminology and bridging the gap in the teaching and learning process (Ustunel, 2016). Code-switching to the learners' native language provides them with a more comfortable environment where they can speak freely without being restricted by an English only policy (Nurhamida *et al.,* 2018). It also allows them to communicate freely with their teachers and themselves during teaching and learning (Alidou *et al.,* 2006; Nurhamida *et al*., 2018). However, code-switching should be done consistently and precisely to support learners from diverse backgrounds (Chikiwa & Schäfer, 2016).

Even though the Department of Basic Education (DBE, 2010:3) defines code-switching as "switching from one language of instruction to another language of instruction during teaching and learning", there is no policy on how it should be implemented.

The findings from the empirical study correlate with the literature review stating that the practice of code-switching as a communicative strategy, enhances quality in the teaching and learning of mathematics.

6.4.2 RQ2: How is code-switching relevant in teaching and learning mathematics of Grade 11 learners?

Code-switching is a vital resource used by teachers to disseminate knowledge to learners in bilingual and multilingual contexts (Maluleke, 2019; Modupeola, 2013; Uys, 2010) and is relevant in the teaching and learning of mathematics (*cf.* 5.4.2). The practice is relevant in teaching and learning mathematics because of the various important functions it can play. Code-switching can be used to introduce a topic by explaining in the learners' home language, which supports the learning process and assists the learners in developing proficiency in the language of teaching and learning (Setati, 2005b). When explaining the subject matter to ensure that learners understand, code-switching is a helpful resource for clarifying concepts that are found to be complex (Sepeng, 2013), promoting learners' understanding and performance in mathematics (Jegede, 2011; Uys, 2010) and ensuring that learners become active participants in the lesson through the use of their home language (Nomlomo & Mbekwa, 2013). (*cf.* 5.4.2 Category 2.1 and 2.2).

The study's findings (*cf.* 5.4.2) align with the literature as discussed in Chapter 3, Section 3.6 and concur with Uys (2010), who states that code-switching is relevant because it supports learning as a good educational practice.

6.4.3 RQ3: How effective is code-switching as a communicative strategy in enhancing quality in mathematics teaching and learning?

Code-switching is effective in the Grade 11 mathematics classrooms, as evident in its promotion of learner performance in mathematics as it addresses potential communicative and comprehension problems arising from learners' lack of English language proficiency and the learner's linguistic background (Selamat, 2014). Code-switching is effective as a communicative strategy in mathematics classrooms, contributing towards learner confidence during classroom interaction, as subject matter can be discussed more effectively, allowing learners to interact, discuss, argue and problem-solve. Code-switching assists learners when they engage in group work, which is also one of the principles of social constructivism where learners interact and learn from each other (Pollard, 2002). It facilitates the thinking processes once there is freedom on communication (Pollard, 2002). This means that code-switching is an effective strategy used by learners to make their intended meaning explicit and to transmit valuable information to the other learners in their classroom interactions (Muthusamy *et al.*, 2020) which thus enhances the quality of mathematical interactions in mathematics classrooms (Sepeng, 2013; Yusob *et al.,* 2018). Code-switching is also valuable for classroom management to reprimand a learner who misbehaves and when the need to praise someone arises (Baker, 1993) aligning with behaviourist learning theory (*cf.*2.3.1).

Code-switching is effective in the teaching and learning process because it contributes to better performance, which aligns with the literature in Chapter 3 Section 3.7.1 that code-switching aids in explaining subject matter, building learners' understanding of what occurs, and facilitating effective communication (Uys, 2010).

6.4.4 RQ4: What are the benefits and challenges of code-switching in the **teaching and learning of mathematics in Grade 11 learners?**

The study established that code-switching has a significant role to play, which is seen in the practice's valuable benefits. It is an important strategy that enhances quality in the teaching and learning of mathematics in this study and leads to a better understanding of mathematical concepts and promotes the learners' reinforcement of learned content, which is in line with Aljoundy (2013) and Memory *et al*. (2018).

According to the empirical research, mathematics teachers and learners are aware of the challenges code-switching has in teaching and learning mathematics. The teachers pointed out that the employment of code-switching by teachers relates to the time involved due to the switching between the two languages (the medium of instruction and the learners' home language). It is time-consuming and prevents teachers from completing lessons in the prescribed time. There are no guidelines from the Department of Basic Education for the proper implementation of code-switching during teaching. Teachers use their discretion on how to use code-switching in the classroom. The practice of code-switching is not allowed during mathematics assessment which is a disadvantage to the learners who may not achieve well due to failing to understand the concepts embodied in the question paper, which is against the principles of social justice theory (*cf*. 2.2.2).

Code-switching cannot be successfully employed if the teacher does not know the learners' home language. Teachers' challenges regarding code-switching from the learners' perspective are that it may lead to the learners' inability to master or understand the subject content and concepts.

However, the majority of the participants in this study agreed on the relevance, effectiveness, challenges and benefits of code-switching in mathematics classrooms.

To sum up, the main research question: *How do mathematics teachers use code-switching as a communicative strategy to enhance quality in mathematics teaching and learning in Grade 11?* can now be answered.

In sharing their understanding of code-switching as an important strategy that enhances quality in the teaching and learning of mathematics, the participant teachers acknowledged its significance in these classrooms through their definitions of the practice (*cf.* 5.4.1 Category 1.1). Mathematics teachers highlighted how code-switching is important in teaching and learning mathematics (*cf.* 3.8), explaining that it leads to a better understanding of mathematics and encourages learner participation in the classrooms (*cf.* 3.8). The teachers agreed that they practise code-switching and their reason for doing so is that it enables them to explain mathematical concepts in the learners' home language (*cf.* 3.9), it bridges the learning process enabling them to disseminate knowledge to the learners who struggle to understand English (the medium of instruction) which is foreign to most of them. Code-switching, therefore, is perceived as a solution to the language barrier. Code-switching leads to a better comprehension of the subject matter and encourages learners to participate in their classrooms (*cf*. 5.4.4 Category 4.2.1). This confirms the social constructivist theory, which states that effective teaching and learning occurs where learners participate actively

The mathematics teachers' understanding of code-switching as a communicative strategy enhancing quality in their classrooms is in line with the views espoused by Maluleke (2019) that code-switching can effectively be used during the teaching and learning process. Of importance to note is that mathematics teachers identified that there are no guidelines for the proper employment of code-switching even though they regard it to be important in the teaching and learning of mathematics (*cf*. 5.4.4 Category 4.1.1).

6.4.5 RQ5: What framework could be employed to enhance quality in mathematics teaching and learning?

Through empirical research, code-switching has been identified as an important strategy that enhances quality in teaching and learning mathematics. However, this research identified a basic deficit that could further support the practice of code-switching:

The Department of Basic Education needs to put a policy in place that will guide the employment of this important practice in mathematics classrooms (*cf.* 5.1). The research findings suggest guidelines in the form of a policy for mathematics lesson preparation where learners' home languages, alongside English, are permitted. Guidelines should be developed so that the teachers know how to incorporate the practice of code-switching and ensure it is included in their lesson preparations. In addition, as the learners' home language is not considered during mathematics assessment (*cf*. 5.4.5 Category 5.1), there is a need to develop a glossary of mathematical terminology and concepts in learners' home language (*cf*. 5.4.5 Category 5.2).

The framework to be employed to enhance quality in mathematics teaching and learning will be beneficial in the teaching and learning of mathematics. It will lead to better performance in mathematics and adequately used, will ensure that mathematics classrooms have a conducive atmosphere for better communication between teachers and learners and amongst learners themselves.

It is proposed that a model for code-switching as a communicative strategy enhances quality in teaching and learning mathematics in Grade 11. The researcher regards this work as her contribution to attaining learners' good performance and better results. This, in sum, is her contribution to the body of knowledge.

6.5 MODEL FOR CODE-SWITCHING AS A COMMUNICATIVE STRATEGY

6.5.1 Overview of the Model

The model for code-switching as a communicative strategy in enhancing quality in teaching and learning mathematics should form the backbone for the exploration of code-switching as a practice in mathematics teaching and learning. The model is based on the theories established in Chapter 2 and the themes that emerged from the empirical study (*cf*. Chapter 5). Sound knowledge of the learning theories that underpin the study also contributes to the foundation of this model as good knowledge of theories will improve mathematics teaching practices, thus creating an atmosphere that fosters its application.

Using code-switching as a communicative strategy enhancing quality in mathematics teaching and learning

Theory Underpinnings

Behaviourist Learning Theory	**Piaget's Cognitive Construction Learning Theory**	**Social Constructivist Learning Theory**	**Social Justice Theory**
▪ Effectively assists teachers to manage classrooms during teaching and learning	▪ Allows teachers to use English and Xitsonga to explain mathematics concepts during lesson preparation	▪ This shows that teaching and learning is a social activity ▪ This indicates that learners learn from their teachers and one another ▪ ZPD allows more knowledgeable learners to assist their classmates through code-switching	▪ Highlights equity, inequality, and fairness in the teaching and learning of mathematics in Grade11

Department of Basic Education

Policy on the guidelines for code-switching in Grade 11 mathematics

1. Provides guidelines for effective code-switching in the CAPS and Grade 11 annual teaching plan (ATP)
2. Conduct workshops on the new policy implementation with Deputy Chief Education Specialist (DCES) and Senior Education Specialists (SES) who will further conduct same at District level

Providing glossary for Grade 11 mathematics assessment

1. Leads to the recognition of the learners' home language (Xitsonga) during mathematics assessment
2. DBE requests for the translation of difficult mathematics concepts for use in grade 11 mathematics question papers and include these during assessment

District level

1. Senior Education Specialists conduct workshops with Grade 11 mathematics teachers
2. Senior Education Specialists from District should regularly visit schools to monitor and support compliance of policy implementation

School level

1. Ensure availability of revised mathematics CAPS and Grade 11 Annual Teaching Plan (ATP)
2. Providing Grade 11 mathematics teachers with resources to attend relevant workshops on the policy regarding code-switching in the teaching and learning mathematics

Teacher Practices

1. Grade 11 mathematics teachers participate in continuous workshops for the implementation of code-switching as a communicative strategy enhancing quality in teaching and learning mathematics

2. Implement code-switching using DBE guidelines in mathematics classrooms

(Source: Researcher's own work)

Figure 6.11: A model for code-switching as a communicative strategy

6.5.2 Application of Theory in the Teaching and Learning of Mathematics

Teachers of mathematics, should be conversant with the theories that underpin the model before implementing it. That is, the social justice theory (*cf*. 2.2.2); behaviourist learning theory (*cf.* 2.3.1) for classroom management, Piaget's cognitive constructivist theory for quality in mathematics teaching and learning during lesson planning (*cf*. 2.3.2.1) and social constructivist learning theory for quality in mathematics teaching and learning (*cf.* 2.3.2.2) for effective lesson presentation.

