DEVELOPING GRADE 10 PHYSICAL SCIENCES SCIENTIFIC LANGUAGE REGISTER FOR TEACHING ELECTRICITY

BY

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DECLARATION

I **Mpho Kenneth Maḓavha** with the student number 64050963 declare that this dissertation entitled **“Developing grade 10 physical sciences scientific language register for teaching electricity**” is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

I further declare that I 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 of it, for examination at Unisa for another qualification or at any other higher education institution.

Maḓavha M.K

SIGNATURE

26 JANUARY 2024

DATE

DEDICATION

This study is dedicated to my wife, Khathutshelo Maḓavha, my daughter Rotondwa Maḓavha for their unwavering patience during my study period.

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ABSTRACT

The South African constitution recognizes twelve official languages, yet only two are utilized for teaching physical sciences, posing a significant concern for our education system's inclusivity. In the Vhembe West district, learners from Tshivenda and Xitsonga backgrounds are taught physical sciences in English, perpetuating inequality in a supposedly democratic system, where only English and Afrikaans are privileged as mediums of instruction for this subject. Physical sciences learners in grade 10 in the Vhembe West district are performing poorly in the subject due to the challenge of language proficiency utilised in the classroom. More learners especially in rural areas are exposed to English in the school environment, which influence their results in the subject negatively. The South African government is embarking on a significant transformation aimed at promoting indigenous languages as the primary medium of instruction, particularly in subjects like physical sciences. This study endeavours to create a scientific language register in Tshivenda, focusing on grade 10 electricity concept, to address the dearth of scientific resources in indigenous languages and to support the government's initiative. Employing a qualitative interpretative case study methodology, the research involves three teachers, parents, and learners from selected schools, seeking answers to several key questions. The findings reveal the absence of scientific terminology in Tshivenda, posing a challenge in the development of the register. However, the application of the Tshivenda scientific register in classrooms fosters interactive and meaningful learning experiences, as perceived by stakeholders. Thus, the study recommends expanding the development of scientific language registers in Tshivenda to encompass other topics in physical sciences.

Keywords: *Tshivenda scientific register; teaching electricity; challenges; opportunities; perception; meaningful learning*

MANWELEDZO (TSHIVENDA)

Ndayotewa ya Afurika Tshipembe i dzhiela nzhele nyambo dza fumimbili sa dzone nyambo dza tshiofisi. Kha idzi nyambo, ndi mbili fhedzi dzine no shumiswa kha u funza na u guda saintsi i no vhonala. Izwi zwi ḓisa nḓaḓo kha pfunzo yashu, sa musi vha ambi vha nyambo dza tshirema vha sa ṋewi tshikhala tsha u guda nga nyambo dzavho dza ḓamuni. Vhana vha no bva tshiṱirikini tsha Vhembe West vha shumisa luambo lwa Tshivenḓa na Xitsonga sa nyambo dzavho dza ḓamuni, fhedzi vhaguda saintsi i no vhonala nga luiisimane. Izwi zwi ita uri hu sa vhe na ndinganelo kha muvhuso washu wa dimokirasi sa musi luiisimane na tshivhuru dzi dzone nyambo dzi no shumiswa kha u guda na u funza saintsi i no vhonala.

Muvhuso wa Afurika Tshipembe u khou ḓisa tshanduko khulwanesa, tshanduko ya u takulela nṱha nyambo dza tshirema sa nyambo dza u guda na u funza thero dzi ngaho saintsi i no vhonala. Tshipikwa tsha idzi ngudo ndi u bveledza redzhisiṱara ya tshisaintsi nga Tshivenḓa kha u guda saintsi i no vhonala ho sedzwa tshipiḓa tsha muḓagasi. Tshivenḓa sa luambo lu sa athu u vha na nyaluwo ya zwishumiswa zwa saintsi, mveledziso iyi ya redzhisiṱara ya tshisaintsi i do thusa u engedzea zwishumiswa zwa saintsi nga Tshivenḓa na u tikedza ḽikumedzwa ḽa muvhuso. Ngundo iyi a si ya mbalo, vhadededzi vhararu, vhabebi na vhagudiswa u bva kha zwikolo zwiraru zwo nangwaho vho vha tshipiḓa tsha ngudo idzi. Hu na ndavhelelo ya u fhindula mbudziso dzi tevhelaho dza ngudo idzi: Mveledziso na kumisele kwa ridzhisiṱara ya tshisaintsi nga Tshivenḓa kha tshipiḓa tsha muḓagasi yo bveledziswa hani? Kuvhonele kwa avho vha no khou kwamea nga mveledziso ya redzhisitara ya tshisaintsi nga Tshivenda ku ri mini? Khaedu dze ha ṱanganwa nadzo kha mveledziso ya redzhisiṱara ya tshisaintsi nga Tshivenḓa ndi dzifhio? Ndi zwifhio zwikhala zwo bvelelaho kha mveledziso ya redzhisiṱara ya saintsi nga Tshivenḓa?   Kushumisele kwa redzhisiṱara ya saintsi nga Tshivenḓa ku vhumba hani u guda ha maṱhakheni? Nyambedzano, u lavhelesa na dayari zwo shumiswa u kuvhanganya mawanwa u bva kha vhadededzi, vhagudi na vhabebi.

Mawanwa a ngudo iyi a bvisela khagala uri hu kha ḓi vha na ṱhahelelo ya maipfi a saintsi nga Tshivenḓa; izwi zwo vhonala musi muṱoḓulusi a tshi ṱangana na khaudu a kha lwendo lwa u bveledzisa redzhisiṱara. Naho zwo ralo, zwo bviselwa khagala uri u shumiswa ha redzhisiṱara ya Tshivenḓa kha u funza saintsi zwi ṱuṱuwedza vhudavhidzani kilasini, zwine zwi ita uri hu vhe na u guda ha maṱhakheni. Avho vho vhaho tshipiḓa tsha ngudo idzi na vhone vho bvisela vhuḓipfi havho vha tshi khou tikedza muhumbulo uyu sa izwi vha tshi khou vhona u tshi ḓo thusa kha u khwinisa kushumele kwa vhagudiswa. Ngudo iyi i themendela mveledziso ya redzhisiṱara ya tshisaintsi nga Tshivenḓa kha zwiṅwe zwipiḓa zwa saintsi i no vhonala.

Khii ya maipfi: *redzhisiṱara ya tshisaintsi nga Tshivenḓa; u funza muḓagasi; khaedu; zwikhala; ngudo dza maṱhakheni.*

NAGANWAGO (SEPEDI)

Molaotheo wa Afrika Borwa o amogela maleme a lesome pedi a aleng molaong. Ka gare ga a a lesome Pedi, a mabedi a gona a shumiswa sa molao ge go etla tja thuto ya mahlale a mmele. Seo se tlisha tshwenyego e kgolo go lenanego la thuto, sa kudu go rena ba go bolela polelo ya se Afurika ka go fapana. Mo Vhembe West district barutwana ba bantsi ba bolela leleme la Tshivenḓa le Xitsonga, efela ba rutiwa mahale a mmele ka leleme la seisimane. Seo se tlisha go se lekane wa temokirasi ka ge go somiswa seisimane la seburu fela bjalo ka maleme a go ithuta lego ruta mahlale ammele.

Afurika borwa e a fetoga, e fetogela go tsea maleme a segagaborena a tsebagatsa sa maleme a thuto go dithero tsa go swana le mahlale a mmele. Thuto ye ikemiseditse go tsweletsa mahlale ya mahlale a mmele e lebeletse kudu mehlagase. Tshivenḓa bjalo ka polelo yeo e sa hlabollwago gabotse go ya ka didiriswa tsa mahlale, tsweletso ya retsisetara ye ya mahlale e tla thusa go oketsa didiriswa le go thekga maitapishi a mmusho. Thuto ye e somisitse nyakishisho ya mohlala ya thlathollo ya boleng. barutwana, batswadi le barutishi gotswa go dikolo tse tharo tse di tlabeng di kgethilwe. Go tlabe go nyakiwa go arabiwa diputsisho tsa dinyakishisho tse di latelwago; tlhabollo le tiriso ya retsesetara ya polelo ya mahlale ya Tshivenḓa bakeng sa dikgopolo tsa mohlagase e hlamilwe bjang? Ke ditemogo dife tsa bakgathatema tlhabollong ya retsisetara ya polelo ya mahlale ya Tshivenḓa bakeng sa dikgopolo tsa mothlakase?
ke mathata mafeng a go kopanweng le ona ge go lekwa go godishwa le go tsebatswa retsisetara ya mahlale ya Tshivenḓa? ke tse difeng di kgonagalo goba menyetla yeo e

ka bang gona go tsweletswa ya retsisitara ya mahlale ya Tshivenḓa? Tiriso ya retsisetara ya mahlale ya tshivenda e bopa bjang thuto ye e nago le mohola? Diputsiso tsa dinyakisisho, dipono le tayari di ile tsa shumiswa go kgobokanya bohlatse bja dinyakishisho gotswa go barutwana, barutishi la batswadi.

Go hweditse gore Tshivenḓa se sa nyaka gore go be le mantsu a sego gona mahlale. Seo sa dira gore ebe go thatafa ga gore go kwa rutwa dithuto tsa retsisetara ya mahlale ka Tshivenḓa. efela go hwetse gore go tirisho ya retsisetara ya mahlali Tshivenḓa go tokafetsa thuto ya barutwana. Go fela fao, tirisho ya retsisetara ya mahlale ya Tshivenḓa bjalo ka maitapiso a magolo ao a tlaga tokafatsa thuto tsa barutwana. Ka fao, nyakishisho ye e sisinya tlhabollo ya retsisetara ya polelo ya mahlale a mmele ka Tshivenḓa, go lebe; etswe kudu diglogo tse dingwe.

Mantsu a bohlokwa: *retsisetara ya mahlali ya Tshivenḓa; thuto ya mutlakasi; dithlolo, menyetla; go ithuta mo go nago le morero*

GLOSSARY OF ACRONYMS

CALP	Cognitive Academic Language Proficiency
CAPS	Curriculum and Assessment Policy Statements
CLAF	Classroom Language Analytical Framework
DBE	Department of Basic Education
IRF	Initiation, Response and Feedback
IRFRF	Initiation, Response, Feedback, Response and Feedback
LiEP	Language-in-Education Policy
LoLT	Language of Learning and Teaching
PanSALB	Pan South African Language Board
SASA	South African School Act
SGB	School Governing Body
TIMSS	Trends in International Mathematics and Science Study
UNESCO	United Nations Educational, Scientific and Cultural Organization

GLOSSARY OF TERMS

- **Authoritative discourse**: one way of communication from the teacher to the learners
- **Constructivism:** a theory that perceives languages as a tool for meaningful learning
- **Dialogic discourse:** engagements/interactions with the content is the priority
- **Interactive-authoritative approach:** the teacher only considers the correct answers
- **Interactive-dialogic approach:** all answers are welcome but only the scientifically correct ones are accepted
- **Tshivenda:** South African official and indigenous language
- **Physical Sciences:** Science discipline that deals with the physical world, e.g. (Physics, Chemistry) taught at FET
- **Register:** a set of lexical items which are distinct and for specific topics and social situations
- **Scientific language resister for physical sciences in Tshivenda:** a register with set of natural science lexical items written in Tshivenda

Contents

CHAPTER 1: INTRODUCTION AND ORIENTATION TO THE STUDY

1.1 INTRODUCTION

In South Africa, the quest for equitable education has been an ongoing journey, marked by efforts to address linguistic disparities in the classroom. Despite the recognition of twelve official languages in the country's constitution, the dominance of English and Afrikaans as mediums of instruction in critical subjects like physical sciences has raised concerns about inclusivity and accessibility, particularly for indigenous language speakers. This study is a response to the imperative need to bridge this linguistic gap by developing a grade 10 scientific language register in Tshivenda, specifically tailored for teaching the complex concepts of electricity in physical sciences. Tshivenda, like many other indigenous languages, has been historically overlooked in the realm of scientific discourse, resulting in a scarcity of educational materials and resources that cater to the linguistic and cultural backgrounds of its speakers.

The overarching aim of this research is to contribute to the broader agenda of promoting linguistic diversity and inclusivity in South African education, aligning with the government's efforts to elevate indigenous languages as mediums of instruction. By focusing on the specific domain of electricity within the realm of physical sciences, this study seeks to pioneer a model for the development and implementation of scientific language registers in indigenous languages, starting with Tshivenda. Through a qualitative interpretative case study approach, this research endeavors to address fundamental questions surrounding the development, application, perceptions, challenges, and opportunities associated with the introduction of a Tshivenda scientific language register for teaching electricity concepts. By engaging with stakeholders including teachers, learners, and parents from selected schools in the Vhembe West district, this study aims to provide valuable insights and recommendations for the advancement of linguistic diversity and meaningful learning experiences in South African classrooms.

In summary, this study represents a significant step towards realizing the vision of a more inclusive and equitable education system, where all learners, regardless of their linguistic background, can fully engage with and comprehend scientific concepts essential for their academic and personal development.

1.2 BACKGROUND

During a parliamentary question and answer session, Minister of Basic Education Angie Motshekga highlighted the collaborative efforts between the Department of Basic Education (DBE) and the National Education Collaboration Trust (NECT) to address linguistic disparities in education. Specifically, they have devised a comprehensive strategy to promote nine historically marginalized African languages, including Tshivenda, IsiNdebele, Sepedi, Sesotho, Setswana, Isizulu, Xitsonga, IsiXhosa, and Siswati, as languages of instruction beyond the Foundation Phase (grade R to grade 3). Motshekga emphasized that learners' poor performance is often attributed to being taught in English, which assesses language abilities rather than cognitive development or understanding.

In response to these challenges, the DBE successfully piloted a Mother Tongue Based Bilingual Education program in the Eastern Cape Education Department, where isiXhosa and Sesotho were used for mathematics, natural science, and technology instruction beyond Grade 3. This initiative, involving 2,015 schools, has laid the groundwork for similar projects nationwide. Lance Schultz, CEO of the Pan South African Language Board (PanSALB), cited the Global Education Monitoring Report (GEM report), revealing that 40% of the global population lacks access to education in their mother tongue. He stressed the necessity of offering STEM subjects in languages spoken at home, as complex concepts are more challenging to grasp in unfamiliar languages.

Recognizing the importance of promoting indigenous languages, UNESCO has declared 2022-2032 as the Decade of Indigenous Languages. This initiative aims to ensure the accessibility of mother tongues in education and public life, aligning with Section 29(2) of the South African Constitution, which guarantees the right to learn in any official language or preferred language. Despite UNESCO's advocacy for mother tongue instruction, Africa remains the only continent where education is predominantly conducted in non-indigenous languages. Renowned scholar Thiong'o underscores the marginalization of African languages, which are often associated with shame, while English is revered for its sophistication and scientific connotations.

Mugabe Ratshikuni, of the Gauteng Provincial Government, emphasizes the importance of preserving and developing African languages to empower the majority in education, innovation, and technology. Similarly, education expert Prof. Mary Metcalfe asserts that an effective education system should strive to enhance educational quality and reduce disparities between learners. The Curriculum and Assessment Policy Statement (CAPS) highlights the importance of promoting scientific inquiry and problem-solving skills. However, language barriers hinder the transfer of scientific knowledge, particularly for learners in rural areas and townships with limited exposure to English outside the classroom. Recognizing the significance of integrating scientific knowledge into indigenous cultures, efforts to develop a scientific language register in Tshivenda for physical sciences aim to bridge this gap and improve educational outcomes for learners, especially those communities where English is the sole medium of instruction.

1.3 PROBLEM STATEMENT

Despite the existence of 12 official languages in South Africa, English and Afrikaans remain the primary languages of learning and teaching (LOLT) (Prah, 2018). This is primarily due to a lack of adequate resources in schools and insufficient training for teachers in many of the country's African languages (Nishanthi, 2020). Consequently, learners who speak English or Afrikaans as their mother tongue have a distinct advantage, as they are instructed in their native language from the foundation phase through university (Shayne, 2020).

Amidst ongoing discussions about academic underperformance, some researchers argue that the predominance of English as the LOLT negatively impacts the performance of students in physical science subjects (Dlodlo, 1999; Mthiyane, 2016). This disparity arises from the fact that English is not the primary language for most learners in South Africa, particularly those from rural areas. This inequality is further reflected in the results of the Trends in International Mathematics and Sciences Study

2019 (TIMSS), which indicate that South African learners achieve significantly lower scores on international mathematics and science assessments (TIMSS, 2019).

Anecdotal evidence from researchers suggests that students struggle to comprehend physical science concepts, possibly due to the language barrier imposed by English being the medium of instruction and assessment. In many instances, learners rely on translation from English to Tshivenda provided by their teachers to understand physical science questions. Consequently, the development of a Tshivenda scientific language register for physical sciences, particularly focusing on electricity concepts, was deemed essential by the researcher for application in Grade 10 classrooms (see Appendix O).

1.4 RESEARCH QUESTIONS

Main research questions and sub-questions:

- How was the development and application of Tshivenda scientific language register for electricity concepts developed?
    - What are the perceptions of the stakeholders in the development of Tshivenda scientific language register for electricity concepts?
    - What are the challenges in the development of Tshivenda scientific language register?
    - What are the opportunities in the development of Tshivenda scientific language register?
    - How does the application of Tshivenda scientific language register shape meaningful learning?

1.5 Aims

- To develop the Tshivenda scientific language register for electricity concepts.
- To explore the application of Tshivenda scientific language register for electricity concepts.

1.6 Objectives

- To develop Tshivenda scientific language register based on electricity.
- To explore the challenges in the development of Tshivenda scientific language register
- To explore the opportunities in the development of Tshivenda scientific language register.
- To evaluate the how the application of Tshivenda scientific language register shape meaningful learning

1.7 RATIONALE

The South African government is embarking on a significant transformation aimed at promoting previously marginalized indigenous languages within the educational system (Ntuli, Nkanyani & Mudau, 2022). This shift seeks to ensure equitable use of all official languages in schools. Mahlasela (2012) and Charamba (2019) support this direction, asserting that employing more widely spoken languages, as opposed to foreign languages, has consistently resulted in improved understanding of scientific concepts. However, Mkhize and Ndimande-Hlongwa (2014) highlight that the integration of African indigenous languages into South African education has sparked debate, with some arguing that these languages may not yet be adequately prepared for academic engagement.

Probyn (2006) notes that teachers often resort to using English, even when fluent in an indigenous language, due to the lack of scientific terminology in the latter. Moreover, Robertson and Graven (2020) suggest that while the government advocates for home language instruction, learners may still struggle if there is insufficient support, emphasizing the necessity of adequate instructional assistance in any chosen medium. This underscores the importance for researchers and curriculum developers to consider linguistic diversity when creating educational materials. By doing so, learners can develop literacy skills applicable across different languages, enabling them to actively participate in academic endeavors conducted in various languages (Selemela, 2020). Thus, the development of a scientific language register in Tshivenda represents a significant step towards the Department of Basic Education's goal of promoting previously marginalized indigenous languages.