Social justice is essential for mathematics teachers who should take cognisance that all mathematics learners can perform well in the subject, if adequately supported and guided. The CAPS document provided by the Department of Basic Education, which is based on the Republic of South Africa Constitution, has made provision for social justice inclusion by considering the redress of previous imbalances. Therefore, as the study revealed, mathematics teachers should have the necessary skills to practice code-switching so that all the learners perform well, especially those with low English proficiency. Through the employment of code-switching, social justice ensures that all learners are supported in mathematics classes to succeed. Success in this regard, results from good performance in mathematics. Learners do well and participate freely and effectively where the principles of social justice theory are observed through the employment of code-switching.

The behaviourist learning theory relates to the fact that learning is behaviour change, and this may also manifest itself in mathematics classrooms where the order is to be maintained. The study found that mathematics teachers manage their classrooms through code-switching. The researcher observes that even though these teachers manage their classrooms at this stage, they might not be aware of the behaviourist theory. The researcher's view is that when they are aware, they will be able to manage their classes correctly and from an informed position. The study found that when learners are reprimanded in their home language, they respond better and effectively. The researcher maintains that the theory will benefit teachers and learners when proper guidelines are in place on managing mathematics classrooms through code-switching. When teachers apply behaviourist learning theory to manage their classrooms, code-switching, as a communicative strategy that enhances quality in mathematics teaching and learning, is fully realised.

Piaget's cognitive constructivist learning theory for quality in mathematics teaching and learning implies that the learners effectively receive mathematics content through the use of the language of teaching and learning. Where necessary, their home language is used as a resource to assist them in understanding. Code-switching is a communicative strategy enhancing quality in these classrooms where complex mathematical concepts are explained in the learners' home language. As the study found, the concepts will have been identified by the teachers and then explained to the learners. The mathematics CAPS document will govern this as it will have also been indicated in the relevant policy by the Department of Basic Education to ensure that only those concepts that are per the learners' cognitive development, will be considered. The concepts, once identified, will be identified and reflected in the mathematics CAPS document as well as its Grade 11 ATP. As informed by the mathematics CAPS and ATP, this will allow mathematics teachers to prepare their lessons before employing code-switching. In this manner, the learners will gain meaningful knowledge that assists them in organising the acquired information that becomes successfully stored and ready for retrieval when these learners perform new activities as they move through the FET phase and into tertiary level education and training. Piaget's cognitive constructivist learning theory for mathematics teaching and learning will be considered for mathematics lesson planning by mathematics teachers. They will have to know beforehand which concepts to explain in the learners' home language and how. In so doing, the medium of instruction will not be compromised in mathematics classrooms where learners will have an opportunity to gain vocabulary, enabling them to know the medium of instruction and thereby enjoy mathematics lessons.

The social constructivist learning theory for quality in mathematics teaching and learning is applicable when mathematics teachers realise that the learners' home language is helpful in the teaching and learning process because learners are taught and assessed through language. Therefore, as the study found, it is important to consider the learners' home language not only for teaching and learning but also for mathematics assessment. Through the guidance of the CAPS document, the teachers will present their lessons being well aware that the learners' home language is a helpful resource that improves quality in these classrooms through planned code-switching practices. It should be explained that even though the study focused on Grade 11 learners, CAPS is organised for the entire Further Education and Training Band, which comprise Grades 10-12 (*cf*. 3.5.1). Instead of teachers deciding during mathematics lessons, the mathematics Annual Teaching Plan for Grade 11 will indicate which concepts necessitate their explanation in the learners' home language. As this happens, quality in the teaching and learning of mathematics is ensured through code-switching. Again, when learners are assessed, the newly developed glossary of mathematical terminology and concepts, will assist the learners in remembering what they were taught and then learners will be able to apply the knowledge, thus improving their mathematics performance. Regarding the Zone of Proximal Development and mathematics, code-switching will also be used by the learners who are more knowledgeable to assist those that are slow, thereby enhancing the quality of learning in these classrooms.

6.5.3 Guidelines for code-switching as a communicative strategy enhancing quality in the teaching and learning of mathematics

The study has established that there are no guidelines for the employment of code-switching in Grade 11 mathematics classrooms. It further found that putting guidelines for the employment of code-switching in mathematics classrooms will ensure that the practice is beneficial in the teaching and learning process. The teachers intimated that mathematics CAPS and Grade 11 ATP should embody the necessary guidelines.

6.5.4 Providing a Glossary during Mathematics Assessment

As previously indicated, the study found that code-switching needs to be implemented during mathematics assessment as well. Mathematical terminology and concepts in the mathematics CAPS and Grade 11 ATP should be translated by the Department of

Basic Education and included in those documents. Some of these concepts should also be included in the Grade 11 mathematics question papers as an addendum so that learners with low English proficiency can understand the questions set in the examination. The glossary used during the assessment will consist of the concepts that were explained during the teaching and learning process by mathematics CAPS and Grade 11 mathematics ATP.

6.5.5 The Stages of implementing the Proposed Code-Switching Model in Grade 11 Mathematics Classrooms

The researcher suggests that the model is implemented in stages so that the Department of Basic Education is afforded time to make the necessary preparations. The five stages for the implementation of this model are discussed in the sub-sequent sections.

Stage 1: Policy formulation stage

The first stage necessitates that the Department of Basic Education familiarises itself with the underpinnings of the theories that have been indicated in the model (*cf.* 6.1). As already alluded to, since the mathematics CAPS is implemented in three grades (Grade 10-12), this implies that the Further Education and Training Band should be considered for this model by the Department of Basic Education. Therefore, the Department of Basic Education should revise the current mathematics CAPS (Grades 10-12) to include the guidelines for code-switching and the mathematics glossary in both English and Xitsonga. Furthermore, the revision of Grade 11 mathematics ATP should be done at this stage since the two documents are implemented simultaneously. Once the revision has been done, the policy documents should be finalised and printed for distribution to the Limpopo Provincial Department.

Stage 2: Translation of mathematical concepts from English to the Home Language of the learners

The second stage involves the Department of Basic Education (DBE) translating the mathematical concepts used for the Grade 11 assessment. These concepts will have to be translated from English to Xitsonga (learners' home language). They will be used during mathematics assessment attached to the question papers as a glossary that will assist the learners in understanding the questions.

Stage 3: Empowering the stakeholders who will conduct workshops

During the third stage, the Department of Basic Education should empower the Chief Education Specialists (CESs) and Deputy Chief Education Specialists (DCESs) for mathematics who will conduct the workshops for Senior Education Specialists (SESs) for mathematics in the province. This necessitates that the new revised mathematics CAPS and Grade 11 ATP be presented, explained and discussed with the stakeholders entrusted with these workshops since they will conduct similar workshops with Grade 11 mathematics teachers. The Limpopo Department of Education is responsible for distributing the revised policy documents and conducting of the workshops in this stage.

Stage 4: Mathematics Senior Education Specialist workshops

Mathematics Senior Education Specialists (SESs) will then attend the workshops on the new mathematics CAPS and Grade 11 ATPs to disseminate the knowledge to mathematics teachers. They will also monitor and support the teachers as they embark on implementing the model in their classrooms.

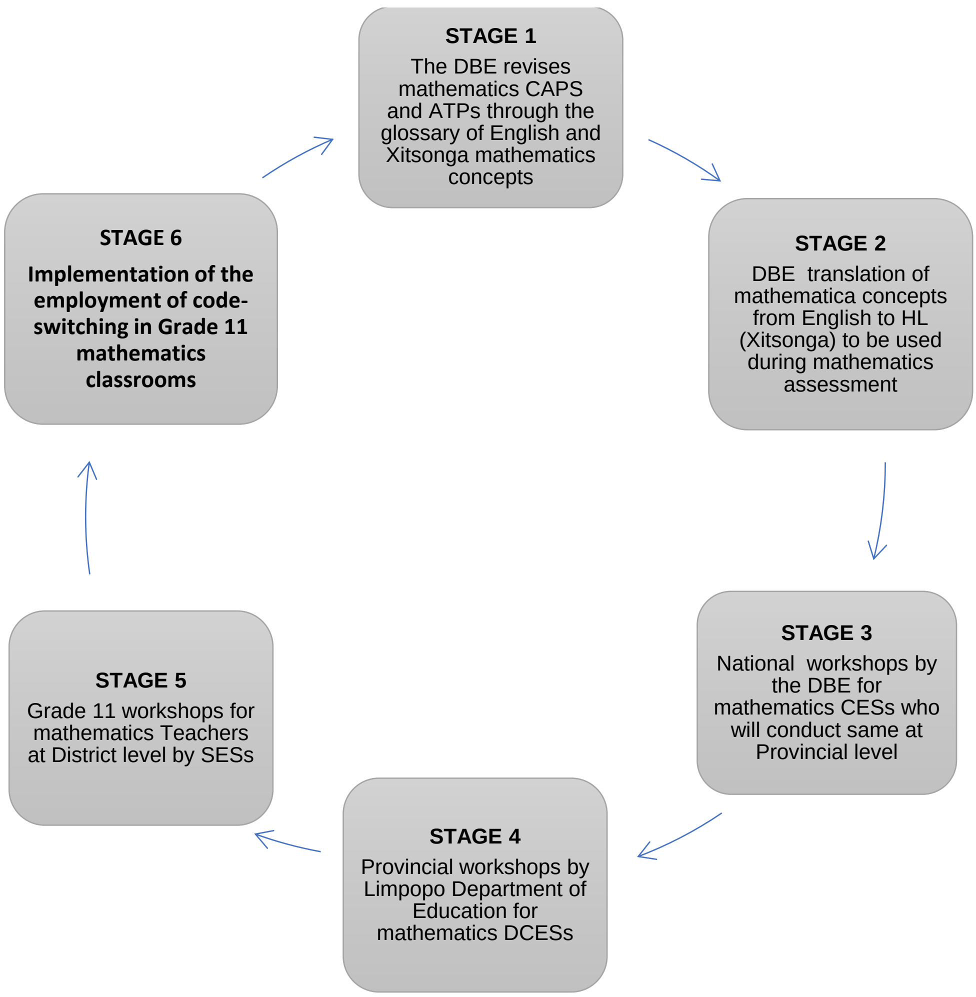
Stage 5: Grade 11 Mathematics teachers' workshops

Mathematics teachers, funded by their SGBs, should avail themselves to attend the workshops on the set dates by their Districts.

Stage 6: Implementation of the employment of code-switching

Upon their return to their workstations, mathematics teachers are expected to implement the new guidelines on the employment of code-switching as a communicative strategy enhancing quality in mathematics teaching and learning. This should be a continuous process since mathematics teachers are always changed in teaching grades in schools on an annual basis.

In summary, Figure 6.1 below represents the stages for the implementation of the model:



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Source: Researcher's own work

Figure 6.12: Stages for the implementation of code-switching as a communicative strategy

6.5.6 Roles and Responsibilities of Stakeholders In implementing the Model

In Figure 6.2, the researcher highlighted the implementation process, which requires thorough planning, preparation, training, and monitoring by different officials assigned to the tasks to ensure that the model is successfully implemented as intended. Table 6.1 presents the roles and responsibilities of the stakeholders from the Department of Basic Education to the school level (top-down) since policy guidelines are involved.

Table 6.15: The roles and responsibilities of the stakeholders

STAKEHOLDER	ROLE	RESPONSIBILITY
Department of Basic Education	Play a leading role in the implementation of this model.	1. Developing guidelines for implementing code-switching 2. Translating of glossary for mathematics to be used in the CAPS, ATPs, and mathematics question papers 3. Printing and distributing Grades 10-12 revised mathematics CAPs and ATPs 4. Funding the implementation of the programme
Provincial Department of Education and Mopani East District	Engage one another to ensure that this model is implemented in schools	1. Distribution of the revised mathematics CAPS and ATPs to the District and schools 2. Organising of workshops for Mathematics Senior Education Specialists 3. Providing permission for the conduction of workshops 4. Planning and monitoring workshop attendance
Mathematics Education Specialists	Work with schools to ensure implementation of the model	1. Distributing revised mathematics CAPs and ATPs to schools 2. Conducting workshops with mathematics teachers 3. Monitoring and supporting mathematics teachers for compliance
Mathematics teachers	Play a key role in implementing the model	1. Attending workshops as determined by the district 2. Participating in the workshops 1. Implementing new guidelines for code-switching

The finals sections of this chapter present recommendations for education stakeholders, avenues for future research, limitations to the study and concluding remarks.

6.6 RECOMMENDATIONS

The discussion below presents recommendations to the Basic Department of Education, subject specialists, mathematics education specialists and mathematics teachers.

6.6.1 Recommendations to the Department of Basic Education

One of the challenges found in this study was that there are no guidelines for implementing code-switching during the teaching and learning of mathematics in Grade 11.

The first recommendation is that the Department of Basic Education guidelines should be in place to guide the use of code-switching in mathematics classrooms. These guidelines should be included in the mathematics CAPS and Grade 11 ATPs for mathematics to enable teachers to employ the practice effectively without compromising the medium of instruction (English).

The second recommendation is that workshops be conducted to empower mathematics teachers to employ code-switching in their classrooms. The mathematics workshops should be conducted regularly so that mathematics teachers beneficially practise code-switching with their learners.

6.6.2 Recommendations to Subject Education Specialists

Thirdly, the study recommends that mathematics education specialists be the ones who conduct the workshops on the correct way of implementing code-switching with mathematics teachers. Using the revised mathematics CAPS and Grade 11 ATPs from the Department of Basic Education, Education Specialists should be at the forefront to conduct workshops on the correct way of implementing code-switching during teaching and learning. After Education Specialists have conducted the workshops, the mathematics teachers start implementing the model in their respective schools.

6.6.3 Recommendations for Schools

Fourthly, it is incumbent upon the schools to provide their mathematics teachers with the revised mathematics CAPS and grade 11 ATP and appropriately fund them to attend the necessary workshops. The school management teams should ensure that the workshops are a success and monitor the proper implementation of code-switching as a communicative strategy enhancing quality in mathematics teaching and learning.

In the interim, the Schools Governing Bodies should include code-switching in the language school policies so that the teachers employ the practice accordingly. Also, it is recommended that measures be put in place to ensure that the teaching of English FAL prepares learners to learn subject content through the medium of English, as per policy and that teachers and learners are encouraged to increasingly use the medium of instruction effectively so that learner proficiency in English is increased.

6.6.4 Recommendations for Mathematics Teachers

The last recommendation relates to mathematics teachers who are key in the implementation of the model. They should then familiarise themselves with the implementation process after attending the workshop. Finally, they are to implement the practice of code-switching by preparing before presenting their lessons so that it becomes relevant, effective and beneficial. The success of the implementation of code-switching depends on the extent of the involvement of Grade 11 mathematics teachers as they are the ones who are in direct contact with mathematics learners whose achievements are important. The learner is a national asset. Therefore, the mathematics teachers should ensure that the learners are fed appropriately with the necessary mathematical knowledge so that the learners that the schools produce become a formidable force that will ensure that the country, in the final analysis, has competent people to lead it.

6.7 AVENUES FOR FURTHER STUDY

The researcher recommends that further research explore best practices of code-switching in the teaching and learning of mathematics with special reference to mathematics assessment in the learners' home languages. Future research could also look into code-switching in mathematics teaching and learning in Grades 10 and 12. The study could also be conducted on code-switching regarding teachers who do not know the learners' home languages regarding how they could code-switch during mathematics teaching and learning. It could also be beneficial to explore best practices code-switching practices in classes where mathematics learners are more proficient in English. Code-switching in urban versus rural areas could also be explored, as well as code-switching in the teaching and learning in the other African languages in South Africa as well as code-switching in the Intermediate and Senior Phases (Grades 4-9). Finally code-switching in the teaching and learning involving multilingual classrooms in South Africa could also be investigated.

6.8 LIMITATIONS OF THE STUDY

The study population comprised thirteen mathematics teachers, and thirty-five (six focus groups) Grade 11 mathematics learners. In the researcher's view, the number of participants in the study, considering the magnitude of the investigated problem, was indeed small. However, code-switching in mathematics classrooms is common in the classrooms where learners are taught in a foreign language. The researcher collected data through semi-structured interviews with mathematics teachers and focus group interviews with Grade 11 learners, in an attempt to answer the research question. The collected data was mathematics teachers' and learners’ experiences of code-switching during the teaching and learning of mathematics. One learner did not attend the interviews in one school due to unforeseen circumstances, while one teacher could also not be interviewed telephonically as he could not answer his phone. The study was completed during the Covid-19 pandemic, and follow-up interviews for member checks purposes were impossible. This was due to the fact that the telephone interviews were mainly aimed at follow-up interviews for face-to-face interviews and it could be challenging for the participants to further participate in telephonic interviews for member checks.

It bears mentioning that notwithstanding the highlighted limitations, the researcher believes that the study remains meaningful in that its application will be of great help to schools facing similar challenges. The study paves the way for cautious and beneficial ways to implement the practice of code-switching as a communicative strategy enhancing quality in mathematics teaching and learning.

6.9 CONCLUDING REMARKS

Research has revealed that code-switching has been the centre of study for learners taught in a language that is not their home language. The orientation highlighted the challenges experienced when learners are taught in a language that is not their home language, which necessitates the practice of code-switching. Mathematics teachers are currently compelled to code-switch as they present their mathematics lessons as the medium of instruction is a language foreign to the learners who have not as yet developed English language proficiency, forming a barrier during teaching and learning.

To obviate the language problem in mathematics teaching and learning and realising that code-switching plays such a vital role during teaching and learning, this research has proffered recommendations such as guidelines to be implemented for code-switching in mathematics classrooms are to be addressed at the National Department of Basic Educational level and school level. The absence of guidelines has prompted the recommendations to assist mathematics teachers in Mopani District in Limpopo province rural schools during lesson preparations and presentations. In addition, the non-availability of a glossary of mathematics terminology and concepts in the learners' home language during mathematics assessment and the fact that some of the mathematics learners' language proficiency has been found a challenge in presenting mathematics lessons without code-switching in those rural schools.

Learners need to be assured that there is in-depth understanding of mathematical terminology and concepts through their mother tongue but that the learning mathematics and mathematical language in English has given them the opportunity to develop English proficiency needed for further studies in the FET phase and in the higher education and training phase. Thus, the relevance, effectiveness, and benefits of code-switching in the teaching and learning of mathematics, which, correctly and effectively employed, contributes to learner performance in mathematics, which is the ultimate goal for the country's development.

The deepening and broadening of the medium we use to educate our learners is as essential and fundamental as the attention we devote to the rest of the curriculum. This study has sought to effect such deepening and broadening of the medium of instruction. I am more than satisfied that this study has achieved its purpose.

The medium of instruction is as important as any of the educative resources in the educator's armamentarium

(Researcher's own quote)

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APPENDICES

Appendix A: Ethical clearance certificate

UNISA university of south africa

UNISA COLLEGE OF EDUCATION ETHICS REVIEW COMMITTEE

Date: 2021/11/22

Ref: **2016/11/16/06477704/49/MC**
Name: Mrs MT MSIMEKI
Student No.: 06477704

Dear Mrs MT MSIMEKI

Decision: Ethics Approval from 2016/11/16 to 2022/11/16

Researcher(s): Name: Mrs MT MSIMEKI
E-mail address: tintswalo.msimeki@gmail.com
Telephone: +2783 377 5766

Supervisor(s): Name: PROF. AS MAWELA
E-mail address: mawelas@unisa.ac.za
Telephone: +2712 429 4381

Name: Prof. G. Van den Berg
E-mail address: vdberg@unisa.ac.za
Telephone: +2712 429 4895

Title of research:

Code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in Grade 11, Mopani District, Limpopo Province, South Africa.