1.8 RESEARCH ETHICS

The researcher meticulously addressed crucial ethical aspects, including obtaining informed consent, ensuring voluntary participation and the right to withdraw, maintaining confidentiality and anonymity, and safeguarding participants from harm. Given that the study involved learners as participants, the researcher sought parental consent by requesting parents to sign a consent form on behalf of their children, indicating their approval for participation. Additionally, learners were informed of their option to withdraw from the study, even if their parents had already provided consent on their behalf.

1.9 DELIMITATION OF THE STUDY

The primary focus of this study centered on three schools within the Vhembe West district, encompassing three physical sciences teachers, as well as parents and learners fluent in Tshivenda. The decision to utilize a small sample size was deliberate to ensure manageable data collection. However, it's important to note that while this study aimed to develop and implement a Tshivenda scientific language register for physical sciences, its findings are not generalizable due to the limited coverage of schools within the Vhembe West district.

1.10 RESEARCH STRUCTURE

Chapter 1: Introduction

This section provided the following information: the research's background, its questions, aims, and objectives, the study's rationale, ethical considerations, and a summary of the chapter.

Chapter 2: Literature review

This section centered on education policies, the significance of mother tongue, scientific registers, and parental perceptions regarding the implementation of mother tongue in education. It also included a comparison of mother tongue policies in Africa with those in other regions worldwide. Additionally, the section outlined the conceptual and theoretical framework utilized in this study.

Chapter 3: Methodology and design

This section elaborated on the methodology employed in this study, covering aspects such as the research approach, paradigm, context, data collection techniques (interviews and observations), data analysis scheme (DAS), interpretation, and the rigor of the study.

Chapter 4: Dynamics about Tshivenda scientific register for teaching physical sciences

In this section, the data gathered through interviews and observations from three chosen schools are analyzed and discussed, leading to the presentation of the findings.

Chapter 5: Summary of findings and recommendation

This section provides responses to the research questions, offering summaries of the findings, contributions to the research, and recommendations.

1.11 SUMMARY OF THE CHAPTER

This chapter provided the data pertaining to the research background, problem statement, research questions, aims and objectives, rationale, research ethics, and delimitation of the study. Additionally, it outlined the forthcoming chapters. The subsequent chapter will delve into a comprehensive exploration of the literature.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

South Africa, like numerous African nations, boasts a diverse linguistic landscape, wherein a majority of parents express a preference for English instruction for their children (Evans & Cleghorn, 2014). Post-1994, the newly established democratic government advocated for mother tongue instruction; however, implementation to support such instruction across all subjects remained deficient. On March 9, 2022, Minister Angie Motshekga of the Department of Basic Education (DBE) announced a shift towards utilizing indigenous languages as the medium of instruction after the foundational phase (Manuel, 2022). Despite this stride, the South African education system continues to grapple with challenges concerning teaching materials, particularly in rural areas, and a shortfall in both teachers' and learners' content knowledge and language proficiency (Ntuli, 2019).

This study devised a Tshivenda scientific language register for teaching Electricity. The chapter delved into the literature on language policy in South Africa, underscored the significance of mother tongue instruction compared to English, and explored parental perceptions regarding the use of indigenous languages in schools. Additionally, it examined language usage across various countries, providing a comparative analysis of instructional mediums in European countries and their impact on African education.

2.2 South African Language Policy

Before 1994, during the apartheid era, indigenous South Africans were marginalized in the education system due to human rights violations (Engelbrecht, Nel, Smit & Van Deventer, 2016), leading to minimal recognition of African languages and the dominance of English and Afrikaans (Selemela, 2020). The advent of democracy in 1994 prompted reforms to rectify the inequalities inherited from apartheid rule (Nomlomo, 2007). The 1996 Constitution of South Africa acknowledged previously disadvantaged languages as official, alongside English and Afrikaans (Probyn, 2006), granting the right, under Section 29(2), for education in the language of choice where practicable in public institutions.

The South African Schools Act (SASA) of 1996 aimed to improve educational opportunities, uphold standards, and establish democratic governance in schools. It made schooling compulsory for children aged seven to fifteen, ensuring equitable access to quality education free from discrimination. The Act allowed mother tongue instruction in the Foundation Phase, transitioning to English from Grade 4 (DBE, 2011). However, despite parental choice being enshrined in SASA, many schools prioritize English instruction from preschool.

To foster effective communication and respect for diverse languages, the government introduced policies promoting multilingualism (Nugraha, 2019), including the Language in Education Policy (LiEP) of 1997, designed to promote all 11 official languages for teaching and learning (Sookrajh & Joshua, 2009). While LiEP is lauded for promoting language equality, its implementation remains challenging, with minimal progress in various schools nationwide (Madiba & Mabiletja, 2008), resulting in learners not utilizing their linguistic abilities effectively.

Despite the establishment of the Pan South African Language Board (PanSALB) in 1995, previously disadvantaged African languages continue to be marginalized (Chitapi, 2018). PanSALB aimed to elevate African languages to the status of English and Afrikaans (Hlatshwayo & Siziba, 2013), with organizations like the Language Task Action Group (LANGTAG) and PanSALB advocating for their use as mediums of instruction in schools (Zano, 2019). The government's commitment to language equality is demonstrated through initiatives like the National Curriculum Statement (NCS) of 2004, aimed at correcting apartheid-era education disparities (Nondabula, 2020).

Despite the availability of parental choice, many are unaware and continue to endorse English as the medium of instruction, believing it offers better opportunities (Nondabula, 2020). Hence, this study developed the Tshivenda scientific language register to challenge the perception that English is the sole gateway to education.

2.3 Importance of indigenous languages as LOLT in South Africa

Language plays a pivotal role in facilitating communication and serves as a conduit for transmitting individuals' knowledge, practices, and cultural values. It also significantly influences and defines various aspects of indigeneity (Shava & Manyike, 2018). In societies like South Africa, characterized by linguistic diversity, the choice of Language of Learning and Teaching (LOLT) in schools is crucial for effective education (Molteno, 2017). Despite the promotion of English as essential for success (Moltano, 2017), the practical implementation of the Language in Education Policy (LiEP) faces significant challenges. Many schools, as found by Sepeng (2015), do not utilize the mother tongue as LOLT in the Foundation Phase, leading to increased reliance on English and decreased mother tongue instruction, resulting in difficulties for learners with limited proficiency in their LOLT (Hopkins et al., 2014).

Children attending schools in townships and rural areas often struggle to meet the demands of English as LOLT, impacting their academic performance negatively (Naketsana, 2019). The 2021 International Reading Literacy Study (PIRLS) revealed that 81% of Grade 4 pupils in South Africa struggle with reading comprehension (Chabalala, 2023). Furthermore, Probyn (2008) noted that many teachers in underprivileged schools lack proficiency in the language of instruction, compromising curriculum delivery and hindering both teacher and learner language skills development, contributing to high failure rates and a decline in education standards (Alidou & Brock-Utne, 2006).

Unfavorable attitudes towards indigenous African languages among education inspectors, as highlighted by Sibanda (2019), hinder the effective implementation of mother tongue-based education policies, exacerbating learners' feelings of inferiority and detachment from their cultural identities. Other barriers to implementing mother tongue instruction include inadequate teacher preparation, lack of teaching materials, insufficient consultation, evaluation, and negative attitudes towards indigenous languages (Bamgbose, 1991). Research indicates that using learners' home language enhances literacy skills (Giambo & Szecsi, 2015), providing a foundation for multilingual education that fosters deeper understanding of concepts and critical thinking (Ojoo & Moyi, 2022). Developing scientific language registers in indigenous languages, such as Tshivenda, can mitigate poor academic performance and promote cognitive development, critical thinking, and overall learning outcomes (Ezeokoli & Ugwu, 2019).

African intellectuals must address the colonial legacy of marginalizing indigenous languages and challenge the mindset that English is superior (Kaya & Seleti, 2013). Therefore, this study proposes the development of Tshivenda scientific language registers to enhance teaching and learning, aiming to elevate educational standards in our country.

2.4 Scientific language register

Halliday (1989) defines register as the conscious selection of vocabulary and grammatical structures by speakers, taking into consideration situational context, participants, and discourse purpose. Solano (2011) suggests that language register arises from the intersection of social situations and everyday circumstances. This implies that using a developed scientific language register in the language familiar to learners for teaching Physical sciences could bridge the gap between their community experiences and school learning. Consequently, it is impractical to separate language from its societal context (Foyewa, Adebanjo, & Ogudenpo, 2016). The creation of scientific language registers in indigenous languages for Physical sciences is essential to realize the vision of enabling every child to learn science in their instructional language (Schafer, 2010).

However, there are perspectives suggesting that developing scientific language registers in indigenous languages lacks purpose, advocating instead for resources to improve learners' English proficiency (Clerk, 2010). Various researchers argue differently; Charamba (2023) asserts that teachers can foster comprehension and engagement in science classrooms only if learners can relate investigations to their own experiences. Motloung, Mavuru, and McNaught (2021) note ongoing challenges with the language of instruction in science classes, particularly in Physical sciences, impacting both teachers and learners negatively.

Efforts are underway to develop sufficient scientific language registers in indigenous languages for teaching various subjects in schools. Researchers such as Ntuli (2022) conducted a study titled "Developing the Scientific Language Register for Natural Sciences in IsiNdebele and its Application in Some Classes in the Siyabuswa 2 Circuit," citing the lack of scientific terms hindering natural sciences teaching and learning in IsiNdebele. Netshivhumbe (2022) conducted a study titled "Developing and Using the Tshivenda Scientific Register for Physical Science," highlighting the challenge of insufficient scientific terminology in Tshivenda. This study focuses on developing a scientific language register in Tshivenda due to the scarcity of materials and scientific terminology in indigenous languages.

2.5 Bilingualism

Wright and Baker (2017) offer a definition of bilingualism, framing it as the utilization of two distinct languages as mediums of instruction, implying their continuous use throughout a learner's educational journey. Cummins (2001) observed that bilingual children perform better academically when their home language is effectively taught in school and aids in their literacy development. Moreover, bilingual education enhances literacy in multiple languages, expanding job opportunities and facilitating intercultural communication (Wright & Baker, 2017). Thondhlana (2002) concludes that bilingual learners outperform monolingual counterparts on intelligence tests, exhibiting greater mental flexibility, abstract thinking, and complex idea formation. Similar findings by Setati (2005) underscore the cognitive benefits of high levels of bilingualism, widely recognized for positively impacting cognitive abilities. Engaging the brain in the acquisition and utilization of multiple languages enhances performance in various nonverbal cognitive tasks, including planning, attention, working memory, and task switching (Gunnerud et al., 2020).

In South Africa, the Language in Education Policy (LiEP) advocates for home language use in the foundation phase, transitioning to English as the Language of Learning and

Teaching (LOLT) from Grade 4 onwards. Cummins (2001) noted that learners with a strong foundation in their mother tongue tend to develop literacy skills more effectively in the second language. Monolingual individuals typically exhibit a richer vocabulary in their mother tongue compared to bilinguals' proficiency in each language (Jawad, 2021). Despite these benefits, bilingualism is often perceived as delaying language acquisition, causing confusion between phonological, lexical, and grammatical systems, and potentially resulting in vocabulary loss in both languages. Nonetheless, some parents prefer their children to learn English from an early age rather than focusing on their home language (Molteno, 2017).

According to Nyimbili & Mwanza (2021, p. 28), drawing from MOE (2014, p. 12), children enter school with extensive oral vocabulary and knowledge of their mother tongue's sound system, yet struggle to utilize and build upon these linguistic skills due to instruction in a foreign language. Disregarding this prior knowledge and attempting to teach reading in an unfamiliar language complicates reading instruction, particularly in under-resourced schools in developing nations.

2.6 Multilingualism

Multilingualism encompasses the use of multiple languages within a community, as well as the proficiency to communicate effectively in various languages (Nomlomo & Kayita, 2018). Schools with learners from diverse language backgrounds commonly practice multilingualism, promoting unity, respect, and embracing linguistic and cultural diversity. It fosters cultural awareness, enhances intellectual and educational value, stimulates creativity, aids social adaptation, and encourages respect for local languages (Okal, 2014).

Africa is estimated to host over 2000 languages (Sands & Gunnink, 2019). However, indigenous African languages are seldom utilized as mediums of instruction in schools beyond the Foundation Phase (Prah & Brock-Utne, 2009). The absence of clear policies supporting learners from diverse linguistic backgrounds often leads to confusion among teachers and schools (Garcia & Lin, 2016). Teaching learners from varied linguistic backgrounds presents challenges requiring teachers to possess additional competencies and skills (Chouari, 2016). Mokala et al. (2022) assert that learners, particularly those from underrepresented language groups, may struggle to engage in the classroom and develop feelings of inadequacy due to cultural disparities in the learning environment. This holds especially true for learners whose languages are marginalized in the classroom. Teachers lacking proficiency in learners' languages face challenges in effectively accommodating diverse cultural backgrounds (Motloung, Mavuru, & McNaught, 2021), often resulting in inadvertently disadvantaging students with different home languages.

According to Parveen et al. (2022), learners without an English background may tend to be passive participants in class discussions, with teachers potentially facing difficulties in communicating with students who speak languages other than their own. Multilingualism may give rise to mixed languages due to extensive language contact, leading individuals to employ a combination of languages in oral discourse and potentially giving rise to slang, as witnessed in Gauteng townships (Okal, 2014). Pattern and Gardyne (2022) argue that children instructed solely in their mother tongue may be less proficient in other languages, whereas multilingual learners gain confidence in using languages beyond their mother tongue, such as English. Multilingual learners are more likely to possess prior knowledge and a deeper understanding of language structures (Cenoz, Santos & Gorter, 2022). Huang, Steinkrauss, and Verspoor (2020) emphasize that learners with greater language learning experience benefit more from learner-centered approaches, facilitating higher proficiency levels in additional languages.

Despite these advantages, the current education system often fails to provide adequate teaching and learning to accommodate diverse learner populations (Nel & Muller, 2010). South Africa's education system struggles to incorporate all official languages as mediums of instruction and lacks resources for mother tongue education. Addressing these challenges requires the development of sufficient materials in mother tongues to support the implementation of indigenous languages as Languages of Learning and Teaching (LOLT).

2.7 Code-switching

Code-switching serves as a prevalent method in teaching and learning, particularly in situations where the Language of Learning and Teaching (LOLT) poses challenges, especially when delivering subjects to learners in a foreign language. Chikiwa and Schafer (2019) demonstrated the benefits of code-switching for learners whose language proficiency is not yet developed enough to serve as the LOLT. Teachers worldwide commonly resort to code-switching in classrooms where a second or foreign language is utilized (Lang, 2018). In South African schools, code-switching involves the use of indigenous languages alongside English, even after the transition to English as the LOLT from Grade 4 onwards, often persisting until Grade 12. It is argued that code-switching can effectively bridge language barriers and enhance teaching and learning (Chikiwa & Schafer, 2010).

Research by Spaull et al. (2016) highlights that a significant proportion of South African learners in rural schools complete their education without sufficient academic skills. To address linguistic challenges in teaching and learning, code-switching has emerged as a communication strategy employed by teachers and learners to effectively convey thoughts and ideas, thereby overcoming the ethnic divisions institutionalized by apartheid (Finlayson & Slabbert, 1997). Code-switching facilitates communication and serves as a tool for conveying meaning, thereby enhancing social interaction and information dissemination (Junaidi, 2019).

However, the absence of code-switching in bilingual classrooms can impede understanding between learners and teachers, disrupting classroom communication and jeopardizing effective teaching and learning (Alidou & Kelch, 2007). Learning certain subjects, such as mathematics and physical science, in English may present difficulties for learners who are not proficient in English (Jedege, 2011). Utilizing learners' home language or code-switching can enhance comprehension of these subjects. Code-switching is noted to streamline classroom instruction by minimizing the need for clarification and fostering positive relationships between teachers and learners (Ahmed & Jusoff, 2009).

Despite its benefits, code-switching faces various challenges. For instance, inadequate English proficiency among teachers impedes their ability to use the intended language effectively (National Education Evaluation and Development Unit, 2013). Learners resort to code-switching as a communication strategy to overcome limited English vocabulary, with the absence of an alternative leading to silence or reliance on native languages (Kumar, Nukapangu & Hassan, 2021). However, improper code-switching practices may hinder effective teaching, as observed in instances where concepts are incorrectly switched between languages (Muthivhi, 2008), compounded by the time constraints of switching languages within limited lesson durations.

To preserve indigenous languages for future generations and avoid elevating English over native languages, minimizing mixing languages and transitioning to mother tongue instruction is advocated. Although code-switching appears beneficial for subject comprehension, a shift to mother tongue instruction is preferable. Hence, the study developed a scientific language register in Tshivenda.

2.8 Translanguaging

Translanguaging refers to the seamless ability of individuals proficient in multiple languages to switch between them effortlessly, treating them as integrated components of a unified linguistic system (Hursk & Mona, 2017). García and Wei (2014, p. 21), as cited by Karlsson, Larsson & Jakobsson (2020, p. 6), define translanguaging as "a novel language practice that reveals the intricacy of language interactions among individuals with diverse linguistic backgrounds, uncovering histories and understandings previously obscured by fixed language identities shaped by nation-states". The dominance of English and Afrikaans in pre-independence South Africa marginalized indigenous languages. Translanguaging challenges the conventional norms of subtractive educational settings and entrenched monolingual perspectives (Zhou & Landa, 2019), presenting a perspective that acknowledges the fluid ways in which individuals communicate across languages without rigid boundaries (Makalela, 2011).

Unlike bilingualism, which involves the mastery of two distinct languages, translanguaging leverages the diverse linguistic repertoire of learners as a valuable resource, encompassing languages acquired at school or spoken at home (Cenoz & Gorter, 2022). Scholars like Gort and Sembiante (2015) and Musanti and Rodriguez (2017) have linked translanguaging with increased class participation, completion of lessons, expansion of learners' vocabulary, and enhanced understanding of subjects such as the sciences. Translanguaging facilitates multilingual classrooms by allowing teachers to organize groups based on learners' home languages (Yuvayapan, 2019), fostering a natural environment where individuals can freely express their thoughts, akin to their interactions in their communities (MacSwan, 2017).

However, Nyimbili and Mwanza's (2021) findings suggest that translanguaging might be perceived as time-consuming in multilingual classrooms due to the extended knowledge delivery process. Garcia (2017) presents a different perspective, asserting that translanguaging serves three primary functions: aiding learners in engaging with complex texts, fostering a learning environment that challenges linguistic hierarchies, and creating an inclusive atmosphere where all learners feel valued and are encouraged to actively participate in class activities by utilizing their linguistic resources. Additionally, translanguaging addresses linguistic inequality by honoring individuals and their language backgrounds, cultures, and identities. It is thus transformative, empowering both learners and teachers to renegotiate power dynamics and facilitate open, fluid learning experiences in their specific pedagogical contexts and beyond (Romanowski, 2020; Li, 2018).

Despite its benefits, many teachers feel ill-equipped to handle learners from diverse linguistic backgrounds (Herzog-Punzenberger, Le Pichon-Vorstman & Siarova, 2017). Moreover, the absence of a defined multilingual policy in South Africa, as noted by Garcia and Lin (2017), means that there are no clear guidelines on how teachers can support classrooms with diverse linguistic profiles, making it challenging to implement translanguaging in schools.