Qualification: PhD CURRICULUM STUDIES

Thank you for the application for research ethics clearance by the UNISA College of Education Ethics Review Committee for the above mentioned research. Ethics approval is granted for the period 2016/11/16 to 2022/11/16.

*The **medium risk** application was reviewed by the Ethics Review Committee on 2016/11/16 in compliance with the UNISA Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.*

The proposed research may now commence with the provisions that:

1. The researcher will ensure that the research project adheres to the relevant guidelines set out in the Unisa Covid-19 position statement on research ethics attached.

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
Telephone: +27 12 429 3111 Facsimile: +27 12 429 4150
www.unisa.ac.za

2. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
3. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the UNISA College of Education Ethics Review Committee.
4. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
5. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing.
6. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.
7. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.
8. No field work activities may continue after the expiry date **2022/11/16**. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

The reference number **2016/11/16/06477704/49/MC** *should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Kind regards,

Prof AT Motlhabane
CHAIRPERSON: CEDU RERC
motlhat@unisa.ac.za

Prof PM Sebate
EXECUTIVE DEAN
Sebatpm@unisa.ac.za

University of South Africa
Preller Street, Muckleneuk Ridge, City of Tshwane
PO Box 392 UNISA 0003 South Africa
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Appendix B: Request for permission to research high schools situated in rural schools in Limpopo Province, Mopani District.

Code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in grade 11.

10 February 2016

The District Director

Limpopo Department of Education

Mopani District

Private Bag X578

Giyani

0826

Dear Doctor L.L Mafenya

APPLICATION TO CONDUCT RESEARCH AT SECONDARY SCHOOLS SITUATED IN RURAL AREAS OF MOPANI DISTRICT, LIMPOPO PROVINCE, SOUTH AFRICA

1. I am Mavies Tintswalo Msimeki bearing South African Identity Number 630104 089 3089 a school Principal of Xikukwana Primary School with Persal Number 81128029 researching under the supervision of **Professor Ailwei Solomon Mawela** and **Professor Geesje. Van den Berg**, lecturers in the Department of Curriculum and Instructional Studies towards a Doctor of Philosophy in Education Degree at the University of South Africa.
2. The study's title is *Code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in grade 11.*
3. This study aims to collect information regarding teachers' and learners' views of code-switching in Grade 11 mathematics classrooms in schools situated in rural areas. Ten high schools with a total number of ten teachers and thirty-five learners will be purposefully sampled to participate in this study. Participants are expected to respond to the face-to-face, telephone, and focus group semi-structured interview questions. To gather information, a tape recorder will be used to record the researcher and participants' conversations, which will later be transcribed.

4. Participating in this study is voluntary and participants are under no obligation to consent to participation. Participants will be given the consent form to read and sign before participating. They are at liberty to can withdraw at any time and without giving a reason. There are no attached promises or benefits for the participants and participation in the study is voluntary. The researcher does not anticipate any harm or negative consequences for you as a participant in this study. However, if any unforeseen harm or negative consequences may take place, such, will be reported to the relevant stakeholders such as UNISA Ethics Committee and the circuits through a written report.
5. Answers will be given a code number or a pseudonym. Participants' names and school names will not be recorded anywhere, and no one will be able to connect participants to the answers you give. Participants will be referred to in the data, any publications, or other research reporting methods such as conference proceedings. A report of the study may also be submitted for publication, but individual participants will not be identifiable in such a report.
6. The researcher will store hard copies of participants' answers for five years in a locked cupboard/filing cabinet at the supervisor's office for future research or academic purposes; electronic information will be stored on a password-protected computer. If necessary, hard copies will be shredded, and/or electronic copies will be permanently deleted from the computer's hard drive through the use of a relevant software programme. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable.

7. This study has received written approval from the Research Ethics Review Committee of the CEDU research ethics, Unisa. A copy of the approval letter can be obtained from the researcher if you so wish. If you would like to be informed of the final research findings, please contact Msimeki Mavies Tintswalo at 083 298 9993 or email tintswalo.msimeki@gmail.com. The findings are accessible for three years.

8. Should you have concerns about how the research has been conducted, you may contact Professor AS Mawela at 0124294381 or email:mawelas@unisa.ac.za and Professor G. Van den Berg at 0124294895 email vdberg@unisa.ac.za.

I look forward to hearing from you.

Yours faithfully

M.T Msimeki (Researcher)

Appendix C: Permission from Limpopo Department of Education

LIMPOPO

PROVINCIAL GOVERNMENT

REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF

EDUCATION

Ref: 2/2/2 Enq: MC Makola PhD Tel No: 015 290 9448 E-mail: MakolaMC@edu.limpopo.gov.za

Msimeki MT
P O BOX 2344
GIYANI
0826

RE: REQUEST FOR PERMISSION TO CONDUCT RESEARCH

1. The above bears reference.
2. The Department wishes to inform you that your request to conduct research has been approved. Topic of the research proposal: **"SIGNIFICATION OF AFRICAN CULTUREAL IDENTITY, CODE-SWITCHING AND MATHEMATICS PERFORMANCE AMONG SOME GRADE 11 AFRICAN LEARNERS IN MOPANI DISTRICT LIMPOPO PROVINCE."**
3. The following conditions should be considered:

3.1 The research should not have any financial implications for Limpopo Department of Education.

3.2 Arrangements should be made with the Circuit Office and the schools concerned.

3.3 The conduct of research should not anyhow disrupt the academic programs at the schools.

3.4 The research should not be conducted during the time of Examinations especially the fourth term.

Request for permission to Conduct Research: Msimeki MT

CONFIDENTIAL

Cnr. 113 Biccard & 24 Excelsior Street, POLOKWANE, 0700, Private Bag X9489, POLOKWANE, 0700
Tel: 015 290 7600, Fax: 015 297 6920/4220/4494

The heartland of southern Africa - development is about people!

3.5 During the study, applicable research ethics should be adhered to; in particular the principle of voluntary participation (the people involved should be respected).

3.6 Upon completion of research study, the researcher shall share the final product of the research with the Department.

4 Furthermore, you are expected to produce this letter at Schools/ Offices where you intend conducting your research as an evidence that you are permitted to conduct the research.

5 The department appreciates the contribution that you wish to make and wishes you success in your investigation.

Best wishes.

-- 22/06/16
MUTHEIWANA NB
HEAD OF DEPARTMENT (ACTING)

DATE

Request for permission to Conduct Research: *Msimeki MT*

CONFIDENTIAL

Request for permission to research schools in your Circuit situated in rural areas entitled*: Code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in grade 11.*

30 July 2016
The Circuit Manager Klein Letaba Circuit
Private Bag X578
Giyani
0826

Dear Madam

1. I, Mavies Tintswalo Msimeki, am researching under the supervision of Professor Ailwei Solomon Mawela and Professor Geesje Van den Berg, lecturers in the Department of Curriculum and Instructional Studies towards a Doctor of Philosophy in Education at the University of South Africa. We invite you to participate in a study entitled "Code-switching as a communicative strategy to enhance mathematics teaching and learning quality *in grade 11.*"

2. This study explores how code-switching as a communicative strategy can be used to enhance the quality of mathematics teaching and learning in grade 11.

3. Your circuit has been selected because **it is one of the circuits in the Mopani District which is the focus of this study.** The study will entail **mathematics teachers in Grade 11 participating in the study. Face-to-face interviews (individual and focus group) and telephone interviews will be used to collect data from the mathematics teachers and learners**. The benefits of this study are that the findings may be used by high schools working together with the Department of Limpopo

Education to use code-switching as a communicative strategy that enhances the quality in mathematics teaching and learning.

4. There are no foreseeable risks for participating in the study. There will be no reimbursement or any incentives for participation in the research. Key findings of the study will be shared with the Department of Limpopo Education, mathematics teachers, and academia through a summary report on the study after its successful completion.

5. Should you have concerns about how the research has been conducted, you may contact and Professor AS Mawela at 0124294381 or email: mawelas@unisa.ac.za and Professor G. Van den Berg at 124294895 e-mail; vdberg@unisa.ac.za

Yours sincerely

M T Msimeki (Researcher)

Request for permission to research schools in your Circuit situated in rural areas entitled*: Code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in grade 11.*

30 July 2016
The Circuit Manager Nsami Circuit
Private Bag X578
Giyani
0826

Dear Madam

1. I, Mavies Tintswalo Msimeki, am researching under the supervision of Professor Ailwei Solomon Mawela and Professor Geesje Van den Berg, lecturers in the Department of Curriculum and Instructional Studies towards a Doctor of Philosophy in Education at the University of South Africa. We invite you to participate in a study entitled "Code-switching as a communicative strategy to enhance mathematics teaching and learning quality *in grade 11.* **"**

2. This study explores how code-switching as a communicative strategy can be used to enhance the quality of mathematics teaching and learning in grade 11.

3. Your circuit has been selected because **it is one of the circuits in the Mopani District which is the focus of this study.** The study will entail **mathematics teachers in Grade 11 participating in the study. Face-to-face interviews (individual and focus groups) and telephone interviews will be used to collect data from the mathematics teachers and learners**. The benefits of this study are that the findings may be used by high schools working together with the Department of Limpopo Education to use code-switching as a communicative strategy that enhances quality in mathematics teaching and learning.

4. There are no foreseeable risks for participating in the study. There will be no reimbursement or any incentives for participation in the research. Key findings of the study will be shared with the Department of Limpopo Education, mathematics teachers, and academia through a summary report on the study after its successful completion.
5. Should you have concerns about how the research has been conducted, you may contact and Professor AS Mawela at 0124294381 or email: mawelas@unisa.ac.za and Professor G. Van den Berg at 124294895 e-mail; vdberg@unisa.ac.za

Yours sincerely
M T Msimeki (Researcher)

Request for permission to research schools in your Circuit situated in rural areas entitled*: Code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in grade 11.*

30 July 2016
The Circuit Manager Shamavunga Circuit
Private Bag X578
Giyani
0826

Dear Madam

1. I, Mavies Tintswalo Msimeki, am researching under the supervision of Professor Ailwei Solomon Mawela and Professor Geesje Van den Berg, lecturers in the Department of Curriculum and Instructional Studies towards a Doctor of Philosophy in Education at the University of South Africa. We invite you to participate in a study entitled "Code-switching as a communicative strategy to enhance mathematics teaching and learning quality *in grade 11***."**

2. This study aims to explore how code-switching as a communicative strategy can be used to enhance the quality in mathematics teaching and learning in grade 11.