2.9 Parents' perceptions of using indigenous language as LOLT

The linguistic exposure that children receive from their caregivers and educators during early childhood education programs plays a vital role in their language development

(Motseke, 2020). While UNESCO (1953) underscores the significance of the mother tongue as a tool for self-expression and learning, a report by UNESCO (2019) reveals that out of approximately 7,000 languages used globally, around 6,700 are classified as indigenous. However, it is noteworthy that only a mere 4% of the global population is proficient in these indigenous languages. In many studies, parents express a preference for their children to use English as the Language of Learning and Teaching (LoLT), believing that fluency in English enhances employment prospects (Maluleke, 2019). There's also a prevalent belief among parents, especially in disadvantaged circumstances, that English is crucial for their children's success, relegating their mother tongue solely to social purposes (Madiba, 2012). Consequently, such parents often prioritize English language acquisition for their children over their native language during early childhood (Molteno, 2017).

The South African National Policy Framework (2002) mandates mother tongue instruction in the Foundation Phase, followed by a transition to English from Grade 4 through tertiary education. Despite this policy recommendation, many parents prefer early English instruction for their children. Cummins (1981) highlights that children typically require five to seven years to develop the Cognitive Academic Language Proficiency (CALP) needed for academic tasks, while Basic Interpersonal Communication Skills (BICS) are usually acquired within two years. Therefore, with inadequate curriculum time dedicated to mother tongue instruction in South African schools, learners may not be adequately prepared to transition to English as their LoLT from Grade 4 onwards. Furthermore, the lack of academic and cognitive support outside of school further hampers the effectiveness of this transition (Mati, 2004).

Negative attitudes towards using the mother tongue for learning in schools may stem from specific languages, cultural beliefs, and assumptions. Ezeokoli and Ugwu (2019) stress the importance of changing the perceptions of teachers, parents, and communities regarding mother tongue education, advocating for it to be seen as an effective learning tool rather than a hindrance. Utilizing the learner's home language in interactions fosters effective communication in the classroom, empowering learners to take ownership of their learning. Additionally, using the indigenous language as a medium of instruction encourages parental involvement in their children's education, establishing a positive connection between the school and the home or community environment, thereby enhancing learners' overall developmental outcomes (Nxasana, 2020).

2.10 ISSUE OF LANGUAGE USE IN DIFFERENT PART OF THE WORLD

2.10.1 Zambia

In Zambia, there are seven official regional languages: Bemba, Kaonde, Lunda, Luvale, Lozi, Nyanja, and Tonga, out of a total of 72 languages spoken in the country (Chamberlain, Rodriguez-Leon & Woodward, 2022). Since gaining independence from Britain, Zambia has witnessed a significant pushback against the English-only language policy in education. Several policy reforms were attempted over the years, including initiatives like Focus on Learning (1992), Curriculum Reforms (1994), Conference on Reading (1995), Educating Our Future (1996), New Curriculum (1997), and Basic Curriculum Framework (2000). However, these reforms made little progress in promoting mother tongue instruction in Zambian schools. Presently, the implemented policies include the 2013 National Literacy Framework and the 2012 Zambia Education Curriculum Framework, which outline the following language strategy: In Grade 1, all learning areas are taught in Zambian indigenous languages. Grades 2 and 3 continue with content subjects taught in local languages, while English language and literacy are introduced. By Grade 4, content subjects and literacy in Zambian languages are emphasized, while English language and literacy are conducted in English. From Grade 5 onwards, content subjects are taught exclusively in English up to tertiary education. At this stage, Zambian languages are taught in local languages, depending on the predominant language in the area (Chishiba, 2016). This implies that English becomes the medium of instruction from Grade 5 onwards, remaining the sole compulsory language from the first grade to tertiary level (Mwanza, 2020).

Unlike many African countries where mother tongue instruction extends only until Grade 3, Zambia's mother tongue instruction continues to Grade 4 due to historically low literacy achievement levels before the introduction of the 2013 National Literacy Framework (Iversen & Mkandawire, 2020). Despite governmental efforts to promote mother tongue instruction, a study by Phiri (2015) conducted in primary schools in Lusaka district revealed low writing abilities among Grade 4 learners. A significant number of learners struggled with writing words and sentences, with many demonstrating an inability to accurately write tested stories. This poor performance was attributed to various factors, including inadequate teacher training in literacy, insufficient teaching and learning resources, teachers' lack of proficiency in effective instructional strategies, and learners from disadvantaged backgrounds having limited time for literacy instruction. Mwanza (2020) concluded that the duration of mother tongue instruction in Zambia alone does not significantly impact literacy outcomes. Rather, there is an urgent need to enhance teacher competencies in literacy instruction through both pre-service and in-service training, as well as ensure the provision of adequate teaching materials to support effective literacy instruction.

2.10.2 Kenya

Kenya boasts more than forty (40) distinct indigenous languages (Sibomana, 2015). As per the constitution, Kiswahili and English hold the status of the Republic of Kenya's official languages. This constitutional provision underscores the country's commitment to preserving and promoting linguistic diversity, encompassing both official and indigenous languages (Sheikh, Rich & Galvão, 2023). Previously, the government suggested that the mother tongue was ill-equipped to serve as the Language of Learning and Teaching (LoLT) (Mose, 2017). Presently, Kenya's language-in-education policy dictates that indigenous languages or Kiswahili should serve as the LoLT from grades 1 to 3, transitioning to English from grade 4 onwards, while indigenous languages remain part of the school curriculum. Kiswahili, as an official language, continues to be taught alongside English as a compulsory subject, given that most Kenyan learners enter school bilingual, proficient in their mother tongue and Kiswahili (Dhillon & Wanjiru, 2013).

Like many African countries, Kenya accords English a higher status compared to indigenous languages, largely influenced by its recognition as a national and international language. Consequently, all national examinations in Kenya are administered in English. However, Kenyan learners often lack communicative and linguistic fluency in English, frequently resorting to code-switching to Sheng (a slang language) or Kiswahili (Gudu, 2015). Anyiendah's study (2017) observed that teachers in Kenyan schools frequently switch the language of instruction, transitioning from English to either Kiswahili or the learners' mother tongue. This shift stems from either the teachers' insufficient proficiency in English or their desire to enhance the learners' comprehension of the subject matter. The challenge of inadequate communicative and linguistic fluency persists from secondary school to university level, with some first-year students in Kenyan universities struggling to participate in class discussions in English without resorting to code-switching or making grammatical errors (Gudu, 2015). Limited English usage among Kenyan learners outside of school, with Kiswahili and Sheng serving as common lingua francas among young people, exacerbates this issue (Mikkonen, 2022).

2.10.3 Rwanda

Kinyarwanda serves as the predominant mode of communication in Rwanda, renowned for its role in fostering national unity. Nearly the entire population, about 99.4%, is proficient in Kinyarwanda (Rosendal, 2009). Historically, Kinyarwanda was the language of instruction in primary schools due to its widespread usage in daily life. However, after Rwanda gained independence in 1962, French became the medium of instruction. Subsequently, with Rwanda's entry into the East African Community and the Commonwealth, both of which predominantly use English, the country's education system shifted from French to English as the medium of instruction from grade 4 to university, while Kinyarwanda remained the medium of instruction from kindergarten to grade 3 (de Dieu Karasenga & Nzanana, 2022). Policymakers viewed this shift as a practical step towards equipping Rwandan students with the skills needed for entrepreneurship and innovation, both locally and globally (Muhayimana, Kwizera & Nyirahabimana, 2022).

However, transitioning to English as the medium of instruction posed challenges for both students and teachers accustomed to French. Research by Sibomana (2022) indicates that proficiency levels in English and French among students in the final grade of secondary school remain limited. It's crucial to note that English proficiency is low among Rwandans, with only 7% reported to have adequate literacy skills in English according to the 2012 national census (National Institute of Statistics of Rwanda, 2014). Consequently, many teachers lack the necessary proficiency in English, further exacerbating the challenge (Ndabaga, Kwok, Sabates, Ntabajyana & Bizimana, 2023).

For decades, languages such as French in Francophone Africa, Portuguese in Lusophone Africa, and English in Anglophone Africa have dominated as languages of instruction, sidelining indigenous African languages (Msila, 2021). Despite Kinyarwanda being Rwanda's national language, spoken by nearly everyone and used in various domains of life (Rosendal, & Amini Ngabonziza, 2023), its development has been limited due to its lack of use beyond primary school as the language of instruction (Rassool, 2007).

2.10.4 India

India is renowned for its vast cultural diversity, which has contributed to a remarkable linguistic variety, making it one of the most linguistically diverse nations globally. Most Indians are bilingual or multilingual, reflecting the close interconnection between different languages (Pradhan, 2022). Despite the significant importance of Hindi in India's linguistic landscape, it is not officially designated as the national language. Instead, India upholds a liberal language policy that emphasizes the growth and equitable respect of all cultures and languages. Notably, there is no designated national language, with the government ensuring the acknowledgment and reverence of all regional languages and cultures.

The recently revised Indian National Education Policy (NEP) (GOI, 2020), endorsed by the government in 2020, demonstrates a clear intention to promote multilingualism and recognize the pivotal role of language in the teaching and learning process. This marks a significant departure in the history of educational policy formulation in India, as previous national policy documents did not explicitly endorse multilingualism as a pedagogical tool across all academic disciplines (Mahapatra & Anderson, 2023).

English, owing to India's colonial history, has played a significant role in the country's multilingual context. It is commonly referred to as a second language in India, primarily due to its status as a co-official language in national policy. However, educational policies regarding the medium of instruction vary across states and institutions. While some schools, notably private ones, adopt English as the medium of instruction across all subjects, others follow a "semi-English medium" approach, using English exclusively for specific subjects in secondary education. Despite the increasing prevalence of English-medium instruction, for most Indians, including school learners, English remains a foreign language with limited relevance beyond the educational sphere (Anderson, 2022).

A study by Gogia (2019) highlighted that in Indian schools, although English is the language of instruction, learners predominantly use Hindi in class discussions, employing English mainly for technical terms such as squares and circles. Additionally, Mehdi and Kumar (2019) found that learners often experience communication anxiety when required to speak in English, particularly when grappling with comprehension difficulties during instruction delivery.

2.10.5 Morocco

Morocco boasts a linguistic landscape shaped by six primary languages: Classical Arabic, which includes Modern Standard Arabic and the local Darija (Moroccan Arabic); and the Imazighen languages, comprising Tamazight, Tashelhit (also known as Tashelhiyt, Tashelhait, or Shilha), and Tarifit. Additionally, French, English, and Spanish contribute to the linguistic diversity of the country. During the colonial period (1912–1956), France exerted its influence over Morocco, establishing French as the dominant language of instruction in education and various spheres of life (Jaafari, 2019). Following Morocco's independence in 1956, there was a call for the Arabization of Moroccan education, resulting in the introduction of Arabic as the primary medium of instruction from primary to secondary school levels. However, French retained its position as the medium of instruction in science universities and technical secondary schools, leading to the development of a bilingual education system (Hammou & Kesbi, 2021).

Arabic assumes the role of the primary language for reading and writing in public schools, with French introduced as a second language at the primary level and utilized as the medium of instruction for scientific and economic subjects in the majority of secondary schools and higher education institutions. Learners also begin learning English or Spanish as foreign languages to facilitate communication during their secondary education (Pellegrini, 2019).

Despite efforts to promote Arabization in the field of science education following independence, French continued to dominate as the language of instruction for scientific subjects. A study by Zakhir and O’Brien (2017) examining the promotion of Arabization highlighted consistent resistance from learners and teachers, as French remained the language of instruction for science at universities. The use of Standard Arabic as a medium of instruction is likely to face continued opposition until attitudes towards language policy shift.

2.11.THE USE OF MOTHER TONGUE AS MEDIUM OF INSTRUCTION IN EUROPEAN COUNTRIES VS THE USE OF FOREIGN LANGUAGE AS MEDIUM OF INSTRUCTION IN AFRICAN COUNTRIES

2.11.1 Zambia vs England

Zambia

According to research conducted by Nkonde et al. (2018), the academic performance of students in mathematics and science has been consistently poor. This observation was first noted in the 1996 Educating Our Future education strategy statement and was subsequently reaffirmed in the 2013 Education Curriculum Framework. The authors further pointed out that Zambian linguist have long argued that the use of English as a medium of instruction has failed to adequately address the needs of the country.

Chisulo (2017) conducted a study in selected secondary schools in Kabwe district to identify the primary causes of school dropout. Among the identified factors were financial difficulties, teenage pregnancies, broken families, lack of positive role models within families, inadequate teaching and learning resources, peer pressure, substance abuse, health issues, and the obligation to care for relatives suffering from terminal illnesses such as HIV and AIDS. Additionally, the persistent use of English as the language of learning and teaching was found to significantly contribute to the high dropout rate as students transition from their mother tongue to English.

England

In England, English serves as the primary language of instruction, starting from preschool all the way up to tertiary education. The PIRLS 2021 national report for England's grade 3 students revealed that England achieved an average score of 558, which is significantly higher than the international median score of 520. This achievement is attributed to the use of English as the language of instruction for both content subjects and literature. Although the National Curriculum in England allows students aged 7 to 14 to learn foreign languages like French, German, and Spanish, a 2018 Flash Barometer Report by the European Commission found that only 32% of individuals in the United Kingdom aged 15 to 30 felt confident in reading and writing in two or more languages. In comparison, this figure was 79% in France, 91% in Germany, and an average of 80% across European Union (EU) member states. The lack of enthusiasm for learning French and German among English speakers is unsurprising given that English is widely used worldwide as the language of instruction in schools and in business.

2.11.2 France vs Chad

France

The French language holds significant global importance, being spoken by approximately 300 million individuals across Europe, Africa, North America, Asia, and Oceania. Its utility spans various spheres, including commerce, diplomacy, entertainment, international relations, and notably, education. In the realm of education, French stands as the second most widely studied language globally, with 77 out of 194 countries offering French language programs (Kankam, n.d). In many countries, including France, the language is mandatory in schools and serves as the primary medium of instruction to foster national unity. The 2013 National Education Bill mandates the compulsory learning of a foreign language from the beginning of primary school (Ghimenton, Cohen & Minniear, 2023). While public schools predominantly use French as the medium of instruction, some private schools offer instruction in English.

From preschool to high school, English dominates as the primary second language taught in French schools, with other languages like German, Spanish, Italian, Portuguese, Arabic, and other Romance languages also offered, though in smaller numbers (Smythe, 2020). However, the prominence of English increases significantly by the end of high school, occupying 91% of foreign language options. According to the PISA 2018 results, 15-year-olds in France scored 493 points in reading literacy and 493 points in science, slightly above the OECD averages of 487 and 489 points, respectively. European countries tend to outperform African nations in literacy due to policies that prioritize mother tongue instruction.

Chad

The nation has designated French and Arabic as its official languages, with French serving as the predominant language for instruction and governance, while Arabic is primarily used in commercial contexts. It is a requirement for every Chadian individual to be proficient in at least three languages. Since 2008, English has been mandated as a compulsory subject in the educational system, alongside French and Arabic, introduced as a foreign language starting in the first year of secondary school. However, English is not universally included in the curriculum of all primary schools in Chad, but it is compulsory for all secondary schools to teach English alongside French and Arabic (Safatso, 2018).

Chad's educational system faces significant challenges, with a low level of schooling resulting in approximately one out of every two school-age children being out of school, particularly girls. According to the 2014 Programme for the Analysis of the Education System (PASEC), only 20 percent of children completing primary school have a solid foundation in reading and mathematics, the two primary classroom languages being

French and Arabic. The youth illiteracy rate stands at around 70 percent, representing over 2 million youth who lack basic literacy skills. The situation is particularly dire among girls aged 15 to 24, with an illiteracy rate exceeding 77 percent (UNICEF, 2019).

In 2012, the results of the grade 12 final exam indicated a pass rate of only 9%, with 91% of students failing. According to the United Nations Development Programme, just 36.5% of all school-age children are enrolled in school in Chad, positioning the country among the least advanced in this aspect, ranked 163rd by the UNESCO Institute for Statistics in 2010 (Rachel, 2012). The continued reliance on French as the primary language for instruction significantly contributes to the low performance observed.

2.12 Reflection

Education in Africa lags other continents, largely because African countries continue to employ foreign languages in their educational frameworks. The poor academic performance observed among learners in the mentioned African countries can be attributed to the utilization of foreign languages, particularly English, as the medium of instruction. In contrast, European learners outperform their African counterparts, benefiting from learning through their mother tongue from an early age until tertiary education. To address the current state of education in Africa, significant efforts are needed, including awareness to educate stakeholders about the importanance of promoting indigenous languages in education and the development of a scientific language register in indigenous languages.

2.13 Theoretical framework and conceptual framework

This study is grounded in Vygotsky's social constructivism (1978) and Halliday’s systemic functional linguistics (SFL) (1978). Vygotsky social constructivism emphasizes the role of language in constructing knowledge through social interaction. Vygotsky's theory highlights the interplay between learning and development, with language acquisition serving as a pivotal framework for understanding this relationship (Vygotsky, 1978). Halliday SFL (1978) view language as a social semiotic, language is a resource for making meaning realized through wording and grounded in a context of situation and context of culture to attain the speaker’s communicative purpose and aims (Linares & Xin, 2020). Within the classroom context, the language of instruction plays a crucial role in facilitating educational growth among learners, enabling effective communication, and understanding between teachers and learners (Degu, 2022).

Ntuli's (2022) Classroom Language Analytical Framework (CLAF) complements Vygotsky's theory, asserting that the language used in the classroom influences interactions between teachers and learners, as well as among learners themselves. The type of discourse in the classroom is shaped by the language employed by both teachers and students. Teaching physical sciences using language familiar to both teachers and learners can enhance discourse within the classroom (Mudau, 2013; Ntuli, 2022). Three main discourses are identified in the physical science classroom: authoritative discourse, dialogic discourse, and reflective discourse. Authoritative discourse involves teachers imparting knowledge through instructional questions and factual assertions, while dialogic discourse encourages debates and challenges. Reflective discourse allows teachers to gauge learners' proficiency levels in a subject.

Language, according to Vygotsky (1978), is a fundamental symbolic cultural artifact, with every child acquiring the linguistic aspect of their culture from birth (Kingsley, 2016). Cummins (1979) suggests that proficiency in a second language (L2), such as English, is influenced by proficiency levels attained in the first language (L1) before exposure to the second language. Therefore, employing mother tongue instruction throughout schooling years may not impede the acquisition of a second language (Yadav, 2014). Madriñan (2014) adapted argument posits that learners taught physical science concepts using registers in indigenous languages do not require English instruction, as the underlying processes remain the same. Thus, the application of the Tshivenda physical science scientific language register does not alter the subject's content. Consequently, CLAF was utilized to analyze whether Tshivenda, as a social language in the science classroom, could facilitate meaningful learning.

Ausubel (1968) emphasizes that in meaningful learning, the learner's existing knowledge plays a crucial role. Knowledge acquisition occurs when relevant information is connected and integrated into the learner's cognitive structure (Ausubel & Novak, 1978). Ezeokoli and Ugwu (2019) found that using the mother tongue in the teaching-learning process enhances learner engagement in the classroom, thereby fostering a positive attitude toward science.

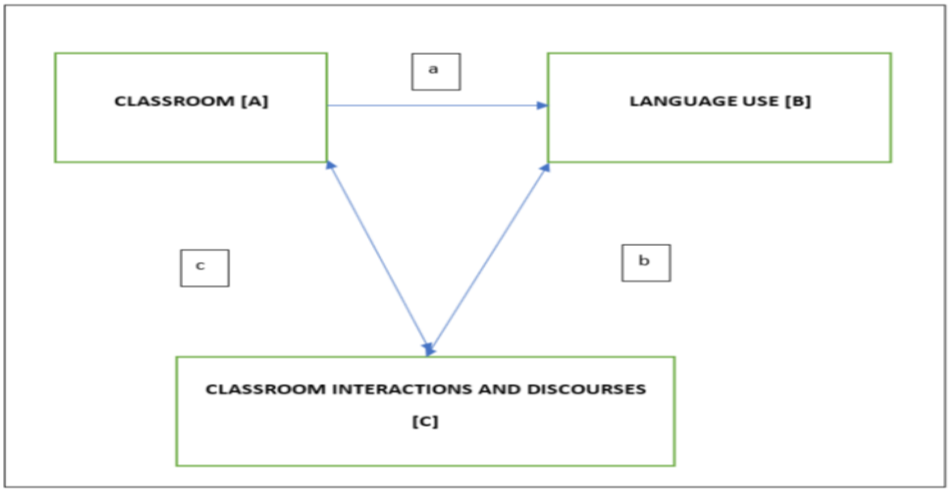


Figure 2.1: Illustration of CLAF [The diagram was adapted from Ntuli (2022)]

CLAF was employed to examine the impact of developing the Tshivenda physical sciences scientific language register on fostering meaningful learning. Frame A represents the classroom environment where interaction occurs between learners and the teacher. Frame B denotes the languages utilized for teaching and learning in this study: Tshivenda and English. Frame C illustrates how interaction and discourse are influenced by the language used (Frame B). Effective interaction and discourse resulting from the language used in the classroom contribute to meaningful learning.

2.14 SUMMARY

The chapter provided a comprehensive overview of the literature pertaining to South African language policies, the significance of home language, and the establishment of a scientific language registers. It also examined African education policies in relation to those of other countries. Furthermore, the chapter explored frameworks that form the foundation of this study. The subsequent chapter will delineate the methodology and design.

CHAPTER 3: METHODOLOGY AND DESIGN

3.1 Introduction

In this chapter, the research methodology, design, context, data management, and rigour are outlined. The objective of this study was to formulate a scientific language register for Tshivenda physical science and evaluate its implementation in the classroom. The study aimed to address the following research questions:

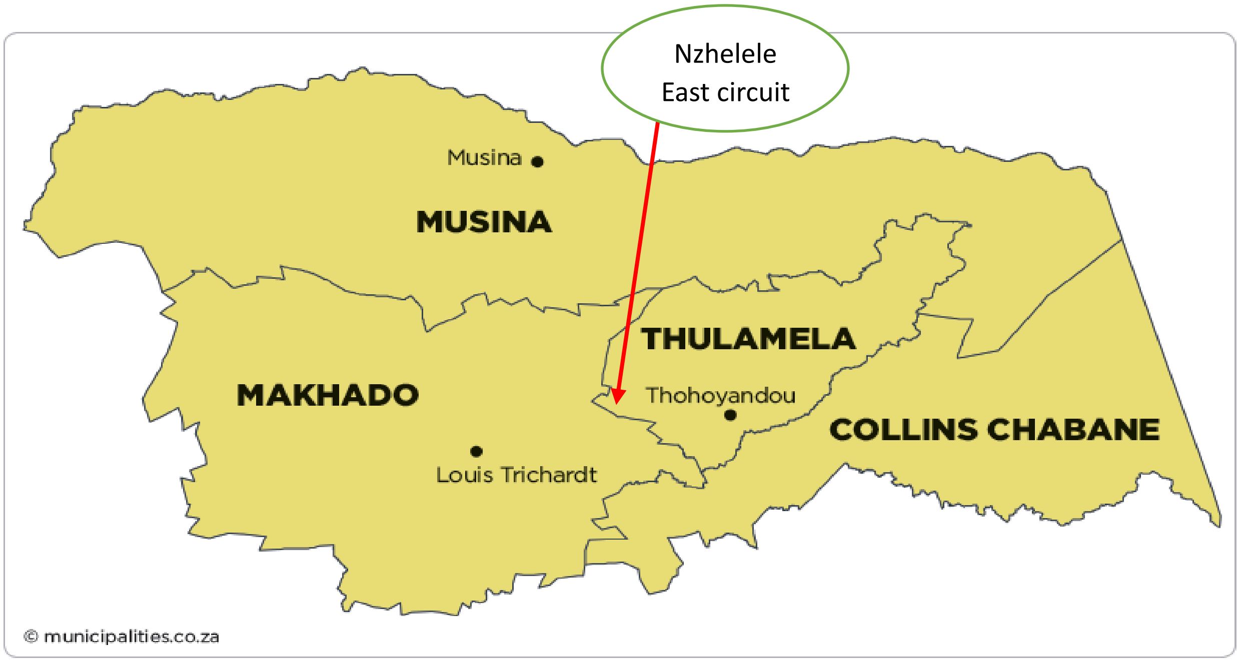
- How was the development and application of Tshivenda scientific language register for electricity concepts developed?
    - What are the perceptions of the stakeholders in the development of Tshivenda scientific language register for electricity concepts?
    - What are the challenges in the development of Tshivenda scientific language register?
    - What are the opportunities in the development of Tshivenda scientific language register?
    - How does the application of Tshivenda scientific language register shape meaningful learning?

3.2 RESEARCH CONTEXT

3.2.1 Research setting

The research setting denotes the specific geographical area where data collection occurs. This study took place in Limpopo Province, situated in the northern region of South Africa and bordered by Mozambique and Zimbabwe to the north, and Gauteng, Mpumalanga, and the North West Province to the south. Limpopo Province comprises five districts: Vhembe, Capricorn, Sekhukhune, Mopani, and Waterberg. The study focused on the Vhembe West District, specifically within the Nzhelele East Circuit, located approximately 600 meters west of Siloam Hospital.

The selection of this location was influenced by the researcher's workplace, situated within Vhembe West District. Notably, learners in this circuit primarily speak Tshivenda, hailing from diverse backgrounds. Consequently, implementing the language register was straightforward, given that all learners are fluent Tshivenda speakers.



3.2.2 Population and sampling

Polit and Hungler (1999) define the population as the entirety of entities or individuals adhering to specific criteria. In this study, the population encompasses all Tshivenda-speaking teachers, learners, and parents. According to Creswell (2012), a sample represents a subset of the population that researchers investigate to generalize about the broader population. Purposive sampling, as employed in this study, involves deliberately selecting individuals based on specific attributes, such as expertise and experience (Etikan, Musa, & Alkassim 2016). This sampling method operates under the premise that valuable insights can be gleaned from a carefully chosen sample size rather than a random selection (Cohen et al., 2011).

Purposive sampling facilitated the selection of participants meeting predetermined criteria, including:

- Teachers with a minimum of three years of experience teaching physical sciences.
- Proficiency in Tshivenda for both teachers and learners.

- Availability and willingness to participate.
- Learners in grade 10 studying physical science.
- Parents from the selected schools.

Data collection from sampled participants involved interviews and observations. For parents and learners, data collection relied solely on interviews, while teachers' data collection utilized both interviews and observations. Purposive sampling ensured manageable data collection, given the small number of participants involved. Out of the 13 secondary schools in the Nzhelele East circuit, only three were selected, chosen based on their proximity to the researcher's workplace, resulting in cost-effective research and efficient time management.

3.2.3 Cases

Physical science scientific language register in Tshivenḓa was applied in three secondary schools. With the focus of collecting data from three teachers, learners and parents. Pseudonyms were used to protect the identity of the participants.

Case 1 Muri secondary school

Muri Secondary School is situated in one of the villages under the Nzhelele East Circuit. It has 300 learners from grade 8 to grade 12, who speak Tshivenḓa as their home language. The study purposefully selected 15 learners learning physical sciences in grade 10. The small sample of learners is based on the fact that the population of the school is small. Tshifhiwa is a black female teacher and holds the BED, specialising in mathematics and physical sciences, and honours in mathematics education. Tshifhiwa has been teaching grade 10 physical sciences for thirteen years. Her home language is Tshivenda. This study selected three parents, with the criteria that they are Tshivenḓa speakers and have children in grade 10 doing physical sciences.

Case 2 Naledzi secondary school

Naledzi Secondary School is situated under the Nzhelele East Circuit. Learners from this school reside in villages around the school. Naledzi Secondary School has the population of 687 learners and offers Tshivenḓa as its home language. Out of these 687 learners, 33 learners are doing grade 10 physical sciences and are proficient in Tshivenḓa, these are the learners who form part of the study. Abigail is a black Tshivenḓa speaker teacher; she holds a Bsc in physics and a post-graduate certificate in senior phase and FET, specialising in physics and chemistry. Abigail has been teaching grade 10 physical sciences for six years. Parents were select on the based that they are Tshivenḓa speakers and have children studying physical sciences in grade 10.

Case 3 Wisdom secondary school

Wisdom Secondary School is also located within the Nzhelele East Circuit. Learners reside in villages around the school. The school has the population of 409 learners and offers Tshivenḓa as a home language. The study focused on 27 learners doing physical sciences grade 10 who are proficient in Tshivenḓa. Peter is a black man who has been teaching physical sciences for more than twenty-seven years. Peter holds a secondary teacher's diploma, a higher education diploma measuring in physical sciences, an advanced certificate in science, and honours in mathematics education. His home language is Tshivenḓa. in this case, three Tshivenḓa speakers' parents with the children in grade 10 were selected to form part of the study.

3.3 RESEARCH APPROACH

3.3.1 Qualitative approach

Qualitative research delves into real-world issues, offering in-depth insights (Moser & Korstjens, 2017). It focuses on capturing participants' experiences, perceptions, and behaviors (Tenny, Brannan & Brannan, 2017). This study employed a qualitative approach, facilitating close engagement with participants to comprehend their perspectives. By utilizing this method, the researcher gained insights into stakeholders' views and the implementation of the Tshivenda scientific language register. Qualitative inquiry aimed to uncover how the adoption of Tshivenda's scientific language register shapes meaningful learning. As noted by Tenny et al. (2017), qualitative research does not quantify data but elucidates it through words. This approach allowed for diverse data collection techniques, such as interviews and observations, without altering the phenomenon of interest (Denzin & Lincoln, 2011). Consequently, the qualitative approach facilitated authentic interactions with participants, considered as rich sources of information.

Data collection in qualitative research occurs in natural settings. Observation was utilized to explore how interactions among participants in the classroom, employing scientific registers, influence meaningful learning. Given that qualitative research is best suited for smaller samples (Langkos, 2014), it enables effective data management. Hence, with three teachers, one class of learners, and five parents from three selected schools, the qualitative approach aligns well with this study's objectives, fostering a comprehensive understanding of participants' perspectives.

3.3.2 Case study

According to Selemela (2020), a case study entails a systematic investigation aimed at examining a chosen phenomenon in an organized manner to generate insights contributing to public knowledge. The case study approach proves valuable when seeking an in-depth understanding of an issue, event, or phenomenon within its natural real-life context (Crowe et al., 2011). In this study, the researcher employed a case study within the classroom setting to closely engage with participants, understanding their sentiments and facilitating comprehension of their interactions and discourse when applying Tshivenda's scientific register.

Given the need to contextualize participants' perspectives comprehensively (Stake, 1995), a case study approach was deemed more appropriate. It was essential to explore study methods and data from diverse angles to address the research question holistically (Creswell, 2009). In this study, involving multiple schools as cases strengthened the research, allowing for varied perspectives from different backgrounds. Through the case study method, the researcher could grasp stakeholders' perceptions regarding the development of the scientific language register in Tshivenda. Therefore, employing a case study was justified, as all participants operated within environments where the same language was utilized.

3.4 RESEARCH PARADIGM

A paradigm serves as a framework or model guiding research by encapsulating a set of ideas and beliefs (Nickerson, 2022). This study adopted a qualitative approach to delve deeply into a specific issue, allowing for thorough exploration and inquiry (Chowdhury & Shil, 2021). Qualitative research fosters interaction, enabling participants to share personal experiences and perspectives on their environment (Creswell, 2007). Within this study, the interpretivism paradigm was employed as it aligns with the qualitative research approach (Mamba, 2019). Interpretivism posits that individuals' perceptions of the world are influenced by their experiences and social backgrounds (Pervin & Mokhtar, 2022). By adopting this paradigm, the researcher aimed to comprehend participants' perceptions regarding the utilization of the Tshivenda scientific language register in teaching physical sciences. Moreover, interpretivism asserts that research cannot be objectively observed from an external standpoint; rather, it necessitates an insider's perspective, rooted in direct experiences (Shisanya, 2019). Therefore, observation within the classroom setting was employed to gather data on how the application of the Tshivenda scientific language register shapes meaningful learning. Interpretivism shares close ties with constructivism, emphasizing individuals' capacity to construct meaning through language (Shisanya, 2019). Vygotsky (1978) underscores the role of social interaction in knowledge construction among learners and teachers. Through constructivism, learners engage with teachers in the classroom, using the Tshivenda scientific register to link their experiences with newly acquired information, thereby constructing their own knowledge.

3.5 DATA MANAGEMENT

In this section, the researcher provides an extensive overview of data collection methodologies. It encompasses the procedure for gathering data, the methods employed for analysis and interpretation, and the way the findings were presented.

3.5.1 Data collection technique (phase 1)

This section outlines the various data collection methods utilized in the study. The techniques employed include interviews, observations, and diaries. The study encompasses two methodologies: the initial phase focuses on the methods utilized in developing the physical science register, while the subsequent phase delves into the instruments employed for data collection following the register's development.

3.5.2 Interviews

An interview is characterized as a prolonged conversation between two individuals with the objective of gaining comprehensive insights into a particular subject or topic. By exploring the significance attributed to a phenomenon by the interviewees, it functions as a tool for understanding it (Schostak, 2006). During the development of the Tshivenda scientific language register (see Appendix O), the researcher faced challenges related to the absence of scientific terminology. To address this, the researcher conducted interviews with various language experts to seek assistance in determining the appropriate terms for use in developing the scientific language register. Continuous consultations were conducted to ensure the production of a high-quality Tshivenda scientific language register.

3.5.3 Diaries

In this research, diaries served as an open-ended tool for collecting data. They were utilized to document all the information the researcher encountered during the development of the Tshivenda scientific language register. This included recording both the challenges faced and the opportunities that emerged throughout the process.

3.5.4 Scientific language register for physical science in Tshivenda

In crafting the Tshivenda scientific language register (Appendix O), my attention was directed towards the topic of electricity within the realm of physical sciences for grade 10. This choice stemmed from my teaching experience, where I observed that learners often struggled with this topic despite being introduced to it in previous grades. Despite their everyday interaction with electricity at home, learners appeared to lack a solid grasp of its fundamental concepts upon reaching grade 10. The challenge seemed to lie in their difficulty in connecting their existing knowledge with the concepts taught in the classroom. Therefore, the focus of the register development centered on the electric circuit, emphasizing basic concepts such as potential difference, EMF, and current. Notably, the register did not delve into calculations but rather concentrated on elucidating these foundational principles. Given that the participants primarily spoke Tshivenda and were non-English speakers, the developed scientific language register aimed to facilitate learning by utilizing their most familiar language.

3.5.5 Data collection procedure (phase 2)

The researcher initiated the process by submitting a formal request letter seeking permission to conduct the research within the Vhembe West District (Appendix F) and the Nzhelele East Circuit (Appendix G). Upon receiving approval, the researcher arranged meetings with school principals to discuss the research plans and ensure minimal disruption to teaching schedules. During the initial visits to the three selected schools, the researcher outlined the purpose of the study to the participants and clarified that participation was voluntary. Additionally, the concept and objectives of a scientific language register were explained in detail.

Teachers were provided with both an English scientific language register (Appendix P) and a Tshivenda scientific language register for review and feedback over the course of a week. Feedback from teachers was solicited to refine and improve the content of the register. Data collection involved engaging with various stakeholders, including learners, teachers, and parents who were members of the School Governing Body (SGB). Arrangements were made to interview parents, recognizing their limited availability during school hours.

In the second week, follow-up meetings were held with teachers to incorporate their inputs into the scientific language register. Subsequently, a workshop was conducted after school hours to train teachers on the practical application of the register in their classrooms, ensuring a smooth integration into their teaching plans. Once teachers were familiar with the scientific language register, its implementation began in the third week. The researcher observed teachers for an hour during class sessions, with the first 45 minutes dedicated to using the Tshivenda scientific language register and the remaining 15 minutes for employing the English scientific language register.

3.5.6 Observations

Through observation, the researcher collected authentic and unfiltered information from participants within their natural surroundings (Dźwigoł & Barosz, 2020). The researcher observed three teachers, one from each school, as they implemented both English and Tshivenda scientific language registers in their classrooms. The primary focus was on the interaction and discourse that occurred when both registers were utilized. This facilitated the collection of data addressing the research questions: How does the application of the Tshivenda scientific language register in physical science contribute to meaningful learning?

Following the guidance of Muzari, Shava, and Shonhiwa (2022), the observer documented observations in their own words to provide a clear depiction of the actions and interactions witnessed. Notes were taken specifically regarding language usage during the observations, with the researcher maintaining a non-participant role to avoid influencing the classroom dynamics. To ensure rigor, each teacher was observed multiple times within an hour. For 45 minutes, they utilized the Tshivenda scientific language register for teaching physical sciences, while the remaining 15 minutes involved using the English scientific language register. This approach allowed for the examination of how interaction unfolded and contributed to meaningful learning when employing these registers.

3.5.7 Interviews

Following classroom observations, structured interviews were conducted to gather data and obtain comprehensive insights from the participants. Maree (2016) characterizes semi-structured interviews as a method wherein pre-planned questions are utilized to collect data, involving presenting participants with a series of open-ended questions and subsequently exploring their responses further. This approach allows respondents the freedom to elaborate on the topic as they deem necessary, with the interviewer intervening to seek clarification or additional explanations through probing questions.

The interview process consisted of two parts, each utilizing specific tools. The first part included questions such as the duration of participants' experience in teaching physical sciences. The second part focused on queries related to the scientific language register, accompanied by follow-up questions. Examples of these questions include participants' perceptions regarding the implementation of Tshivenda's scientific language register in the classroom, along with follow-up inquiries like why they hold those perceptions. Additionally, participants were asked about the impact of language on the teaching of physical sciences, aiming to gain a deeper understanding of the phenomenon under investigation.