3. Your circuit has been selected because **it is one of the circuits in the Mopani District which is the focus of this study.** The study will entail **mathematics teachers in Grade 11 participating in the study. Face-to-face interviews (individual and focus group) and telephone interviews will be used to collect data from the mathematics teachers and learners**. The benefits of this study are that the findings may be used by high schools working together with the Department of Limpopo Education to use code-switching as a communicative strategy that enhances quality in mathematics teaching and learning.

4. There are no foreseeable risks for participating in the study. There will be no reimbursement or any incentives for participation in the research. Key findings of the study will be shared with the Department of Limpopo Education, mathematics teachers, and academia through a summary report on the study after its successful completion.
5. Should you have concerns about how the research has been conducted, you may contact and Professor AS Mawela at 0124294381 or email: mawelas@unisa.ac.za and Professor G. Van den Berg at 124294895 e-mail; vdberg@unisa.ac.za

Yours sincerely
M T Msimeki (Researcher)

Appendix G: Information letter to participating schools

UNISA college of education

Information letter to research your school*: Code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in grade 11.*

05 September 2016

The School Principal

Dear Sir/Madam

1. I, Mavies Tintswalo Msimeki, am researching under the supervision of Professor Ailwei Solomon Mawela and Professor Geesje Van den Berg, lecturers in the Department of Curriculum and Instructional Studies towards a Doctor of Philosophy in Education at the University of South Africa. We invite you to participate in a study entitled "Code-switching as a communicative strategy to enhance mathematics teaching and learning quality *in grade 11.*"

2. This study explores how code-switching as a communicative strategy can be used to enhance the quality of mathematics teaching and learning in grade 11.

3. Your circuit has been selected because **it is one of the circuits in the Mopani District, which is the focus of this study.** The study will entail **mathematics teachers in Grade 11 participating in the study. Face-to-face interviews (individual and focus group) and telephone interviews will be used to collect data from the mathematics teachers and learners**. The benefits of this study are that the findings may be used by high schools working together with the Department of Limpopo Education to use code-switching as a communicative strategy that enhances quality in mathematics teaching and learning.

4. There are no foreseeable risks for participating in the study. There will be no reimbursement or any incentives for participation in the research. Key findings of the study will be shared with the Department of Limpopo Education, mathematics

teachers, and academia through a summary report on the study after its successful completion.

5. Should you have concerns about how the research has been conducted, you may contact and Professor AS Mawela at 0124294381 or email: mawelas@unisa.ac.za and Professor G. Van den Berg at 124294895 e-mail: vdberg@unisa.ac.za

Yours sincerely
M T Msimeki (Researcher)

Appendix H: Request for mathematics teacher to participate in the study

Request a Grade 11 mathematics teacher to participate in the study entitled **"***Code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in grade 11.***"**

5 September 2016

DEAR PROSPECTIVE PARTICIPANT

I am Mavies Tintswalo Msimeki, conducting research under the supervision of Professor Ailwei Solomon Mawela and Professor Geesje. Van den Berg who are lecturers in the Department of Curriculum and Instructional Studies towards a Doctor of Philosophy in Education at the University of South Africa. We have no funding to sponsor this study. We are inviting you to participate in a study entitled: **"***Code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in grade 11.* **"**

WHAT IS THE PURPOSE OF THE STUDY?

This study is expected to collect important information that could explore how teachers and learners use code-switching as a communicative strategy that enhances quality in the teaching and learning of mathematics.

WHY AM I BEING INVITED TO PARTICIPATE?

You are invited because you are currently teaching mathematics in Grade 11, have vast knowledge in the teaching of mathematics that sometimes involves the practice of code-switching. Your contact details were obtained from your school principal. The total number of teachers who will participate in this study is fourteen (14) whilst thirty-six (36) Grade 11 mathematics learners are expected to participate in focus group interviews.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

You are expected to respond to the face-to-face semi-structured interview questions. To document information, an audio recorder will be used to record our conversation, which will later be transcribed. During the interview, you will be expected to respond to the questions that are in line with confirmation of signing the consent form; teacher's demographic information; your understanding of what code-switching in the teaching of mathematics is, the relevance of code-switching in the teaching, and learning of mathematics, the effectiveness of code-switching in the teaching and learning of mathematics, the challenges and benefits of code-switching as well as how code-switching can be used as the strategy that enhance quality in the teaching and learning of mathematics in Grade 11. The researcher further requires your expertise in observing the practice of code-switching to share these experiences during the interview session.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and you are under no obligation to consent to participation. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw at any time and without giving a reason.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

There are no benefits for the participants and participation in the study is voluntary.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

The researcher does not anticipate any harm or negative consequences for you as a participant in this study. However, if any unforeseen harm or negative consequences may take place, such, will be reported to the relevant stakeholders such as UNISA Ethics Committee through a written report.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

Your name and the name of the school will not be recorded anywhere, and no one will be able to connect you to the answers you give. Your answers will be given a code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings. A report of the study may also be submitted for publication, but individual participants will not be identifiable in such a report.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

The researcher will store hard copies of your answers for five years in a locked cupboard/filing cabinet at the supervisor's office, and or researcher's home for future research or academic purposes; electronic information will be stored on a password-protected computer. If necessary, hard copies will be shredded, and/or electronic copies will be permanently deleted from the computer's hard drive through the use of a relevant software programme. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

You will not receive any payments for taking part in this research.

HAS THE STUDY RECEIVED ETHICS APPROVAL?

This study has received written approval from the Research Ethics Review Committee of the CEDU research ethics, Unisa. A copy of the approval letter can be obtained from the researcher if you so wish.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact Mavies Tintswalo Msimeki at 083 377 5766 or through email: tintswalo.msimeki@gmail.com.The findings of this study are accessible for three years.

Should you have concerns about how the research has been conducted, you may contact Professor A.S Mawela at 0124294381 or email:mawelas@unisa.ac.za and Professor G. Van den Berg at 124294895 e-mail vdberg@unisa.ac.za and

Thank you for taking the time to read this information sheet and for participating in this study.

____

(insert signature)

____

(insert your name)

Appendix I: Participant consent form (Mathematics teacher)

UNISA college of education

Title: *Code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in grade 11.*

I, __________________ ______________________ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet. I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications, and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree with the recording of the questionnaire/ interview.

I have received a signed copy of the informed consent agreement.

Participant Name and Surname (please print) : _________________________________

___________________________ _________________________________

Participant Signature Date:

Researcher's Name and Surname (please print): Mavies Tintswalo Msimeki

____

Researcher's signature Date:

Appendix J: Request for permission from parents of Grade 11 mathematics learners to participate in the study

UNISA | college of education

Request your son/daughter to participate in the study entitled **"***Code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in grade 11.***"**

05 September 2016

DEAR PARENT OF PROSPECTIVE GRADE 11 MATHEMATICS PARTICIPANT

We are inviting your son/daughter to participate in a study entitled: "Code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in grade 11, Mopani District, Limpopo Province, South Africa." I am Mavies Tintswalo Msimeki, researching under the supervision of Professor Ailwei Solomon Mawela and Professor Geesje. Van den Berg who are lecturers in the Department of Curriculum and Instructional Studies towards a Doctor of Philosophy in Education at the University of South Africa. We have no funding to sponsor this study.

WHAT IS THE PURPOSE OF THE STUDY?

This study is expected to collect important information that could explore how teachers and learners use code-switching as a communicative strategy that enhances quality in the teaching and learning of mathematics.

WHY IS MY SON/DAUGHTER BEING INVITED TO PARTICIPATE?

You are invited because you are currently learning mathematics in Grade 11and also have vast knowledge in the learning of mathematics that sometimes involves the practice of code-switching. Your contact details were obtained from your school principal. The total number of teachers who will participate in this study is fourteen (14) thirty-six (36) Grade 11 mathematics learners are expected to participate in focus group interviews. Your son/daughter to participate in the focus group interviews where he/she will be part of other learners in that group.

WHAT IS THE NATURE OF MY SON'S/DAUGHTER'S PARTICIPATION IN THIS STUDY?

Your son/daughter is expected to respond to focus group interview questions. To document information, an audio recorder will be used to record this discussion, which will later be transcribed. During the interview, your son/daughter will be expected to respond to the questions that are in line with confirmation of signing the consent form; learner's demographic information; his/her understanding of what code-switching in the learning of mathematics, the importance of mathematics as a school subject and the factors that cause the teachers to practice code-switching during the teaching and learning of mathematics.

CAN HE/SHE WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and your son/daughter is under no obligation to consent to participation. If you permit your son/daughter to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw your son/daughter's participation at any time and without giving a reason. Your son/daughter must also agree to participate in the study by signing the assent that accompanies this letter.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

There are no benefits for the participants and participation in the study is voluntary.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR HIM/HER IF HE/SHE PARTICIPATES IN THE RESEARCH PROJECT?

The researcher does not anticipate any harm or negative consequences for your son/daughter's participation in this study. However, if any unforeseen harm or negative consequences may take place, such, will be reported to the relevant stakeholders such as UNISA Ethics Committee through a written report.

WILL THE INFORMATION THAT HE/SHE CONVEYS TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

Your son's/daughter's name and the name of the school will not be recorded anywhere, and no one will be able to connect him/her to the answers he/she gives. His/her answers will be given a code number or a pseudonym and he/she will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings. A report of the study may also be submitted for publication, but individual participants will not be identifiable in such a report.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

The researcher will store hard copies of your son's/daughter's answers for five years in a locked cupboard/filing cabinet at the supervisor's office, and or researcher's home for future research or academic purposes; electronic information will be stored on a password-protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. If necessary, hard copies will be shredded, and/or electronic copies will be permanently deleted from the computer's hard drive through the use of a relevant software programme.