Teachers

Following the observations, face-to-face interviews were conducted with all three teachers at their respective schools. The interviews employed two tools. The first tool consisted of biographical questions, including inquiries such as: "How long have you been teaching physical sciences in grade 10?" The second tool focused on questions related to the scientific language register of physical sciences, such as: "What are your perceptions on the application of the Tshivenda scientific language register in the classroom?" Each teacher's scheduled interview duration ranged between 10 and 15 minutes.

Learners

A focus group interview was conducted with one class of learners from each school. In each school, learners were divided into groups of five. All groups were presented with the same set of questions, and their responses were documented. One of the questions posed to the learners was: "Do you encounter difficulties when learning physical sciences in English?" Their feedback was instrumental in addressing research inquiries such as how the Tshivenda scientific language register contributes to meaningful learning. To ensure methodological rigor, the researcher engaged with each group sequentially, thereby avoiding the challenge of simultaneously recording responses from multiple groups. Each interview session lasted approximately 10 to 15 minutes.

Parents

Parents represent a crucial stakeholder group in this research. Five parents from each of the selected schools participated in face-to-face interviews. Prior to the interviews, the researcher communicated with the parents to explain the interview process. Given their role as decision-makers regarding language implementation in schools, parents were asked questions pertaining to language, such as their perceptions of using Tshivenda to teach physical sciences and their language preference for their children's science education. Each interview session lasted between 10 and 15 minutes and was conducted in Tshivenda to accommodate all participants. To ensure accuracy, the data collected from the parents were audio-recorded. Following the interviews, parents were given the opportunity to review the recorded data, allowing them to confirm the accuracy of the captured information. The collected data were then utilized for analysis.

3.5.8. Data analysis and interpretation

In qualitative research, data analysis involves the process of transforming raw collected data into coherent facts and ideas (Alem, 2020). The data gathered from interviews and observations with participants were consolidated and subjected to content analysis. Content analysis aided the researcher in examining the recorded data from semi-structured interviews, which were transcribed into written form after multiple listens to audio recordings. The same procedure was applied to visual materials, such as pictures and videos obtained during observations. Given that the participants were non-English speakers, instances of code-switching were recorded verbatim, as they contributed to addressing the research question: What are their perceptions of using the Tshivenda scientific language register to teach physical sciences?

Thematic analysis was also employed to analyze the transcribed data from interviews and observations. Thematic analysis is a systematic method used to identify, organize, and derive insights from the emerging themes and patterns present in the data (Dawadi, 2021). To ensure the validity of the findings, the data collected from interviews and observations were meticulously categorized to uncover recurring themes and patterns through a process of coding.

Table 3.1: The data analysis using the Data Analysis Scheme (DAS)

Theme	**Categories**	**Characteristics**
Development and application	Perceptions (Teachers, learners and parents)	How stakeholders perceive the need to develop Tshivenda scientific language register for electricity concept.
	Challenges	challenges of developing Tshivenda scientific language register for electricity concept
	Opportunities	Opportunities in the development of Tshivenda scientific language register
	Meaningful learning	How is the application of Tshivenda scientific language register influence meaningful learning

3.6 RIGOUR

Brink (1993) suggests that the integrity of qualitative research hinges on its reliability and validity. To uphold the validity and reliability of this study, a trustworthiness strategy was implemented, examining credibility, dependability, confirmability, and verisimilitude (Guba & Lincoln, 1989).

3.6.1 Credibility

Credibility (internal validity) stands as the initial criterion in qualitative research, aiming to ascertain the trustworthiness and believability of the research findings from the participants' standpoint (Lincoln & Guba, 1985). To uphold the study's credibility, triangulation was adopted as the data collection method, incorporating observations, semi-structured interviews, and focus group interviews.

3.6.2 Dependability

Dependability pertains to the consistency and reliability of the findings (Lincoln & Guba, 1985). To uphold dependability in this qualitative research, member checking was employed to validate the research findings.

3.6.3 Confirmability

"Confirmability" denotes the degree to which one can verify that the findings of a research study stem from data rather than the researcher's biases and preconceptions. In this study, both triangulation and member checking were carried out to ensure that the participants affirmed the data collected in the study.

3.6.4 Verisimilitude

In this study, the researcher opted to directly quote the participants when analyzing the data and presenting the results. This approach was chosen to maintain the authenticity of the data and to prevent any doubts or misconceptions about its accuracy. To accurately convey the participants' responses, the researcher represented their words in italics, emphasizing that these statements reflect the participants' voices rather than those of the researchers.

3.6.5 Triangulation

Bans-Akutey and Tiimub (2021) define triangulation as a method aimed at bolstering the credibility and validity of research. In this study, interviews, observations, and diaries were employed by the researcher to ensure the credibility and authenticity of the data. Validating research methodologies through corroboration is essential in qualitative studies, involving the utilization of multiple research methods to obtain findings. To achieve this, the researcher employed interviews and observations to cross-reference the participants' responses, a practice known as "methodology triangulation," which entails the use of diverse data collection techniques.

3.6.6 Pilot study

A pilot study serves as a crucial initial phase in assessing the viability of methods and procedures intended for use in the main study (Teresi, 2022). It allows the researcher to evaluate the effectiveness of research instruments, gauge the feasibility of conducting a full-scale study, and experiment with protocols for the larger study. Additionally, it helps in identifying potential challenges and determining the ease or difficulty of conducting the research (Connely, 2008).

During the pilot study, the instruments were submitted to the supervisor for feedback. Subsequently, the researcher met with a participant who was not part of the main study and did not work at the same location. The Tshivenda scientific language register was then shared with this participant for further evaluation. The accuracy of the developed questions was assessed through interviews with the participant, who met specific criteria:

- Possession of a science degree
- Teaching experience in physical science for more than three years
- Proficiency in Tshivenda
- Willingness to volunteer for the study

Insights gained during the pilot study included the observation that responses to the first question in part B of the questions also addressed subsequent questions that had not yet been asked. This prompted the researcher to refine the questioning approach. Additionally, recording the entire interview session allowed the researcher to review the recording and identify areas where questions needed adjustment. In conclusion, the pilot study served as an invaluable opportunity to identify and address potential issues before commencing the main study.

3.7 ETHICAL CONSIDERATIONS

The researcher prioritized key ethical principles, including obtaining informed consent, ensuring voluntary participation and withdrawal, maintaining confidentiality and anonymity, and safeguarding participants from harm. Given that learners were involved in the study, the researcher sought parental consent for their children's participation, emphasizing the importance of parental approval by requesting them to sign consent forms. Learners were also informed about their right to withdraw from the study, even if their parents had already provided consent on their behalf.

3.8 SUMMARY

This chapter elucidates the methodology employed for gathering data from participants. It covers various elements, including the qualitative and case study approaches, research paradigm, research context, data management, and rigor, focusing on aspects such as validity and trustworthiness. Detailed discussions were provided on the data collection techniques, namely interviews, observations, and diaries.

CHAPTER 4: DYNAMICS OF PHYSICAL SCIENCES SCIENTIFIC LANGUAGE REGISTER FOR TEACHING ELECTRICITY IN TSHIVENDA

4.1 INTRODUCTION

In the preceding section, the focus was on delineating the research methodology, design, contextual framework, data administration, and adherence to rigorous standards. In this subsequent section, the researcher delves into data analysis. According to Taherdoost (2022), data analysis entails the transformation of collected data into meaningful insights. The examination of data in this study is structured around the following research questions:

- What are the perceptions of the stakeholders in the development of Tshivenda scientific language register for electricity concepts?
- What are the challenges in the development of Tshivenda scientific language register?
- What are the opportunities in the development of Tshivenda scientific language register?
- How does the application of Tshivenda scientific language register shape meaningful learning?

Incorporating these research inquiries, the researcher sought to uncover stakeholders' perspectives, challenges, and opportunities associated with cultivating a scientific language register in Tshivenda, and its impact on facilitating meaningful comprehension of electricity concepts in the classroom.

Table 4.1: The data analysis using Data Analysis Scheme (DAS)

Theme	Categories	Characteristics
The development and application	Perceptions (Teachers, learners and parents)	How stakeholders perceive the need to develop Tshivenda scientific language register for electricity concept.
	Challenges	challenges of developing Tshivenda scientific language register for electricity concept
	Opportunities	Opportunities in the development of Tshivenda scientific language register
	Meaningful learning	learning approach that influences meaningful learning

4.2 Challenges and opportunities in the development of the scientific language register in Tshivenda

4.2.1 Data presentation and discussion

Tshivenda, a minority language, was granted official recognition alongside other indigenous languages in South Africa. According to the Language-in-Education Policy (Department of Education, 1997), schools have the autonomy to select their Language of Learning and Teaching (LOLT). In South Africa, schools typically opt for English as the LOLT starting from grade 4 (Probyn, 2004). However, this presented challenges to the researcher in developing a scientific language register in Tshivenda, as the language is not currently employed for teaching content subjects. Consequently, the researcher encountered difficulty in sourcing an adequate supply of scientific terminology in Tshivenda.

> *"I had a discussion with my colleague, principal Dr Peter Makhado about developing Tshivenda scientific register, he shared with me the multilingual natural sciences and technology terminology list translated in Afrikaans, Tshivenda and Xitsonga. The document was useful to start developing the register although some of the words were directly translated from English to Tshivenda. Therefore, I had to make further consultation".*

The researcher's observations are reinforced by the discoveries of Netshivhumbe (2022), who found that Tshivenda has a scarcity of scientific terminology, with many terms being direct translations from English and Afrikaans. Similarly, Ntuli (2022) reached comparable conclusions in her investigation into the development of a scientific language register for teaching Natural Science. To gain further insights, the researcher sought guidance by reaching out to Mr. Maphiri, a Tshivenda subject specialist associated with the Competitive Programme for Rated Researchers (CPRR), via WhatsApp. They inquired about terms such as voltmeter, ammeter, switch, circuit, among others, and Mr. Maphiri responded as follows:

> *"There are technical terms which may not have the equivalent in our indigenous languages. Example voltmeter-volithimitha, ammeter-amitha, switch-switshi, circuit-sekhethe"*.

This hindered the advancement of register development, as the supervisor advised the researcher against direct translations from Afrikaans or English in the register. Despite encountering these obstacles, the researcher identified opportunities during the register's development. The multilingual term list document provided by the Department of Arts and Culture, which translates scientific terms into Afrikaans, Tshivenda, and Xitsonga, served as a valuable resource for initiating the development of the Tshivenda scientific register. Additionally, Phalaphala FM, a radio station broadcasting in Tshivenda and dedicated to preserving and promoting the language, presented another opportunity. Leveraging a friendship with a news reader at the station, the researcher sought assistance and was referred to Mr. Joseph Masimbane, with whom they engaged in a telephone discussion. Below are some of the topics we discussed:

> *"I had a telephonically discussion with Mr Joseph Masimbane about terminologies was struggling to get, such as voltage, resistance and circuit. He told me that some of the words we don't have them in Tshivenda, if we are not using direct translation then it will be difficult to name the using just one word. Therefore, these words can be explained using more than one word. voltage we can call it Maanda nyelelo a mulilo, resistance- phungudza nyelelo ya mulilo and resistor- tshifhungudza nyelelo ya mulilo."*

4.2.2 Findings

The researcher discovered that the Tshivenda language continues to lack well-documented terminologies in physical sciences. During the register development process, certain terminologies were formulated in a manner that could elicit varied explanations from individuals from different regions within the Tshivenda-speaking community. Despite the existence of a multilingual term list translating some English terminologies into Tshivenda, it remains insufficient due to reliance on direct translations, which may not capture nuanced meanings. Given that the language is still evolving, it falls upon Tshivenda researchers to collaborate and devise comprehensive physical sciences terminologies for documentation.

4.3 STAKEHOLDERS' PERCEPTION

4.3.1. Case 1: Tshifhiwa from Muri secondary school

4.3.1.1. Data presentation and discussion

Given that it has been established that the Language-in-Education Policy (LiEP) grants schools the authority to select their Language of Learning and Teaching (LOLT), stakeholders harbor varying viewpoints regarding the preferred language for instructional purposes. In the process of developing the register, the researcher needed to grasp the stakeholders' perspectives on utilizing Tshivenda for teaching physical sciences. Tshifhiwa, a teacher at Muri Secondary School, expressed the following sentiments:

> *"Ee nne ndi tshi sedza musi ndi tshi khou shumisa registara, vhana arali vha khou to vhala na u funzwa nga luambo lwavho lwa damuni zwi nga leluwa. Tsha u thoma thoma ni wana uri nwana u vha a na phindulo, fhedzi wa wana uri u khou balelwa upfa mbudziso. Musi u tshi ita ndulamiso navho u tshi vha talutshedza uri mbudziso yovha I khou uri mini nga Tshivenda u wana vha tshi fhindula, fhedzi nga luisimane vho vha vha sa pfi uri I khou toda mini. Zwine zwi amba uri arali yovha yo nwalwa nga Tshivenda nwana o vha a tshi do fhindula" (when I look at it, it becomes simple for learners to understand when learning in their home language. In most cases learners have answers, but they do not understand the questions. When we do corrections in class, translating questions from English to Tshivenda, they tend to answer the question they were failing to answer in English. This tells us that if the questions were set in their home language, they would have answered the question without any difficulties).*

The statement above indicates Tshifhiwa's endorsement of employing the Tshivenda scientific language register for teaching physical sciences. Being situated in a rural area where students encounter English instruction in schools, Tshifhiwa observes that learners struggle with comprehending physical science when taught in English, thereby impacting their academic performance. Mweli (2018) contends that the mother tongue serves as a crucial bridge between subject content knowledge and a learner's worldview and cognitive processes. Trujillo (2020) underscores that learning in one's mother tongue fosters self-assurance and enhances classroom engagement. Tshifhiwa's perspective, in conjunction with these scholarly assertions, highlights that employing English instruction for learners lacking proficiency in the language inhibits their classroom participation, resulting in teacher-centered lessons. When questioned about the role of language in shaping meaningful learning through learner interaction and discourse, Tshifhiwa further responded as follows:

> *"Luambo lu a influence nga maanda, tshinwe tshifhinga ri khou u funza nga luisimane wa nga to vhudzisa mbudziso udo wana vhana vha tshi sedzana. Arali hu luambo lwavho vha a lingedza. Kha luisimane u do wana nwana asa divhi uri u do to a vheisa hani maipfi (language influences interaction and discourse in the classroom, when we teach and ask questions in English, it becomes difficult for learners to understand and answer questions asked in English. Honestly in English they struggle to put words together, unlike in their home language)".*

Despite Tshifhiwa's favorable stance toward the scientific language register, one challenge encountered in its use pertains to terminologies. Netshivhumbe (2022) notes the absence of equivalent terms for science concepts in Tshivenda. Tshifhiwa views Tshivenda terminologies in the following manner:

> *"Nga ku vhonele kwanga, athi hani zwi do di dzhia tshifhinga kha manwe a maipfi arali asongo pambiwa, zwinga dzhia tshifhinga uri vhana vha a pfesese. Ndi vhona ungari arali manwe a maipfi a pambiwa ayelana na a luisimane zwi nga sia vhana vha tshikhou benefitha nga maanda (According to my understanding, not disputing that it will take time to understand some of the terminologies since are not directly translated from English. I think if we direct translate some terminologies from English learners will benefit a lot)".*

Despite encountering difficulties with English, both learners and teachers resort to the code-switching strategy to mitigate the challenges associated with using English as the medium of instruction. Maluleke (2019) validates this approach, suggesting that code-switching serves as an effective means to bolster learners' academic achievements.

Teachers utilize code switching to afford learners opportunities for interaction with both peers and educators, thereby augmenting comprehension (Modupeola, 2013). Tshifhiwa shares this perspective:

> "*Challenge dzi hone ngauri ha vha vhana vho dowela luambo lwa Tshivenda, lune wa sa switsha wa ya kha Tshivenda u va kha luisimane unga sala u songo ita tshithu lesson yothe. Vhunzhi ha zwithu zwine ravha ri khou funza ri tea u funza ri tshi talutshedza nga Tshivenda uri vha kone upfa uri u khou amba uri mini (There are challenges, because these learners are used to Tshivenda. If you do not switch when teaching from English to Tshivenda you will end up doing nothing the whole lesson. Most of the things that we teach should also be explained in Tshivenda so that learners understand fully)".*

The statement above indicates that Tshifhiwa employs code-switching as the sole strategy to aid learners in comprehending English instruction, a consequence of schools selecting English as the Language of Learning and Teaching (LOLT). The researcher also sought to comprehend learners' perceptions on this matter.