WILL MY SON/DAUGHTER RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

Your son/daughter will not receive any payments for taking part in this research.

HAS THE STUDY RECEIVED ETHICS APPROVAL?

This study has received written approval from the Research Ethics Review Committee of the CEDU research ethics, Unisa. A copy of the approval letter can be obtained from the researcher if you so wish. The Limpopo Department of Education through Mopani District has also granted permission for the conduction of this study.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If your son/daughter would like to be informed of the final research findings, please contact Mavies Tintswalo Msimeki at 0832989993 or through email:

tintswalo.msimeki@gmail.com.The findings of this study are accessible for three years.

Should you have concerns about how the research has been conducted, you may contact Professor A.S Mawela at 0124294381 or email:mawelas@unisa.ac.za and Professor G. Van den Berg at 0124294895 e-mail vdberg@unisa.ac.za and

Thank you for taking the time to read this information sheet and for allowing your son/daughter to participate in this study.

____

(insert signature)

Appendix K: Parent consent form

Title: *Code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in grade 11.*

I, ___________________ _______________________ (parent/guardian name), cell. Number________________, hereby grant permission for my son/daughter_________________________________ to participate in this research. I confirm that the person asking my consent for this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet. I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my son's or daughter's participation is voluntary and that he/she is free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications, and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.

I agree with the recording of the questionnaire/ interview.

I have received a signed copy of the informed consent agreement.

Name and Surname (Print) of Parent/Guardian : __________________________________

____________________________ __________________

Signature Date:

Researcher's Name and Surname (please print): Mavies Tintswalo Msimeki

Researcher's signature:___________________ Date:_____________

Appendix L: Request for assent from Grade 11 mathematics learners to participate in the study

Request for your assent to participate in the study entitled entitled **"***Code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in grade 11.***"**

05 September 2016

DEAR PROSPECTIVE PARTICIPANT

I am Mavies Tintswalo Msimeki, researching under the supervision of Professor Ailwei Solomon Mawela and Professor Geesje Van den Berg who are lecturers in the Department of Curriculum and Instructional Studies towards a Doctor of Philosophy in Education at the University of South Africa. We have no funding to sponsor this study. We are inviting you to participate in a study entitled: **"***Code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in grade 11, Mopani District, Limpopo Province, South Africa.***"**

WHAT IS THE PURPOSE OF THE STUDY?

This study is expected to collect important information that could explore how teachers and learners use code-switching as a communicative strategy that enhances quality in the teaching and learning of mathematics.

WHY AM I BEING INVITED TO PARTICIPATE?

You are invited because you are currently learning mathematics in Grade 11and also have vast knowledge in the learning of mathematics that sometimes involves the practice of code-switching. Your contact details were obtained from your school teacher. The total number of teachers who will participate in this study is ten (10) whilst thirty-six (36) Grade 11 mathematics learners are expected to participate in focus group interviews. You will participate in the focus group interviews where you will be part of other learners in that group.

WHAT IS THE NATURE OF MY SON'S/DAUGHTER'S PARTICIPATION IN THIS STUDY?

You are expected to respond to focus group interview questions. To document information, an audio recorder will be used to record this discussion, which will later be transcribed. During the interview, you will be expected to respond to the questions that are in line with confirmation of signing the consent form; learner's demographic information; your understanding of what code-switching in the learning of mathematics, the importance of mathematics as a school subject, and the factors that cause the teachers to practice code-switching during the teaching and learning of mathematics.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participating in this study is voluntary and you are under no obligation to consent to participation. If you agree to take part, you will be given this information sheet to keep and be asked to sign a written consent form. You are free to withdraw your participation at any time and without giving a reason. Your parent is also supposed to permit you to participate in this study.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

There are no benefits for the participants and participation in the study is voluntary.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR HIM/HER IF HE/SHE PARTICIPATES IN THE RESEARCH PROJECT?

The researcher does not anticipate any harm or negative consequences for your participation in this study. However, if any unforeseen harm or negative consequences may take place, such, will be reported to the relevant stakeholders such as UNISA Ethics Committee through a written report.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

Your name and the name of the school will not be recorded anywhere, and no one will be able to connect you to the answers he/she gives. Your answers will be given a code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings. A report of the study may also be submitted for publication, but individual participants will not be identifiable in such a report.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Hard copies of your answers will be stored by the researcher for five years in a locked cupboard/filing cabinet at the supervisor's office, and or researcher's home for future research or academic purposes; electronic information will be stored on a password-protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable. If necessary, hard copies will be shredded, and/or electronic copies will be permanently deleted from the hard drive of the computer through the use of a relevant software programme.

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

You will not receive any payments for taking part in this research.

HAS THE STUDY RECEIVED ETHICS APPROVAL?

This study has received written approval from the Research Ethics Review Committee of the CEDU research ethics, Unisa. A copy of the approval letter can be obtained from the researcher if you so wish. The Limpopo Department of Education through Mopani District has also granted permission for the conduction of this study.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact Mavies Tintswalo Msimeki at 083 377 5766 or through email: tintswalo.msimeki@gmail.com.The findings of this study are accessible for three years.

Should you have concerns about how the research has been conducted, you may contact Professor A.S Mawela at 0124294381 or email:mawelas@unisa.ac.za and Professor G. Van den Berg at 124294895 e-mail vdberg@unisa.ac.za and

Thank you for taking the time to read this information sheet and for allowing your son/daughter to participate in this study.

____

(insert signature)

Appendix M: Participant consent form (Grade 11 mathematics learners)

UNISA | college of education

Title: *Code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in grade 11.*

I, __________________ ______________________ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet. I have had sufficient opportunity to ask questions and am prepared to participate in the study.

I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications, and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified.
I agree with the recording of the questionnaire/ interview.
I have received a signed copy of the informed consent agreement.
Participant Name and Surname (please print) : _________________________________

___________________________ _________________________________

Participant Signature Date:

Researcher's Name and Surname (please print): Mavies Tintswalo Msimeki

____

Researcher's signature Date:

Appendix N: Confidentiality for the focus group interviews

UNISA college of education

Title: *Code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in grade 11.*

I Mavies Tintswalo Msimeki Student Number 0647 770 4 Identity Number 630104 0893 089 referred hereto as the principal researcher for the study entitled *Code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in grade 11, Mopani District, Limpopo Province, South Africa.* hereby enter into agreement with my participant ___________________________________ (Name) who participates as a Grade 11 mathematics learner that;

The information that you will convey to me will be regarded with high confidentiality. You have the right to insist that your name will not be recorded anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this research or your name will not be recorded anywhere. No one will be able to connect you to the answers you give. Your answers will be given a code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings.

The only person who will have access to your name is me. Your answers may be reviewed by people responsible for making sure that research is done properly, including the transcriber, external coder, and members of the Research Ethics Review Committee. Otherwise, records that identify you will be available only to people working on the study, unless you permit other people to see the records.

While the researcher will make every effort to ensure that you will not be connected to the information that you share during the focus group, I cannot guarantee that other participants in the focus group will treat the information confidentially. For this reason, *I advise you not to disclose personal sensitive information in the focus group. I shall, however, encourage all participants to do so.*

Signatures:

Learner:

Name:_______________________ Signature:_______________ Date: ___________

Researcher:

Name: _______________________ Signature:_________________ Date: _________

Appendix O: Mathematics teachers' interview guide

UNISA | college of education

Title: *Code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in grade 11.*

DEAR PROSPECTIVE PARTICIPANT:

I, Mavies Tintswalo Msimeki, am researching under the supervision of Professor A.S. Mawela and Professor G. Van den Berg, lecturers in the Department of Curriculum and Instructional Studies, towards a Doctor of Philosophy in Education (Ph.D.) at the University of South Africa and would like to know if you have read and signed the consent form as a participant of this research study. Would you please indicate by saying Yes or No before we can proceed with this interview? There are five main sections that you are requested to respond to.

Section A: Teachers' demographic information.

1. Please indicate your name, surname, gender, and school name
2. For how long have you been teaching mathematics in Grade 11?
3. Would you please indicate your highest qualification?
4. Apart from mathematics, which other subjects and grade are you teaching?

Section B: Code-switching in the teaching and learning of mathematics.

Face-to-face interviews for grade 11 mathematics teachers

1. How long have you been teaching mathematics, and what have you noted concerning learner performance?
2. What do you think are the factors that compel you to practice code-switching in teaching and learning mathematics?
3. Do you think code-switching is good during mathematics lesson presentations? Give reasons for your answer.
4. Do you think code-switching is good for teaching mathematics? Why?

5. Share your experience when you code-switched during lesson presentations.

Telephone interview guide for mathematics teachers

Question 1: Code-switching as a communicative strategy enhancing quality in mathematics teaching and learning in grade 11

1.1. What would you say code-switching is?

1.2. Do you code-switch when teaching maths in your class?

If yes, why?

If No, why?

1.3. Do you think code-switching is an important communicative strategy to enhance the quality of teaching and learning of mathematics?

If yes, why?

If No, why?

Question 2: The relevance of code-switching during teaching and learning of mathematics of grade 11 learners?

2.1. Do you think code-switching is relevant in teaching and learning mathematics?

If yes, why?

If No, why?

2.2. Based on your experience, do you think code-switching promote learners' understanding and performance in mathematics?

If yes, why?

If No, why?

Question 3: The effectiveness of code-switching as a communicative strategy to enhancing quality in mathematics teaching and learning

3.1. How was the learners' performance in your class before code-switching?

3.2. Does code-switching improve learners’ confidence to communicate with the teacher during teaching and learning?

If yes, why?

If No, why?

3.3. Can you say code-switching assist you to manage your maths classroom well or not?

If yes, why?

If No, why?

Question 4: The challenges and benefits of code-switching in the teaching and learning of mathematics in grade 11 learners?

4.1. What would you say is the challenge of code-switching during teaching and learning of mathematics…

1. To you as a teacher? And
2. To learners?

4.2. When assessing learners, are you allowed to give a glossary of some words that do you frequently use when code-switching during teaching and learning?