> "*Arali hu khou shumisiwa English fhedzi kilasini ri nga si participate u fana na musi ri khou tanganyisa dzi nyambo (yes, if use English only in class we do not participate. We participate when we switching the languages)". Group 2*

Additionally, the researcher needed to grasp learners' perceptions regarding the utilization of Tshivenda in science education. Learners responded in the following manner:

> "*Nga Tshivenda ri a kona u pfesesa khwine sa izwi hu luambo lwashu na musi u kho u nwala nga lwo u a kona u talutshedza u fhira musi u khou shumisa English (in*

Tshivenda we are able to understand better even when we write we are able to explain better than English)". Group 2

"Ee, nga Tshivenda ri kona u talutshedza zwe nda vhudziswa hu si na u kondeliwa nga luambo (Yes, because are able to explain our answers with language barrier)". Group 1

According to Mavuru and Wilson (n.d.), learners perceive English as a challenging language, leading to underperformance in science subjects. This suggests that the lack of engagement in science classrooms does not stem from a deficiency in understanding the concepts but rather from the language employed for instruction. Consequently, learners exhibit subpar performance in science. Additionally, Mavuru and Wilson (n.d.) discovered in their research that utilizing learners' home languages would foster an equitable environment, affording them opportunities akin to their peers benefiting from instruction in their native language, English. Learners echo this sentiment:

"*Huna dzinwe mbudziso dza English ri a balelwa u dzi fhindula nga u sa pfesesa zwa uri mbudziso I khou uri mini (Some of English question we fail to answer them, because of language barrier)". Group 1.*

This assertion finds backing in Probyn's (2006) research, which highlights that a significant portion of South African learners struggle to articulate their scientific ideas in English, the language used for assessments. Despite regarding the use of their mother tongue as conducive to improved performance in physical sciences, some learners hold divergent opinions. While acknowledging that learning physical science in Tshivenda would enhance their understanding compared to English, they express a preference to persist with English instruction. Their perspective is detailed below:

"Ro no dowela u guda science nga tshikhuwa lune nga tshivenda zwi do ri kondela (No, because we are used to learn physical sciences in English, in Tshivenda it will be a challenge)". Group 2

Several learners reiterated a point made to the researcher during the register development process, emphasizing the necessity of providing explanations for certain scientific terms when translating them into Tshivenda to ensure comprehension. For instance, they highlighted the term "current" being translated to "Lutsinga lwa muḓagasi," suggesting a need for clarification. The learners' response is outlined below:

> "*Manwe maipfi o hulesa (some of the words are too long)". group 2*

While investigations like Molteno (2017) propose that parents perceive early English learning as advantageous for their children's future prospects, Ezeokoli and Ugwu (2019) discover that parents advocate for teaching through the mother tongue to improve learners' educational experiences, classroom engagement, self-assurance, and overall academic performance. These conclusions align with parental perceptions regarding the use of Tshivenda as the language of instruction in science education. Their responses are detailed below:

> *"Nne ndi zwi dzhia zwavhudisa ngauri vhana vha nga di funzwa nga tshikhuwa vha balelwa u fhindula, mara nga Tshivenda vha kona u fhindula (It is a good thing, because learners can be taught in English and fail to answer the questions, but in Tshivenda they can be able to answer)" parent 1*

> *"Muhumbulo uyu ndi khou ima nawo, u nga wana uri vhana a vha khou feila nga u sa kona. Musi vha khou u funza nga English u ngapfa u nga vha khou zwipfa nga maanda vha tshiya u nwala hezwila zwithu zwa xela, lune vha funziwa nga Tshivenda thamusi zwi nga ita uri vha fhirele phanḓa hu sina u kondeliwa (I stand with this idea of teaching science using Tshivenda. Learners are not failing because they do not understand. When they learn in English one can assume they understand, one for them to forget everything when they go for writing)" parent 2*

> *"Nne ndi khou vhona uri zwi ngavha zwavhudi nga maanda arali vhana vha funzwa nga Tshivenda science. Zwi nga vha thusa na uri maipfi haya ane avha difikalthi (difficult), lune nga luambo lwadamuni zwi nga leluwa na u li talutshedza. Na musi nwana o hangwa, nga Tshivenda u do tavhanya a li humbula zwavhudi na u li talutshedza khwine (I think is a good idea if learners learn in Tshivenda. In their home language learners will have better understanding of difficult words and able to remember them)". Parent 3*

The statements from the parents endorse the adoption of the Tshivenda scientific language register. Essentially, parents endorse the notion that employing Tshivenda to teach physical science is beneficial, especially for learners encountering difficulties with English as the medium of instruction. Dlodlo (2021) contends that learning in one's mother tongue enhances comprehension of science subjects and subsequently improves academic performance, thereby supporting parents' concerns about their children's underperformance in physical sciences. Their sentiments are expressed as follows:

> *"Science ndi tshi sedza a I khou shuma zwavhudi, I dinga zwinwe thero u fana na maths (science like maths is not performing well in our school)". parent 2*

> *"Nne ndi thisedza report ya nwana wanga sa mugudi wa science u khou mukondela nga maanda (when I look at my child's report, he/she is struggling with science)"*

According to parents' perspectives, their children are struggling in physical science. Given their favorable stance on using Tshivenda for teaching this subject, they believe that:

> *"Ndi vhona unga tshikhuwa tshi khou khakhisa vhukuma, nga Tshivenda ndi vhona unga zwithu zwi do tshimbila, vhana vha do phasa (I think English is affecting learners a*

lot. I think in Tshivenda a lot will go well; learners will pass)" parent 3

"Ndi zwa vhukuma lu amba lu a kwama ku shumele kwa vhana. Na rine ro rali sa vha hulwane luambo lwa tshikhuwa lu kha di ri kanganyisa vhukuma, lune hapfi vha khou funzwa nga Tshivenda zwi nga Shandukisa zwithu zwinzhi (It is true language affect learners' performance. Even us adults English confuse us, if they learn in their language Tshivenda a lot can change)." Parent 2

4.3.1.2 Findings of participants in Muri secondary school Teacher's perceptions

Tshifhiwa expressed a favorable opinion regarding the utilization of the Tshivenda scientific language register for teaching physical sciences. According to Tshifhiwa, learners can greatly benefit from the Tshivenda scientific language register, as they encounter difficulties understanding assessments conducted in English. Tshifhiwa further underscores the use of code-switching as a strategy to assist learners who struggle with English-medium instruction. One challenge Tshifhiwa encountered while using the Tshivenda scientific language register is the lengthy nature of Tshivenda scientific terminologies, suggesting that direct translation from English would be beneficial.

Learners' perception

Learners perceive the incorporation of Tshivenda in physical science instruction as advantageous. As the primary stakeholders impacted by decisions made by the government, teachers, or parents, learners assert that studying in Tshivenda would enhance their academic performance by facilitating better understanding of assessments and increasing their engagement in the classroom. However, despite this sentiment, some learners express conflicting views. While they acknowledge the benefits of learning physical sciences in Tshivenda, they find it challenging to transition from their accustomed English-medium instruction.

Parents perception

Parents view the adoption of Tshivenda for teaching physical sciences positively, seeing it as a beneficial initiative that can help their children unlock their full potential. They hold the belief that learners' academic struggles are not due to a lack of comprehension, but rather stem from language barriers that impede their progress towards achieving their aspirations.

4.4. MEANINGFUL LEARNING

4.4.1 Data presentation and discussion

According to Mweli (2018), quality teaching and learning are perceived within the framework of the notion that learning is a collaborative endeavor, with both learners and educators constructing knowledge through active engagement. To evaluate which language fosters active participation, the developed Tshivenda scientific register was introduced in the classroom, incorporating both Tshivenda and English for teaching physical sciences. This assessment aimed to discern which language facilitates meaningful learning. Ntuli (2022) defines meaningful learning as a dialogic process wherein diverse ideas are synthesized and deliberated upon. It occurs when learners actively integrate new information with prior knowledge, resulting in increased engagement, and enhanced knowledge retention and application (Andrews, van Lieshout & Kaudal, 2023). The following research question was employed to investigate meaningful learning:

- How does the application of Tshivenda scientific language register shape meaningful learning?

According to Mortimer and Scott (2003), as referenced by Ntuli (2022, p.113), meaningful learning transpires in three stages: the social plane, where new content is introduced to learners; the internalization process, where learners are guided to comprehend and make sense of the new content; and the application of the new content presented to them. From this assertion, it can be inferred that meaningful learning is impeded if learners lack proficiency in the language used for instruction. Language not only shapes discourse in the science classroom but can also act as a barrier to learning (Mudau, 2013). When questioned about the influence of language on learning, Tshifhiwa from Muri Secondary School responded with the following:

> *"Ee luambo lu avha na influence, vhana tshinwe tshifhinga vha vha vha songo pfesesa mbudziso, arali o vha o I pfesesa o vha a tshi do fhindula. Tshinwe tshifhinga mbudziso I da I khou toda zwezwo zwe nwana a vhala, fhedzi nga u sa I pfesesa a balelwa u I fhindula (Yes, language has an influence to learners' performance. Any some cases learners fail to understand the questions that require what they have studied, just because they don't understand the language used in the question, they fail to answer them".*

Learners and their parents held a unified perspective concerning the influence of language on their performance in physical science.

> *"Ee, tshikuwa tshi ngo to leluwa ari khou to feila nga u sa kona fhedzi (Yes, English is not that simple, we are not failing not only because we do not know)". Group 1*

> *" Ee, ndi vhona u nga zwi a kwama, ngauri luambo lwa tshiisimane vhana a vha ngo dowela u lu shumisa. Ri wana uri kilasini ndi hone fhethu hu hothe hune vha kombetshedzea u lu shumisa (Yes, ithink it affects interactions, because learners do not use English regularly. They are only exposed to it in the classroom)". Parent 1*

Classroom observation

The researcher conducted classroom observations of both learners and their teacher to explore how the implementation of the Tshivenda scientific language register influences meaningful learning. Tshifhiwa endorsed the notion of employing Tshivenda for teaching physical science, citing potential benefits for learners in understanding the questions posed to them. The following were noted during the observations in the physical science classroom:

Tshifhiwa : *Zwine ra dovha ri khou amba ngazwo namusi ndi mudagasi une nga inwe ndila ri u vhidza uri liisela la mudagasi. Kha liisela la mudagasi rina zwithu zwine ra tea u dzhiela ntha. A ri thome upfa uri liisela la mudagasi ndi mini? Ndi ndila ine mulilo wa mudagasi kana lutsinga lwa mulilo lwa isa phanda u sudzuluwa lwa mona lwa dovha hafhu lwa vhuya afho he lwabva hone. Kha liisela la mudagasi mudagasi u thoma hafho hune wa khou thoma hone wa mona wa dovha wa vhuelela he wabva u hone. Vheiwe uya nga ha vheiwe ni divha uri mudagasi u thoma kha mini kha liisela uri uvhe hone? (Today we are going to talk about electricitiy in other way we call it electric circirt. In an electric circuit there are certain thing we should not take for granted. First all what is an electric circuit? It is the path that the current continues to move around and come back where it started. According to you where do electricity start at the electric current?*

Learners : *Kha betiri (In the battery)*

Tshifhiwa:` : *Rothe ri a zwidivha uri betiri asi Tshivenda. Nga Tshivenda ipfi mini (we all know that battery is not a Tshivenda term, what is battery in Tshivenda)*

Learners : *Tshiko tsha fulufulu (battery)*

Tshifhiwa : *Ee, kha tshiko tsha fulufulu ndi hone hune wa thoma hone uri u kone u mona. Tsumbo (vha nwala kha board), ari sedze liisela kheli lina tshiko tsha fulufulu hune ndi hone hune mulilo wabva hone. (Yes, in the battery is where it started. Let's look at the circuit, in the battery is where the charges come from). A ri sedze zwivhumbi zwa liisela la mudagasi. Vheiwe ni divha zwifhio? (let's look in to the components of electric circuit, which component do you know?)*

Learner : *Livhone (bulb)*

Tshifhiwa : *Livhone li shuma mini? (what is the function of the bulb?)*

Learner 1 : *U rifha tshedza. (to give us light)*

Leaner 2 : *Ndi uri vhone tshela*

Tshifhiwa : *Ndi u ri vhonetshela kana u rifha tshedza a si zwone? (Is to shine at us or to give us light, right?)*

Figure 4.1: Learners' engagement in the lesson

Based on the preceding observations, learners possess prior knowledge of the concept of electricity. Effective learning necessitates linking prior knowledge with new information (Gurlen, 2012). In the classroom, the researcher noted Tshifhiwa's use of dialogic discourse, enabling learners to actively participate in the lesson (Mudau, 2013). Ntuli (2022) asserts that meaningful learning entails a dialogic process, wherein learners attain a profound understanding of the subject (Gurlen, 2012).

The researcher also noted the following occurrences while Tshifhiwa assigned an activity to the learners:

Tshifhiwa : Ari zwidzhie rofhiwa fulufulu lo sudzuluswaho la 240J na mulilo wa 10C. Todani maanda a nyelelo ya mulilo. (Let us say we are given work of 240J and the charge of 10C. calculate the voltage.

Figure 4.2: Learners working on an activity

From the scenario, the researcher observed that learners were given the opportunity to independently seek answers while the teacher monitored their progress. This approach, as described by Mudau (2013), is deemed interactive-authoritative. Both Mudau (2013) and Chin (2006) characterize this approach as one where the teacher primarily seeks correct answers from the learners. In this context, the researcher noted the teacher's movement around the classroom, ensuring learners were providing accurate responses. However, this approach does not foster significant interaction among the learners. Interactions and discourse between the teacher and learners are pivotal in the science classroom, as they facilitate the creation of meaning (Mortimer & Scott, 2003; Mudau, 2013). Therefore, without such interaction and discourse, the lesson may lack significance. Nonetheless, the researcher observed that Tshifhiwa recognized the learners' struggles and subsequently engaged them in additional activities to ensure the lesson remained meaningful to them.

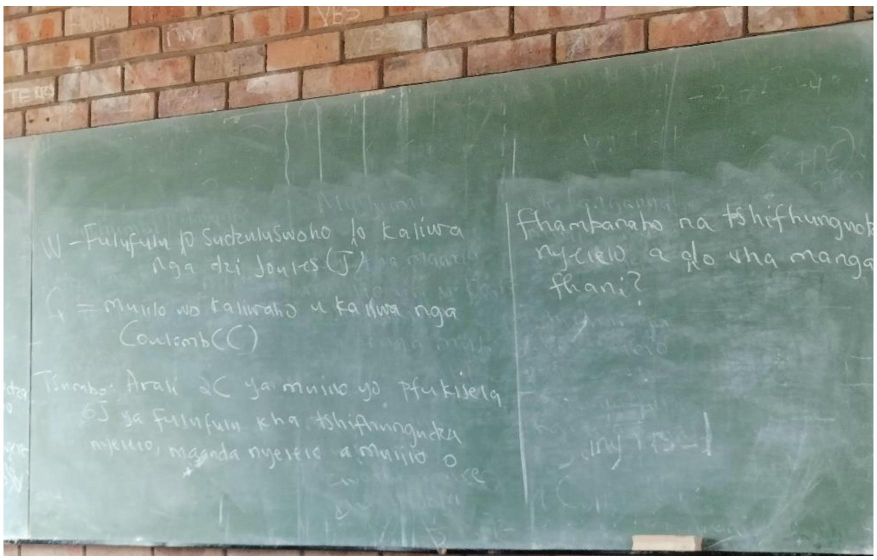


Figure 4.3: Activity engaging learners

Following the observation of the implementation of the Tshivenda scientific language register, the researcher also noted the utilization of the scientific language register in English.

Tshifhiwa	*: What is a circuit? I am sure you all know what a circuit is. So let us talk about the components of a circuit. What are the components of a circuit?*
Learner	*: Light bulb*
Tshifhiwa	*: What is its function?*

Learner : The bulb gives us light

Tshifhiwa : Another component?

Learner : Switch

Tshifhiwa : What is a function of a switch?

Learner : Is to turn on and off

Based on the observation in English, Tshifhiwa's questioning style did not stimulate discussion in the classroom. Ntuli (2022) characterizes this approach as interactive-authoritative, given the absence of interaction among the learners.

4.4.2 Summary of observation from Muri secondary school

The researcher noted that Tshifhiwa employed varied approaches when delivering the lesson in Tshivenda, which effectively engaged the learners, fostering interaction between them and their teacher. However, during the observation of the English scientific language register, only a few learners displayed interest in responding to the questions, and the teacher did not provide as thorough explanations as when using the Tshivenda scientific register. This suggests a proficiency issue with English language among both the learners and their teacher when utilizing the English scientific language register.

4.5 CASE TWO: ABIGAIL FROM NALEDZI SECONDARY SCHOOL

4.5.1 Data presentation and discussion

Offering education to learners in their native language is a beneficial practice, as it enhances the likelihood of learners remaining enrolled in school (Adedigba, Soretire & Ajayi, 2023). Additionally, learners encounter challenges in associating scientific learning with everyday experiences (Fung & Yip, 2014). These statements were utilized by the researcher to gauge the teacher's perspective on the use of Tshivenda as a scientific language register for teaching electricity:

> *“I think it is ok. It will be easier to use our own language, though I find that some terms they will still give learners difficulty because most of learning areas are in English. So, for beginners, they might find a challenge to use Tshivenda. In the physical science area and also, it's a new thing that is going to be introduced to them. So, learning new things remains difficult, but I think as we go on it will be an advantage because they will have to understand a lot of things and most of the things they do. Speak about them thinking of physical sciences in everyday life, they do know most of the things in their daily lives, but when it comes to a physical science in class, it becomes as if it's something different since they are learning in a foreign language. But when they're using their own language, I think it will be very helpful and useful”.*

Despite Abigail's belief that changes can be challenging, she views the utilization of Tshivenda to teach physical sciences as a positive initiative. Abigail recognizes that learners possess a wealth of scientific knowledge but struggle to connect their prior knowledge to new scientific concepts due to language limitations. She emphasizes that the inadequate English language skills among most learners in rural schools hinder both teachers and learners from effectively using English (Probyn, 2006). Furthermore, Abigail highlights the use of code-switching as a strategy to assist learners struggling to comprehend physical sciences taught in English. Code-switching is regarded as a supportive tool in communication and social interaction, enhancing understanding and facilitating the transfer of meaning (Junaidi, 2019):

> *“It is very important that I do so because at some point you will find that you continuing with English and then the learners do left behind, not understand anything. So, you have to code switch that you bring also the attention of the other learners”*

In the absence of other options, teachers resort to code-switching due to the prevalent use of English as the medium of instruction in schools. As noted by Prophet and Badede (2009), learners encounter the dual challenge of understanding both English language and scientific concepts when taught in English. Consequently, this obstacle impedes their success. Abigail identifies this challenge as having a significant impact on learner performance:

> *"It does have an impact, because speaking a foreign language itself, it's hard. So, when you just have to interpret it in questions, let just say an example. Speaking of the crumble zones of a car to another learner, it's something difficult a learner will not even think what that is. Learners know a lot of things just because is been asked in English it becomes difficult for them."*

Both the teacher and the learners themselves acknowledge the influence of language on learners' performance, as evidenced by their expressed viewpoints aligning with the teacher's observation.

> "*Nne ndi vhona u nga luambo lu a dzhenelela kha u sa phasa hashu, ngauri Tshikhuwa asi rothe ro no tshipfesesa khwine (I think language has an impact on our performance, not all of us understand english better)".* Group 1

Thus, Abigail posits that if given the choice, learners would opt to be instructed in Tshivenda over English. This preference stems from their greater comprehension of Tshivenda, which enables them to articulate their thoughts without hindrance.

> *"They will prefer Tshivenda, because have had of them when using English complaining they do not understand. I*

have noticed that when I use Tshivenda a have more of their attention than when I use English".

Moreover, Probyn (2006) contends that learners often revert to their native language within the classroom, interacting with peers and, to varying degrees, with the teacher, influenced by the teacher's personal stance on the issue. This assertion aligns with Abigail's emphasis on the significance of code-switching and reflects learners' recognition of the language's impact, as proficiency in the medium of instruction is crucial for learners' academic success (Prinsloo, Rogers & Harvey, 2018).

"Ndi vhona ku kwa vhudi ngauri nga English hu na manwe maipfi ane ndi nga balelwa u divha thalutshedzo dza hone mara nga Tshivenda ndi nga kona u a pfesesa (It is a good idea, because there are certain words or terms that are difficult to understand their meaning in English, but in Tshivenda it would be simple to understand)".

Some learners perceive the introduction of Tshivenda in teaching physical science as a positive step, citing challenges in understanding certain English terminologies. Conversely, other learners advocate for continuing with English as the medium of instruction for physical science, as they have been accustomed to it since primary school. Here is their response:

"Hai, ngauri ro no a dowela u shumisa tshikhuwa, nga Tshivenda vhunzhi ha maipfi ndi maswa kha rine (No, because we are used to learning in English, scientific words in Tshivenda are new to us)". Group 2

This is because our educational system permits an early shift from the home language to English starting from the fourth grade, after which learners use English as the Language of Learning and Teaching (LOLT) up to tertiary level. Additionally, English has emerged as the predominant global language for scientific endeavors, offering access to a vast array of scientific literature and facilitating international scientific communication (Ramulumo, 2023). This aligns with the viewpoint of these learners who perceive learning physical science in English as advantageous:

> "*Ndi nga takalelela nga tshikhuwa, ngauri u tshiya dzi university hu vha tangana vhana vha nyambo nnzhi ringa si nwale nga Tshivenda, ri do tea u nwala nga English sa izwi nyambo dzashu dzoya nga u fhambana (I would like to learn in English, because in the university we have different languages, so English will be used as a medium of instruction as we are from different cultures)". Group 2*

Moreover, the researcher was also intrigued to explore parental perspectives on the utilization of Tshivenda as the language of science, as parents wield significant influence in determining the language of instruction in schools. Here is their viewpoint:

> *"Nne ndi vhona u muhuhumbulo wa vhudi, asi zwiswa hazwi kale ro vha ri na thero dzo no fana na nguda mutakalo [I think it is a great idea, we used to have subject such as nguda mutakalo (life sciences) in Tshivenda)". P1*

The concept of education through mother tongue instruction is not novel; it has existed previously. Therefore, parents regard this as a beneficial idea that will significantly impact learners' academic performance. Furthermore, it was suggested that utilizing indigenous languages as a medium of instruction encourages parental involvement in their children's educational endeavors (Ezeokoli & Ugwu, 2019). Both parents exhibit concern as their children are not excelling in physical sciences.

> *"Vhana khou lila ngayo sciences, zwine zwi amba uri a vha khou shuma zwavhudi (They complaining about science, which tells us that they are not performing)". P2*

The researcher notes that there is little they can do at home to aid their children since they also lack proficiency in English. Naom and Sarah (2014) discovered in their research that parents perceive the adoption of the mother tongue would decrease learners' absenteeism and dropout rates, thereby enhancing interaction and discourse in the classroom. These findings were also echoed by parents during the researcher's interviews, as they recognized the benefits of teachers employing code-switching to ensure comprehension of the concepts being taught. Here is the parents' response:

> *“Vhadededzi havha vha tshi funza vha do vha hafhu vha talutshedza nga Tshivenda u itela uri vhana vha pfesese khwine (the teachers when they teach, they explain in Tshivenda so that learners can understand well)”. P1*

The parent's statement underscores the preference for code-switching, as previously indicated by both learners and teachers, to address the issue of poor performance. As a result, the parent stated:

> *“Ndi nga funa vhana vha tshi funziwa nga Tshivenda uri a topfa a pfe a pfesese athi vhoni a tshi do feila hu luambo lwawe lwa damuni (I would prefer them to use Tshivenda, so that they understand to the fullest extent. I do not think they will fail their mother tongue)”. p2*

4.5.2. Findings of participants at Naledzi secondary school

4.5.2.1. Teacher’s findings

Abigail initially perceives the idea of using Tshivenda to teach physical science as challenging but essential, given learners' difficulty in connecting prior knowledge to new concepts due to language barriers. Moreover, learners face challenges in understanding questions and concepts due to language deficiencies. Abigail suggests that to address learners' poor performance, code-switching is employed to accommodate all learners. Consequently, she believes that learners would prefer learning in Tshivenda, as their participation is maximized when lessons are delivered in their native language.

4.5.2.2. Learner’s findings

The introduction of Tshivenda as the language of science has led to differing opinions among learners. While some view it as a positive initiative, others disagree. They argue that language significantly influences their academic performance since they lack fluency in English and struggle to comprehend some scientific terms in English. Therefore, they believe it would be more beneficial to learn physical sciences in Tshivenda. Conversely, other learners feel accustomed to learning physical science in English and see no need to switch to Tshivenda. They express concerns that learning in Tshivenda may disadvantage them in university settings where they will interact with learners from diverse cultural backgrounds.

4.5.2.3. Parent's findings

They appreciate the efforts made by teachers, who employ various strategies like code-switching to ensure effective knowledge transmission to learners. Additionally, parents endorse the use of Tshivenda for teaching physical science, considering it a beneficial measure given its historical use. They believe reintroducing this approach will be particularly advantageous for learners struggling with English as the medium of instruction.

4.6. Meaningful learning

4.6.1 Data presentation and discussion

The researcher employed classroom observation to ascertain the impact of the developed Tshivenda scientific language register on meaningful learning. It was crucial for the researcher to grasp stakeholders' perspectives on how language influences interaction and discourse in the classroom. Here is Abigail's response:

> *"Yes, when you ask learners questions in English, they will just look at you because they do not understand; they don't know what to say themselves*."

The statement suggests that employing English with learners who are not proficient in it creates a disconnect between learners and their teacher. This disconnect subsequently reduces interaction, resulting in less meaningful lessons. Learners also recognize this challenge, as evidenced by their statement:

> *"Ee, ngauri u wana tshinwe tshifhinga u tshi balelwa u fhindula zwine mudededzi vha khou vhudzisa zwone nga tshikhuwa (Yes, at some point we fail to answer questions asked by our teach in English)."* Group 1

While the teacher and certain learners acknowledge the influence of language on learning, others perceive no issue with the current learning process. They believe that language has no bearing on their performance. Their responses are as follows:

> *"Hai, ngauri na luambo lwa hayani vhanwe vhana vha kho di lu feila (No, because some leaners are also failing their home language)."*

It was imperative for the researcher to conduct classroom observations to highlight the viewpoints expressed by stakeholders regarding the influence of language on interaction and discourse, and how this influence shapes meaningful learning. Observation is considered a crucial method of data collection for classroom research among teachers and learners (Yanan, 2023). The researcher utilized observation to examine how the interaction and discourse during the implementation of the Tshivenda scientific language register contribute to meaningful learning. This segment of the study focuses on observing the application of the Tshivenda scientific register.

> ***Abigail:*** *Namusi ri khou do amba ngaha liisela la mudagasi (Today we are going to talk about electric circuit). Liisela la mudagasi ndi mini? (What is electric circuit? Liisela la mudagasi ndi ndila ine mulilo wa mudagasi kana lutsinga lwa mulilo lwa isa phanda u sudzuluwa lwa mona lwa dovha hafhu lwa vhuya afho hune lwabva hone ((Electric circuit is the path in which the current continues to move around and comes back when it started). Liisela la mudagasi li itiwa nga zwivhumbeo zwo fhambanaho, no zwita ca NS ya grade 9*

(the circuit is made up of components. You did this component in grade 9 NS). Tshivhumbi tsha u thoma ndi livhone, huna muthu asa divhi livhone afha? (The first component is a bulb, is there anyone who doesn't know a bulb?)

Learners: *Hai (No)*

The researcher noted that at the beginning of the lesson, the teacher did not consider the learners' prior knowledge. The teacher assumed that the learners were unfamiliar with what an electric circuit is, so they posed a question and provided the answer. Additionally, the teacher guided the learners by offering an example of the components. In the researcher's opinion, the teacher should have encouraged the learners to draw upon their prior knowledge to identify the components.

Abigail: *Tsha vhuraru ndi Tshilanga mulilo tsha mudagasi. Nitshi lavhelesa tshifanyiso ni vhona unga tshi shuma mini? (The third component is the switch), what is the function of the switch when you look at the symbol?)*

Learner 1*: U imisa muḓagasi uri u sa tshimbila (to stop electricity from flowing)*

Abigail: *Ndi zwone mara, Tshi to u imisa fhedzi? (does it stop electricity only?)*

Learner 2*: Tshi langa mulilo uri u tshimbile kana usa tshimbile (It controls the flow of current)*

Abigail: *Ee, na dzina latsho li khou to di amba. Zwino tshilanga mulilo tsho sumbedziwaho afho kha bambiri tsho fungiwa kana tsho tsimiwa? (Yes, even its name says it. The switch on the paper, is it closed or opened?)*

Learners: *Tsho tsimiwa (opened)*

Abigail: *zwiamba uri arali tsho vulea (tsimiwa) mulilo a u koni u tshimbila kana a u tshimbila?*

Learners: *a u koni tshimbila (it does not flow)*

Through the interactions occurring in the classroom, the research correlates this communicative approach with the interactive/dialogic approach (Chin, 2006). In the interactive/dialogic approach, learners' perspectives are considered, even if they diverge from the accepted scientific interpretation. The findings by Limberg, Alexandersson, Lantz-Andersson, and Folkesson (2008) suggest that teacher and learner interaction, centered on learning goals and content, is essential for meaningful learning.

> ***Abigail****: Zwiamba uri vheiwe ninga kona u ita liisela la mudagasi ni khou shumisa zwivhumbi zwe ravha ri khou amba ngazwo? (So now, can you be able to draw the electric circuit using these components?)*
>
> ***Learners:*** *Ee! (yes)*
>
> ***Abigail:*** *A ri ole liisela la mudagasi lire na livhone lithihi, tshilanga mulilo tsho vuleaho, tshi fhirisa fulufulu na tshiko tsha fulufulu. Tshiko tsha fulufulu tshivhe tshina tshilanga mulilo tsha 5V. (Draw the circuit with one bulb, open switch, battery of 5V)*

The learners were tasked with writing in their books. Once they finished writing, the teacher directed volunteers to depict their written work on the board. The image below shows a learner sketching their circuit diagram on the chalkboard.

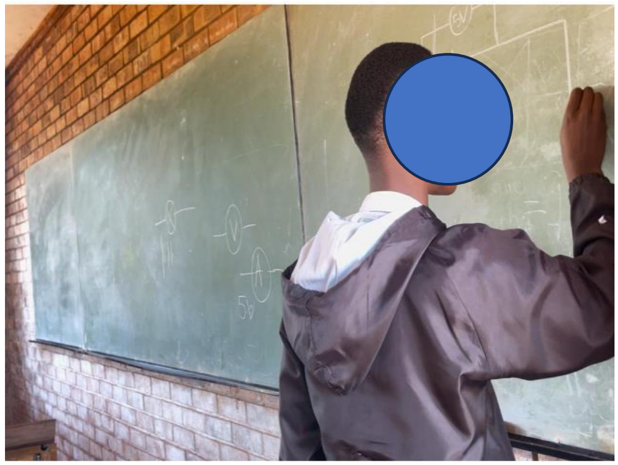


Figure 4.4: Learner interaction

This teaching method fosters interaction among learners: as one learner writes on the chalkboard, others observe and offer corrections. The teacher's role is primarily to validate the accuracy of the written content. This facilitates communication since learners are using a language in which they are fluent. Language serves not only as a means of communication but also as a crucial factor influencing comprehension and the development of new ideas (Ramulumo, 2023). Therefore, this approach contributes to meaningful learning.

In the implementation of the English scientific language register, the teacher made the following observations:

Abigail: What is the function of a bulb?

Learner: *is to….to to to light*

Abigail: *in other words, it produces light, what is the function of a switch?*

Learner: *Is to, is to make the fire go around and stop.*

Abigai: *In other words, it is used to turn on and off the circuit. What is the function of a resistor?*

***Learner**: Is to decrease the energy in the circuit*

Abigail: *Yes, is to reduce the current that is flowing through the circuit. What is the function of a voltmeter?*

***Learner**: Is to measure the ampere*

Abigail: *In other words, it measures the voltage*

Based on the above observation, the teacher employed an interactive/authoritative communicative discourse (Chin, 2006), primarily focusing on obtaining correct answers. Even when learners provided incorrect answers, the teacher did not inquire further into their reasoning. Although the teacher did not outright dismiss learners' responses as incorrect to encourage interactive engagement, the questions posed did not stimulate critical thinking among the learners. Additionally, the researcher noted that learners encountered difficulties in constructing sentences. The image below depicts a learner using hand gestures to illustrate their answer as they struggled to articulate the complete sentence.

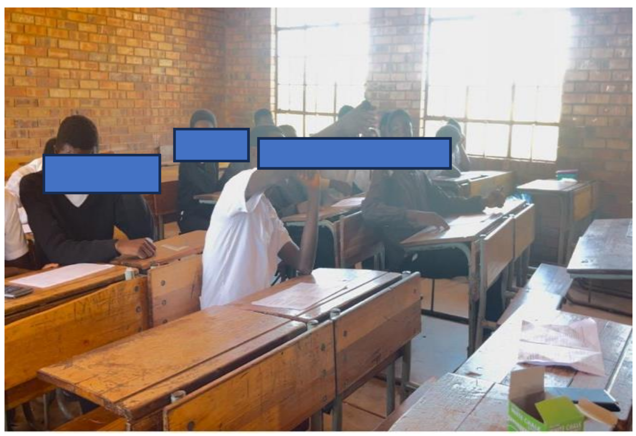


Figure 4.5: Question-and-answer sessions

The sole reliance on English as the language of communication during question-and-answer sessions in the classroom hinders learners from actively engaging in interactions. When a learner struggles with English, their peers often react with laughter. Consequently, this undermines learners' self-confidence and sense of belonging. Furthermore, the inability to use their home language for learning exacerbates these feelings, particularly when learners experience repeated underachievement (Owen-Smith, 2010). This supports the teacher's assertion that learners would prefer learning in Tshivenda.

4.6.2. Summary of observation from Naledzi secondary school

In this study, stakeholders suggest that language impacts the interactions between learners and their teacher in the classroom. The study outlines how the implementation of a scientific language register in Tshivenda contributes to meaningful learning. The findings suggest that learners encountered difficulties interacting with their teacher in English, as evidenced by instances where learners paused mid-sentence and resorted to using hand gestures to convey their ideas. This observation highlights the challenges learners encounter when using English as the medium of instruction.

4.7. Case three: Peter from wisdom secondary school

4.7.1. Data presentation and discussion

The perceptions teachers and learners hold about English influence how effectively learners acquire the language. These perceptions are influenced by their individual experiences (Day, 2023). Peter describes the challenges they face when learning in English as follows:

> *"Yes, sometimes we experience the problem of teaching physical science in English, because you may find that some of the explanations that you are supposed to elaborate concerning the concept of physical science are complicated, especially to the learners, and then that result the learners not to compete more efficiently".*

Observations indicate that science learners who do not utilize their home language in scientific discussions struggle to comprehend scientific concepts when English is the language of instruction (Dlodlo, 1999). Additionally, it was noted that during assessments, learners may know the answer to a question, but struggle to comprehend what is being asked due to how the question is worded (Prophet and Badede, 2009).

Peter noticed an improvement in learners' interaction and discourse when the lesson was conducted in Tshivenda. Peter expressed the following sentiments:

> *"Oh, yes. There was a little bit change or a little bit improvement to the learners because some of the concepts that are usually taught by English, when we teach them in Tshivenda, they find them clear, they were able to identify things in a very good manner. Because, so usually when we are giving them, say, the examples in Tshivenda, you were found to be clear in the concept"*

Moreover, learners encounter difficulty expressing themselves confidently and effectively when engaging with subjects through English communication (Raphael & Tibategeza, 2022). UNESCO (1953) regards the mother tongue as a fundamental tool for self-expression and learning. Peter echoes UNESCO's assertion in the following manner:

> *"Yes, because when you are teaching in Tshivenda more learners participate in the lesson than when you are using English because of language barrier."*

According to Peter's perspective, language profoundly influences learners' academic performance. It was essential for the researcher to gather the viewpoints of the learners too, to ascertain if they view this matter differently from the teacher. Two sets of learners were interviewed, and some of them expressed their difficulties with English. Here is their response:

> *"Ee, ngauri vhunzhi ha zwithu zwino khou u funzwa ri vha risa zwipfi nga English (Yes, we don't understand a lot of things in English)". Group 2*

This statement indicates a consensus between learners and the teacher regarding the significant influence of English as the medium of instruction on learners' performance in physical sciences. Consequently, learners perform poorly in exams due to their lack of proficiency in English (Naom & Sarah, 2014). Mackay (2014) suggests that learners with limited competence in their Language of Learning and Teaching (LOLT) may encounter challenges in thinking, speaking, listening, reading, and reasoning in a second language. This explains why learners believe it would be preferable to learn in Tshivenda. Their response was:

> *"Nga Tshivenda, ri vha ro zwi pfesesesa khwine zwi khou funziwaho (In Tshivenda, we understand better what we are learning)" group 2*

This reinforces the teacher's assertion that teaching physical sciences in Tshivenda would be optimal, as learners demonstrate their highest level of engagement in the classroom when using this language. However, the teacher's argument does not sway all learners' perspectives on the use of Tshivenda for teaching physical sciences. While some view it as beneficial, others do not perceive any challenges associated with English:

> "*English, ngauri science ya tshivenda a ri i pfesesi zwavhudi (English, because we are not used to study science in Tshivenda)" group 1*

They believe that learning physical sciences in English is preferable because they encounter challenges when learning the subject in Tshivenda. This is primarily because learners are unfamiliar with scientific terminology in Tshivenda, which is underdeveloped in this aspect. Consequently, learners find Tshivenda scientific terms difficult to grasp.

> *"vhunzhi ha maipfi ari ngo dowela maipfi a physical science nga Tshivenda (we are not used to scientific terminologies in Tshivenda)". Group 1 L1*

> *"Zwi right ngauri huna vhanwe vha sa pfesesi English (I think it is right, because other learners do not understand)" group 1 L2*

Learners held differing perspectives on this matter. While some regarded it as a difficulty, others believed it would provide an opportunity for fellow learners to study in a language they comprehend. Ultimately, they recognized that some learners encounter challenges when learning physical sciences in English. Here is their viewpoint:

> *"Ee, nga uri vhana vhanzhi vhapfesesa Tshivenda u fhira English (Yes, because most of the learners understand Tshivenda more than English)" group 1*

Despite studies indicating that parents and learners generally favor English over the mother tongue as the language of instruction, the researcher deems it necessary to understand how parents perceive the use of Tshivenda in teaching physical science. Here is a quote from a parent:

> *"Nne muhumbo wanga kha science I tshi funzwa nga Tshivenda ndi vhona huna hune zwavha khwine hone. Nwana zwine a khou zwi funziwa u a kona u zwi pfesesa a zwi fara nga ngelekanyo a sa tavhanye o zwi hangwa. U a kona u divha uri zwithu zwi itiswa hani arali o funzwa nga luambo lune a lupfesesa. Naho zwi tshi ngavha na vhuvhi nyana, fhedzi azwi nga do fhira zwivhuya zwazwo. Luambp lwa English lu to vha na vhukhwime uri u kone u pfesesana na vhathu vha dzinwe nyambo. Sa tsumbo lu lugisa goloi azwi todi luambo, tshi khou todea ho fhedzi ndi tshikili tshine muthu u a tshi wana naho asa koni luambo lwa tshikhuwa. (My opinion on science being taught by Tshivenda, I see it as a good idea. If a learner is taught in the language they understand, it helps as it won't be easy to forget. They are able to learn how things work if they learn in their language. There are more advantages than disadvantages. English only helps when we communicate with people of different cultures. For example, fixing a car does not require a*

language, the only thing needed is the skill to fix not the English language)"

The parent underscores the viewpoint expressed by other stakeholders that learning in the mother tongue is the most effective method to facilitate learning. Moreover, the parent suggests that the significance of English lies solely in communication with individuals from diverse cultures. This notion is supported by Prophet and Badede (2009), who assert that proficiency in language during daily interactions often leads to an overestimation of learners' linguistic abilities to comprehend scientific concepts. Chaudron (1988) and Ndamba (2008) argue that learners instructed in English face the dual challenge of comprehending tasks presented in English and mastering the content itself, particularly in subjects like physical science. Hence, the parents believe that language profoundly influences learners' performance.