1. If yes, how does that benefit the learners?
2. If no, how does that disadvantage the learners?

4.3 Are there any benefits of code-switching in the teaching and learning of mathematics in general?

1. If yes, what are they?
2. If no, why?

Question 5: Framework to be employed to enhance quality in mathematics teaching and learning?

5.1. When designing lesson plans, do you include home-language terminologies as part of code-switching?

1. If yes, which policy support such practices?
2. If no, do you think, such practices will enhance your teaching and learning of mathematics?

5.2. When answering questions, are learners allowed to use their home language (code- switch)?

1. If yes, does the DBE policy allow you to mark such answers?
2. If no, what would you suggest to the DBE?

Thank you very much for your participation in this interview.

Appendix P: Grade 11 mathematics learners interview schedule

Title: *Code-switching as a communicative strategy to enhance the quality in mathematics teaching and learning in grade 11.*

DEAR PROSPECTIVE PARTICIPANT:

I, Mavies Tintswalo Msimeki, am researching under the supervision of Professor A.S. Mawela and Professor G. Van den Berg, lecturers in the Department of Curriculum and Instructional Studies, towards a Doctor of Philosophy in Education (Ph.D.) at the University of South Africa and would like to know if you have read and signed the consent form as a participant of this research study. Please indicate by saying Yes or No before we can proceed with this interview. There are five main sections that you are requested to respond to.

Section A: Learners' demographic information.

Please indicate your names, gender, and school name
Are you in Grade 11 this year?
Apart from mathematics, which other subjects and grade are you learning?

Section B: Code-switching in the teaching and learning of mathematics.

Group Interviews for grade 11 mathematics learners

1. What is the medium of instruction for the teaching and learning of mathematics in Grade 11?
2. What do you think are the factors that compel teachers to code-switch during the teaching and learning of mathematics?
3. Do you think code-switching helps in the teaching and learning of mathematics? Let us look into it both ways. If you are saying it helps, give reasons and if not, also give reasons.

Appendix R: An example of transcribed interviews (Grade 11 mathematics teachers and learners)

Example 1: Grade 11 mathematics learners focus group interviews

School D focus group interviews transcription

Number of grade 11 mathematics learner participants: 6

Date of Interviews: 1 November 2017

Duration of interviews: 29 minutes 32 seconds

Researcher: Good afternoon, learners and your teacher. I am Mavies Tintswalo Msimeki, researching on "Code-switching as a communicative strategy enhancing quality in mathematics teaching and learning in Grade 11 in Limpopo, South Africa" with the University of South Africa. I welcome you to this session of interviews as we have met previously and done the introductions. You are free to express yourselves in the language you are comfortable in (English or Xitsonga). You respond according to the code that has been allocated to you (A, B, C, D, E or F).

Participants: Good afternoon, madam.

Researcher: Question 1

QUESTION 1

What is the medium of instruction for teaching and learning mathematics in grade 11? And what are your experiences concerning this?

Learner B School D: The medium of instruction is English.

Learner D School D: Va hi dyondzisa hi English mara loko va fika ka marito lama hi nga ma twisiseki va dyondzisa hi Xitsonga, so swa hi pfuna swinene hi ku hi kota ku twisisa ku lahaya va vulavula hi yini. [They teach us in English but when we do not understand certain terminology they explain in Xitsonga and it helps us a lot as we then are in a position to understand what the teachers are teaching us about.]

Learner E School D: They teach us in both languages, Xitsonga and English.

Researcher: But what is the medium of instruction? We start there.

Learner E School D: Language ya kona i English. [The language is English.]

Researcher: But what happens when they are teaching?

Learner E School D: Loko va kha va hi dyondzisa mi kuma ku swin'wana a hi swi twisisi hi Xilungu lexiya, i vi va hi explainela swona hi Xitsonga. [As they are teaching us you find that some of the things we do not understand and then they explain these things in Xitsonga. (Learner E School D)

Learner A School D: Va hi pfuna ngopfu hi ku hina vanwana English a hi yi koti ngopfu hi ku a primary hi suke hi nga yi dyondzanga ngopfu. [They help some of us because we do not know English as we were not exposed to this language in primary school.

Learner F School D: The teacher sometimes observes that sometimes some don't understand, so they code-switch to make the learners understand.

QUESTION 2

What do you think are the factors that compel your teachers to practice code-switching in the teaching and learning of mathematics?

Learner D School D: Some of our teachers teach us in Xitsonga to enable us to understand what we are learning in mathematics. Those that use English are not familiar with Xitsonga.

Learner C School D: We have people who better understand Xitsonga and people who better understand English so all learners will be accommodated to make the lesson productive.

Learner B School D: I mhaka ya ku sometimes va hi vona ku sometimes loko va kha va dyondzisa a hi va twisisi, hi ku vanwana va good ka English, vanwana a va good se va switcha va suka ka English va ya ka Xitsonga. [It is because teachers observe that as they are teaching, we do not seem to understand as some us who are good in English while others are not so they switch from English to Xitsonga.]

Researcher: How does the teacher know you did not understand?

Learner F School D: Mi kuma ku nkarhi wunwana i n’wana wa xikolo a nga vutisa ku sir; ' rito leriya ri vula yini?' [You will find that sometimes the learner may ask: 'Sir, what does that word mean?']

Learner C School D: Va lava ku hi kota ku famba swin’we ni ku swi twisisa. [They want us to move with them and understand what they are teaching.]

Learner B School D: Loko va hi dyondzisa maths hi English, hi Matsonga hina, English a hi yi koti, ku na la hi fikaka kona hi twa Xilungu xi entile se hi yimisa mavoko hi va byela ku a hi swi twisisi, se va hi hlamusela hi Xitsonga va hi komba ku swi vula yini. [When they teach maths in English, we are Vatsonga, we do not know English, there are times when English is deep so we raise our hands and tell them we do not understand, so they explain in Xitsonga and show us what it means].

Learner C School D: Teachers code-switch from Xitsonga to English because they want to accommodate all learners.

Question 3

Do you think code-switching is good for the teaching and learning of mathematics? Give reasons.

Learner B School D: Mina I think ku ri swi kanhle ku va hi dyondza hi English va pfa va hi hlamusela hi Xitsonga swi endla ku hi twisisa. [I think it is good when we learn in English and they sometimes explain to us in Xitsonga it makes us understand.]

Learner F School D: It is right to code-switch because mathematics concepts are clarified.

Learner D School D: Mina ni vona o nge a yi fanele yi nga tirhisiwi because loko hi ri ka examination kumbe ka test ku va ku ri na marito manwana hi nga ma twisisiki, se swa hi tikela se ni vona ku yi nga tirhisiwi. [I feel code-switching must not be practiced because when we write our examination or test and come across difficult words, it becomes a challenge for us so it must not be used.]

Learner B School D: Sometimes yona a yi kahle because loko ho va hi ri ka test a ku na loyi a nga ta ku hlamusela hi Xitsonga u ta fayisana na question paper u ri wexe. [Sometimes it is not good because when we are writing a test there won’t be anyone to explain to you in Xitsonga but you will face the question paper alone.]

Learner A School D: Challenge i ku loko hi ri ka examination kumbe hi tsala test ku na marito man'wani hi va hi nga ma twisisi hi ku hi nge hlamuseriwi. [The challenge is that when we are writing an examination or a test, we do not understand other words and they do not explain them to us.]

Example 2: Grade 11 Mathematics Face-to-face Interviews

Teacher M@11

Date of Interviews: 1 November 2017

Duration of interviews: 18 minutes

School D

Question 1: Do you practice code-switching during teaching and learning mathematics? If so, why?

Interviewer: Do you practice code-switching during teaching and learning mathematics? If so, why?

Participant: Two reasons make me code-switch. Number one, we have learners who understand and speak English fluently. Secondly, some hear but cannot speak, and the other group does not understand what you are saying when you speak in English. When we teach in English, those who do not understand will be left behind.

Question 2: Do you think code-switching is effective in the teaching and learning of mathematics? If so, why?

Interviewer: Do you think code-switching is effective in the teaching and learning of mathematics? If so, why?

Participant: Let me come back to the same theorem. When we talk about the theorem at the centre, doubled angle at circumference we explain this in English, there is no need to say this is a circumference. It is unnecessary to tell them that this is subtended arch because they understand what we mean. But a learner who has low English proficiency may not understand these words. They have to take that new word and put it in their imagination to understand what you are talking about. The lesson may come to an end while they are still thinking about the word subtended and they might be left behind. So, I code-switch in the following manner.

”hi Xitsonga loko u hlamusela ku loko hi vulavula hi subtended hi vulavula hi ntila kumbe layini leyi masayiti mambirhi ma nga hlangana eka yona. Loko hi vulavula hi circumference hi vulavula hi layini leyi nga endla circle. So va kota ku swi twisisa ku okay loko hi vulavula hi circumference we are talking about the line that makes the circle and loko hi vulavula hi center or angle leyi nga ka center hi vulavula hi tilayini timbirhi leti sukaku ka center ti ya ka circumference and then la xikarhi hi kona ku nga angle laha angle leyin’wani yi nga yi davulaka circumference le henhla”.[… in Xitsonga when you explain that when we talk of subtended we talk of a line where two sides meet. When we talk of circumference, we speak of a line which forms a circle. They then understand that when we speak of circumference… when we speak of a centre or circle in the centre, we refer to two lines that move from the centre to the circumference and the centre part forms the angle where the other line can cut the circumference at the top]. So, it becomes easier for them to understand what the theorem is all about.

Question 3: What do you think are the challenges of code-switching in the teaching and learning of mathematics?

Interviewer: What do you think are the challenges of code-switching in the teaching and learning of mathematics?

Participant: But when you want to move from English to Xitsonga some of the terms you cannot explain them but if they understand English it is simple for them to explain this other term in a different way but English. It makes them understand for example if you are teaching a lesson in Geometry, we have terms and theorems that Let’s take you have given a learner a theorem talking about an angle at the centre, double at the circumference, you see those terms are new for the learner who cannot understand English. When you say angle at the centre, doubled angle at the circumference, what is the circumference? You cannot even explain it in a good way to a person who does not understand English but those who understand English it becomes more easier for them because you said this is the circumference, they understand the word circumference. When you talk about the word centre they understand. When you say this angle is subtended, they those who understand English will understand but it will be difficult for those who do not understand English.

Question 4: Are there any benefits of code-switching as a communicative in the teaching and learning of mathematics in grade 11? If so, what are they?

Interviewer: Are there any benefits of code-switching in the teaching and learning of mathematics in grade 11?

Participant: Yes, it is helping a lot on my side because if you don't do that, you will be talking to yourself inside the classroom with learners will be looking at you and only two or three will be participating. Some learners fail tests where lessons are only presented in English. However, they perform better in their tests when code-switching is practice. It helps a lot.

<u>Example 3: Grade 11 mathematics teachers' telephone interviews</u>

(Teacher M@2)

Date of telephonic interview: 8 June 2021

Duration of the interview: 25 minutes 5 seconds

Introduction and biographical information

Interviewer: Good evening to you sir.

Participant: How are you?

Interviewer: I am good and you?

Participant: I am good.

Interviewer: You are respondent M@2 because we are not talking names. I would like to welcome you to this session. Feel heartily welcome. I am Mavies Tintswalo Msimeki, a doctoral student at the University of South Africa conducting research as I have explained in the consent form. We have two sections, the first section is the teacher's demographic information, and the second section you will respond to five questions with maybe two sections. You are free to express yourself in the language that you understand. You are not confined to English. Right. Please indicate the following information about yourself: your gender, your age, the subjects that you teach besides mathematics, your teaching experience, the total number of periods per week as well as your highest academic qualifications.

Participant: Ok thanks madam. My gender is male, I am fifty years old, the subjects that I am teaching other than mathematics Grade 11 are Physical Sciences Grade 12, and I am also teaching mathematics Grade 9. I have twenty-six years in the teaching field and coming to the number of periods per week is twenty-one. My highest academic qualification is Bachelor of Education Degree with the University of Potchefstroom, now known as the University of North West.

Interviewer: Thank you very much. We are going straight to Section B: Code-switching in the teaching and learning of mathematics.

Question 1:

Code-switching as a communicative strategy enhancing quality in mathematics teaching and learning in grade 11

1. **What would you say code-switching is?**

Participant: Code-switching is a switch from one language to another, particularly from English to the learners' mother tongue. If they are Venda speakers, it refers to moving from English to Venda. Suppose they are Xitsonga speakers and primarily teaching learners who are Xitsonga speaking, code-switching as a switch from English to Xitsonga to make learners understand complex mathematical concepts.

Interviewer: Ok thank you very much.

2. **Do you code-switch when teaching mathematics in your class?**

Interviewer: Do you code-switch when teaching mathematics in your class?

Participant: Yes, I do

Interviewer: Why?

Participant: Err, I code-switch because I realise that in most cases, language is a barrier to comprehending the learning content. Sometimes the medium of instruction that we use to explain complex mathematical concept to the learners makes it difficult for the learners to comprehend what is being communicated to them. Code-switching, in this instance, as a solution to the problem, is employed.

Interviewer: Now you are saying language is a barrier. What language are you talking about here?

Participant: English language in particular, to my learners who are mostly Xitsonga speaking.

Interviewer: Okay. So, am I right when I say English is the medium of instruction?

Participant: Yes, English is the medium of instruction. It is actually the language that should be used to teach.

1.3. Do you think code-switching is an important communicative strategy to enhance the quality of teaching and learning of mathematics?

Interviewer: Do you think code-switching is an important communicative strategy to enhance the quality of teaching and learning of mathematics?

Participant: Yes, I do

Interviewer: Why?

Participant: Those problematic concepts which are unfamiliar to the learners compel one to code-switch into their vernacular.

Question 2:

The relevance of code-switching during teaching and learning of mathematics of grade 11 learners?

2.1. Do you think code-switching is relevant in teaching and learning?

mathematics?

Participant: Yes, I do.

Interviewer: Why?

Participant: Because I find a way of making learners understand the subject matter as the only way to encourage a person is for the person to understand what you are talking about. If you are far above them in terms of the language barrier, they cannot understand no matter how much good information you have it becomes useless because it is not getting across. So, I code-switch to encourage my learners.

2.2. Based on your experience, do you think code-switching promote learners'

understanding and performance in mathematics?

Participant: Yes.

Interviewer: Why?

Participant: You know when you are teaching mathematics, at times you are breaking new ground. When you introduce new mathematical concepts, it is such a challenge when it does not relate to learners’ everyday experiences. The better way is to connect this to the learners’ everyday experiences for them to understand those concepts through code-switching.

Interviewer: Okay So I am hearing you saying when you introduce …

Participant: Yes, when I introduce concepts, new concepts particularly.

Interviewer: So, when you introduce new concepts that is where you code-switch.

Participant: No, not necessarily there but even in some other parts of the lesson when I realise the need.

Interviewer: Okay.

Question 3:

The effectiveness of code-switching as a communicative strategy to enhancing quality in mathematics teaching and learning

3.1. How was the learners' performance in your class before code-switching?

Participant: Before I realised that these learners had a problem with the language, the performance of my learners was so poor, and after I realised that I engaged in code-switching. Somehow, I saw things differently in terms of the performance of the learners which had become better.

Interviewer: What was it? Can you briefly tell me?

Participant: I saw the performance starting to improve and that made me conclude that language was one of the aspects that could harm the learners’ performance.

3.2. Does code-switching improve learners’ confidence to communicate with the teacher during teaching and learning?

Participant: Yes, it does.

Interviewer: Why?

Participant: I realised that learners do occasionally wish to speak with their teachers during teaching and learning. However, most of them keep their thoughts or questions to themselves. Some learners were unable to express their personal experiences concerning the lesson taught. Failure to communicate in English resulted in a hostile environment.

3.3. Can you say code-switching assists you to manage your mathematics classroom well or not?

Participant: I think it assists me.

Interviewer: Okay

Participant: I think it assists me in the sense that sometimes when learners are out of control in class when I speak to them in their language, I use idiomatic expressions in their mother tongue and quickly get their attention. When using English, they often do not understand what you are saying.

Interviewer: Now can you just give me an example of how you do that?

Participant: Let's take the example of learners who do not want to do their work, the learners may fail to understand you when you instruct them in English but switching to their home language using idiomatic expressions, the learners understand you quickly respond. For example, I can say: "u ta tshovela leswi u swi byalaka" which means you will reap what you sow. This effectively reprimands the learners.

Question 4:

The challenges and benefits of code-switching in the teaching and learning of mathematics in grade 11 learners?

4.1. What would you say is the challenge of code-switching during teaching and learning mathematics?

4.1.1 Challenges for the teachers

Participant: To me one challenge would be that it might be time-consuming. It is just like when for example, there is a session, we have got a speaker and an interpreter; the time it takes to complete the session becomes longer because of the interpretation.

So, it applies when you code-switch because you are trying to explain concepts in Xitsonga. Code-switching takes a lot of time and the periods are short.

4.1.2 Challenges for the learners

Interviewer: And to the learners what is the challenge?

Participant: And to the learners is that sometimes they might not have enough time to master the language of learning and teaching and at the end of the year when the examination paper comes it is in the language of learning and teaching and not in their home language that we used to code-switch and that might be the setback in that regard.

4.2 When assessing learners, are you allowed to give a glossary of some words that you frequently use when code-switching during teaching and learning?

Participant: When they are writing we expect them to use the language of teaching and learning.

Interviewer: Now let's go back to the question I was asking that are you allowed to give the Xitsonga and English words during assessment?

Participant: No in mathematics we are not allowed to give those concepts in Xitsonga.

Interviewer: Now how does that disadvantage the learners if you don't give those words?

Participant: The medium of instruction might have made it difficult for learners to comprehend the content. Obviously, it will be a disadvantage if a glossary is not available for the learners during assessment.

4.3 Are there any benefits of code-switching in the teaching and learning of Mathematics in general?

Participant: Yes, there are benefits. Code-switching benefits learners' understanding during lesson presentation. Failing to code-switch makes it difficult for learners to understand the subject content.

Interviewer: Okay, the last question.

Question 5:

Framework to be employed to enhance quality in mathematics teaching and learning?

5.1. When designing lesson plans, do you include home-language terminologies as part of code-switching?

Participant: Yes

Interviewer: Do you?

Participant: Being not allowed to use the learners' home language in my lesson planning, I, however, from time to time come across concepts where I feel it is necessary for me to code-switch for the benefit of the learners. (M@2)

Interviewer: And now if you are saying you do that do you think do you have a policy that supports the practice?

Participant: As of now we do not have the policy that supports us but I think that is something we should forward to the higher authorities to attend to.

Interviewer: Is it, you think if you were to include these terms in your lesson planning then it would assist?

Participant: Yes, it would.

Researcher: Thank you.

1. **When answering questions, are learners allowed to use their home language (code-switch)?**

Participant: No, learners are not allowed to code-switch when answering questions.

Interviewer: Is it? If they are not allowed, what would you suggest to the Department of Basic Education in that regard?

Participant: My suggestion would be to let the language of the learners be taken into consideration because we do have some other subjects where we have two papers for example, mathematics question papers are set in English or Afrikaans.

Interviewer: Is it?

Participant: Yes, you find that Afrikaans speaking learners are advantaged because they use even their mother tongue to respond to questions. In our case learners must answer in English which is a disadvantage for them.

Interviewer: Now finally what is your suggestion to the Department of Basic Education regarding answering questions of mathematics?

Participant: Let the DBE consider the learner's mother tongue during mathematics assessment.

Interviewer: And how do you want them to do it?

Participant: I suggest that the DBE translate complex mathematics concepts from English into Xitsonga in the form of a glossary. I know it might not be an easy task as it might need a lot of research and resources for the translators that might be involved.

Interviewer: Thank you very much. I would like to heartily thank you for your time, I will update you on the progress of my studies.

Appendix S: Proof of editing

To whom it may concern

This letter serves to confirm that editing and proofreading was done for:

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Code-Switching as a Communicative Strategy to Enhance the Quality in Mathematics Teaching and Learning in Grade 11, Limpopo Province, South Africa

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