"Luambo lu a kwama ngauri arali vhathu vha tshi khou amba nga luambo lune vha khou pfana zwi a ita uri nyambedzao I vhe ndapfu. Vha vha vha khou kona u pfesesana kha zwine vha khou amba nga hazwo. Unless vhatshi khou shumisa luambo lune a vha lupfesesi zwi ita uri nyambedzano dzi vhe thukhu. Ane a khou ita tsumbo asa pfeseswe nga ane a khou mu itela tsumbo. Fhedzi arali hu khou shumiswa luambo lwa Tshivenda u ita tsumbo, zwi ita uri a tavhanye azwipfe nga uri hu khou shuma luambo lwa Tshivenda lune vhothe vha a lupfesesa. Luambo lwa tshikhuwa a lua to vha na vhundeme nga nnda ha u go uri muthu a kone u amba nav ha dzinwe tshaka.arali ri khou kona u tandulula dzi thaidzo nga luambo lwashu azwi ngo khakhea. (Yes, language influences, because when people talk using language, they both understand they have a long conversation since they both understand what they are talking about. Unless they are using language they do not

understand, that is when they have short conversation. If the teacher is making example to learners in Tshivenda, learners will understand better as it is the language they understand. The only importance of English is for people of different tribes to be able to understand each other. If we are able to solve some of the challenges in our language there is nothing wrong with that)"

4.8. Findings of participants at wisdom secondary school

4.8.1. Teacher's perception

The teacher regards the adoption of the Tshivenda scientific language register as a significant opportunity for enhancing learners' academic achievement. Based on Peter's extensive teaching experience, he has observed that learners struggle with English-medium lessons. However, Peter noticed a positive shift when the Tshivenda scientific language register was introduced; learners became more engaged and participative in the classroom. Consequently, Peter is confident that this approach will help boost the confidence of learners who are feeling demotivated in their studies.

4.8.2. Learners' perception

The learners' feedback indicates varied perspectives regarding the adoption of Tshivenda for teaching physical sciences. Some perceive it as a beneficial initiative, particularly for those grappling with English as the instructional language. Conversely, there are individuals encountering challenges in grasping Tshivenda scientific terminology, thus favoring the continuation of English instruction. Despite these differing opinions, they unanimously advocate for support for learners facing difficulties with English. Consequently, they endorse the utilization of Tshivenda for teaching physical sciences as a beneficial approach for struggling learners.

4.8.3. Parents' perception

Parents view the notion of instructing science in Tshivenda favorably, asserting that science can effectively be taught in any language. They underscore the significance of English primarily for intercultural communication, citing examples of individuals proficient in fields like car mechanics without formal English instruction. They emphasize that scientific knowledge transcends language barriers and argue that effective communication and comprehension in the classroom are enhanced when both learners and teachers are fluent in the language used.

4.9. Meaningful learning

In this study, the researcher aimed to explore how the implementation of Tshivenda scientific registers impacts meaningful learning. Language proficiency plays a crucial role in acquiring the conceptual understanding necessary for students to excel in future academic endeavors, particularly in scientific subjects (Prinsloo, Rogers & Harvey, 2018). Therefore, it was imperative for the researcher to gauge stakeholders' perspectives on the influence of language on students' academic performance.

> *"Yes, when you are teaching in English, sometimes you may find that you are talking to yourself, learners cannot be easily engaged in the lesson. That has impact on their performance". Peter*

> *"Ee, ari pfesesi English nga u to ralo (Yes, we don't understand English that much)" group 1 learners*

Parents also express worry about their children's underperformance in physical science, although they are unsure about the root cause of the issue. Their response is provided below:

> *"A thi vhoni performance ya physical science I ine ya fusha, fhedzi zwi nga vha zwi hudzhi. Zwi nga vha zwi khou itiswa nga uri mufunzi a nga vha asi khou talukanya, mufunziwa anga vha nae asi khou talukanya kana tshinwe tshifhinga mufunzwiwa ha khou u vha serious. A thi to divha uri mufunzi*

kana mufunziwa ndi nnyi ane a vha thaidzo kana funzo yone ine thaidzo naa. (I do not think the performance of physical sciences is enough. The reason for this could be that a teacher is not understanding, a learner is not understanding or a learner is not serious. I am not so sure if the problem is with a learner or a teacher or the education itself)" parent

The following observations were made during the implementation of the Tshivenda scientific language register.

> **Peter :** Mulilo uvha u khou bva kha mini? (*where are those charges coming from?*)
>
> **Learners**: Kha cell (*from the cell*)
>
> **Peter:** Kha cell kana kha mini? (*in the cell or what?)*
>
> **Learners:** Kha battery (*in the battery*)
>
> **Peter :** yes, kha battery, Itshi ndi mini? (*What is this?) (Showing learners on the board*)
>
> **Learners:** Ndi livhone (*is the bulb*)

During the utilization of the Tshivenda scientific language register, the teacher was noted to employ English terminology instead of Tshivenda equivalents when teaching physical sciences. This could be attributed to either inadequate lesson preparation or a lack of familiarity with Tshivenda scientific terminology. In subsequent interview sessions, both the teacher and learners highlighted the difficulties they encounter when attempting to use Tshivenda terminologies:

> *"Yes, that one, the register that I was using for Tshivenda the preparation that have been given which is in Tshivenda was a little bit complicated especially to differentiate between some of the terms. For an example, the different between voltmeter and the ammeter together with the functions. And then you may find that the answers given are more or less the same and by that it usually confuses the learners". Peter*

“Maipfi a ita a tshi kanganyisa (some of the words are complicated)” learners’ group 2

Despite encountering challenges, the specific English terminologies used by the teacher in the Tshivenda lesson were not new to the learners, as they had already been introduced to them in Grade 9 Natural Sciences, as the teacher mentioned at the beginning of the lesson. The researcher focused more on the teacher's approach in applying the Tshivenda scientific register and how it influenced meaningful learning. From the application of the Tshivenda scientific language register, the researcher observed two types of discourses that influenced how learners connected concepts with meaning. In the observed instance, the teacher employed the Initiation, Response, and Feedback (IRF) model (Ntuli, 2022 & Netshivhumbe, 2022). Initially, the teacher-initiated communication by posing questions to the learners. The learners then responded to the questions, and finally, the teacher provided feedback. However, all the questions posed by the teacher were straightforward and did not stimulate critical thinking among the learners.

Another approach observed was the Initiation, Response, Feedback, Response, and Feedback (IRFRF) model. Here, the teacher initiated the lesson by asking probing questions, followed by responses from the learners. The teacher then responded by posing further questions based on the learners' responses, and finally provided a concluding response to the learners' contributions (Ntuli, 2022). The following illustrates the application of IRFRF in the classroom:

***Peter**: zwisumba zwauri livhone lia funga la dovha la tsima mara huna tshithu tshine tsha ita uri livhone li funge li dovhe li tsime, ndi mini tshila tshithu? (The light can be on and off, there is something that makes that to happen. What do we call that?)*

***Learner:** Ndi switch. (Ndi switch)*

***Peter:** Nga Tshivenda ri ri ndi tshilanga mulilo (In Tshivenda we say tshilanga mulilo). Zwisumba uri switch kana tshilanga* *mulilo arali tsho rali hupfi tshoo ita mini na hone mulilo u a kona u tshimbila? (Demonstrating on the board) (So this implies that if the switch is in this manner, we say it is? And also, can electricity pass through?)*

***Learners:** I open, muḓagasi a u koni u fhira (opened electricity cannot pass through)*

***Peter:** Tsho valea hu itea mini kha tsho? (When it is called what happens to it?)*

***Learners:** Mulilo u a kona u fhira (Electricity can pass through)*

***Peter:** khezwo, ndi zwone. Muḓagasi u fhira musi tshilanga mulilo tsho valea.*

As Peter mentioned during the interview, learners tend to be more engaged when the lesson is delivered in their native language. Teachers facilitate the expression of learners' own ideas, leverage the information provided by learners, and draw on their experiences to guide them towards deeper levels of understanding (Sharan, 2018). Consequently, Peter utilized the IRFRF model to foster learners' engagement in critical thinking and reflective dialogue, thereby promoting meaningful learning. Additionally, it was crucial for the researcher to observe the interaction between learners and the teacher during the application of the English scientific language register.

***Peter:** We are going to talk about electricity. In electricity we must know what a current is. What is a current?*

***Learners:** (looking at each other)*

***Peter:** Ok, Current is the flow of charge from positive terminal to negative terminal. Now, in the diagram of electric circuit, there are symbols that you should know and also know their functions. What is the function of a resistor?*

> ***Learners:*** *Is to oppose flow of current*
>
> ***Peter:*** *yes yes, to limit the current from flowing. We also have the cell; the function of the cell is to produce the current. The next one is voltmeter and its function is to measure the voltage*.

The passage suggests that the teacher failed to involve the learners actively in the lesson, a method of teaching that is not recommended as it does not empower learners to take control of their own learning. The concept of passive learning, where students are not actively engaged, is often associated with authoritative, teacher-centered science class routines (Prophet and Badede, 2009).

4.9.1. Summary of observation from Wisdom secondary school

Despite facing challenges with the Tshivenda scientific language register, Peter employed the IRFRF method to involve learners in science teaching in Tshivenda. Learners were seen participating, although they encountered difficulties with English terminologies during the Tshivenda lesson. However, when using the English scientific language register, learners were not sufficiently engaged, and the questions posed by the teacher did not stimulate critical thinking.

4.9.2. Summary

This chapter elucidated the challenges and opportunities encountered during the development and application of the Tshivenda scientific register, as well as its impact on meaningful learning. It also outlined the findings from each case examined in this study. The next chapter will synthesize these findings and provide recommendations.

CHAPTER 5: SUMMARY OF FINDINGS, CONCLUSION AND RECOMMENDATIONS

5.1. Introduction

In this chapter, I will consolidate the key findings from the study and draw conclusions based on the observations and data collected. Additionally, I will offer recommendations based on these conclusions to inform future practices and research in the field. This chapter serves as a culmination of the study, providing insights into the implications of the research findings and suggesting avenues for further exploration and application.

5.2. Research Question

The objective of this study was to create a Tshivenda scientific language register and implement it in select schools within the Vhembe West district. The study was driven by the following research question:

- How was the development and application of Tshivenda scientific language register for electricity concepts developed?
    - What are the perceptions of the stakeholders in the development of Tshivenda scientific language register for electricity concepts?
    - What are the challenges in the development of Tshivenda scientific language register?
    - What are the opportunities in the development of Tshivenda scientific language register?
    - How does the application of Tshivenda scientific language register shape meaningful learning?

5.3. What are the perceptions of the stakeholders in the development of Tshivenda scientific language register for electricity concepts?

CASE ONE: TSHIFHIWA FROM MURI SECONDARY SCHOOL

Tshifhiwa perceives the use of Tshivenda for teaching physical science as beneficial, noting that learners struggle with understanding assessments in English but grasp the questions when translated into Tshivenda. Tshifhiwa underscores the significance of language in learners' performance, suggesting that while teaching physical sciences in Tshivenda is preferable, direct translation of scientific terms from English to Tshivenda is necessary due to the lengthiness of Tshivenda terminologies. However, learners hold diverse perspectives on this matter. Some believe that learning physical sciences in Tshivenda would enhance their academic performance as they would be using their native language, enabling better comprehension and explanations. Conversely, others express concerns about understanding physical science in Tshivenda due to the complexity of terminologies, as they are accustomed to learning in English. Similarly, parents share the sentiment that adopting Tshivenda for teaching physical science is advantageous, attributing learners' struggles not to lack of knowledge but to the English medium of instruction, suggesting that using Tshivenda would improve understanding of difficult terms.

CASE TWO: ABIGAIL FROM NALEDZI SECONDARY SCHOOL

The study indicates that Abigail holds a favorable perspective regarding the use of Tshivenda for teaching physical sciences. While initially acknowledging potential challenges for learners, she anticipates long-term benefits, especially since students currently struggle to grasp physical science concepts when taught in English. The choice of language for teaching physical sciences significantly influences students' comprehension of scientific concepts. Abigail mentions employing code switching as a strategy to alleviate confusion arising from the English medium of instruction. On the other hand, learners express varied opinions on the use of Tshivenda as the language of instruction. Some believe it will positively impact their academic performance, citing difficulties with English terms during learning and assessments. However, others advocate for continuing education in English, emphasizing the need to prepare for university education where English is predominant. Contrary to learners' perspectives, parents recall past experiences of learning content subjects in their native language and view the proposal favorably. They note the current underperformance of students in physical sciences and commend teachers for implementing a bilingual approach, utilizing both Tshivenda and English to accommodate all learners.

CASE THREE: PETER FROM WISDOM SECONDARY SCHOOL

This study highlights Peter's positive outlook on teaching physical sciences in Tshivenda, stemming from the complexities of explaining scientific concepts in English to learners. Moreover, Peter observes an improvement in learners' engagement with the application of the Tshivenda scientific register. Learners express a belief that studying science in Tshivenda would aid them, particularly those who lack proficiency in English, though some acknowledge unfamiliarity with scientific concepts in Tshivenda. Despite their differing perspectives, they concur that learners struggling with English would benefit from lessons conducted in Tshivenda. Parents share the belief that learning in a language where learners are proficient would enhance their academic performance, considering English's primary role in cross-cultural communication.

5.4. What are the challenges in the development of Tshivenda scientific language register?

This study uncovers the ongoing challenges faced by the Tshivenda language, particularly concerning scientific terminology. The researcher concentrated on crafting a scientific register for the concept of electricity. While many components of electricity are part of daily life, their names are often translated directly from English and Afrikaans. This posed a challenge for the researcher in finding appropriate scientific terms to describe them accurately.

5.5. What are the opportunities in the development of Tshivenda scientific language register?

The researcher utilized a multilingual term list, translating English into Tshivenda, Afrikaans, and Xitsonga, to initiate the development of the scientific language register. Additionally, assistance from colleagues and radio presenters was instrumental in refining the register to a standardized form suitable for educational purposes.

5.6. How does the application of Tshivenda scientific language register shape meaningful learning?

CASE ONE: TSHIFHIWA

In this investigation, stakeholders asserted that the language employed in classroom instruction significantly influences meaningful learning. When the teacher utilized the Tshivenda scientific register, learners actively engaged with the material, leading to a more meaningful lesson. Conversely, when English was the medium of instruction for physical sciences, learners displayed less enthusiasm for learning.

CASE TWO: ABIGAIL

Interviews with stakeholders revealed that learners struggle with learning in English, which isn't their native language. This lack of proficiency leads to lessons lacking meaning for the learners. During the use of the English scientific register, learners faced challenges in communicating with their teacher, which affected their confidence. Conversely, when the Tshivenda scientific register was used, learners participated more actively and could communicate effectively with both peers and the teacher.

CASE THREE: PETER

In this instance, as observed in similar cases, learners demonstrated significantly more engagement when the lesson was conducted in Tshivenda, their most familiar language. Although parents were uncertain about the exact issue, it was evident that during English lessons, learners did not engage to the same extent as they did during Tshivenda lessons.

5.7 CONTRIBUTION TO THE FIELD

The study contributes significantly to the field of education and language development, particularly in multilingual contexts. By creating a scientific language register in Tshivenda, the study contributes to the development of the language, especially in scientific terminology. This is crucial for promoting linguistic diversity and ensuring that learners can access scientific knowledge in their mother tongue. The implementation of the Tshivenda scientific language register provides learners with a more accessible and comprehensible means of learning scientific concepts, particularly in the domain of electricity. This can lead to increased engagement, understanding, and performance in the subject. Teaching science in Tshivenda acknowledges and respects the cultural and linguistic diversity of learners. It promotes inclusivity and ensures that educational practices align with the cultural backgrounds of students, fostering a sense of belonging and identity.

The study sheds light on effective pedagogical approaches for teaching science in multilingual settings. It explores the impact of language on learning outcomes and provides valuable insights into how language registers can shape meaningful learning experiences in the classroom. The findings of the study may inform educational policies and curriculum development initiatives aimed at promoting multilingual education. It underscores the importance of incorporating diverse languages into the educational system to cater to the needs of linguistically diverse learners.

Overall, the study contributes to the broader discourse on language-in-education policies, curriculum development, and pedagogical practices, with implications for improving educational outcomes and promoting linguistic and cultural diversity in educational settings.

5.8. RECOMMENDATIONS ARISING FROM THE STUDY

Based on the findings of the study, the following recommendations are outlined:

Further Development of Tshivenda Scientific Language Register: Continue to expand and refine the Tshivenda scientific language register to include a wider range of scientific terms, particularly in the domain of physical sciences beyond electricity. This will enhance its utility and effectiveness in teaching various scientific concepts.

Professional Development for Teachers: Provide professional development opportunities for teachers to enhance their proficiency in using the Tshivenda scientific language register effectively. Training programs can focus on strategies for integrating the register into lesson planning, instruction, and assessment practices.

Integration into Curriculum and Teaching Materials: Integrate the Tshivenda scientific language register into the curriculum and develop teaching materials and resources that align with its usage. This includes textbooks, worksheets, multimedia resources, and laboratory manuals tailored to support instruction in Tshivenda.

Support for Multilingual Education Policies: Advocate for policies that support multilingual education and recognize the importance of teaching science in learners' mother tongue. Engage with educational stakeholders, policymakers, and community members to promote the use of indigenous languages in education.

Research and Evaluation: Conduct further research to evaluate the effectiveness of using the Tshivenda scientific language register in improving learning outcomes and fostering learner engagement. Monitor and assess the implementation of the register in classrooms to identify areas for improvement and refinement.

Community Engagement: Involve parents, community members, and other stakeholders in the development and implementation of the Tshivenda scientific language register. Foster partnerships between schools, universities, and local communities to ensure the register reflects the linguistic and cultural contexts of learners.

Sustainability: Ensure the sustainability of efforts to develop and implement the Tshivenda scientific language register by securing long-term support and resources. This may involve collaboration with government agencies, educational institutions, and non-profit organizations committed to promoting indigenous languages in education.

By implementing these recommendations, stakeholders can work towards creating an inclusive and culturally responsive learning environment where learners can access quality education in their mother tongue while developing proficiency in scientific concepts and language.

5.9 RECOMMENDATIONS FOR FURTHER RESEARCH

Based on the study, the following recommendations for further research are proposed:

Longitudinal Studies: Conduct longitudinal studies to track the long-term effects of using the Tshivenda scientific language register on learners' academic performance, language proficiency, and attitudes towards science. Follow cohorts of learners over an extended period to assess their progress and retention of scientific knowledge.

Comparative Studies: Compare the effectiveness of teaching electricity using the Tshivenda scientific language register with other language registers, such as English or Afrikaans. Investigate how learners' comprehension, engagement, and achievement differ across different language mediums to identify optimal instructional approaches.

Teacher Training Impact: Explore the impact of teacher training programs focused on the Tshivenda scientific language register on teacher practices, confidence, and attitudes towards teaching science. Assess the effectiveness of professional development initiatives in promoting the integration of indigenous languages in science instruction.

Multimodal Learning: Investigate the use of multimodal learning approaches, such as incorporating visual aids, demonstrations, and hands-on activities, in conjunction with the Tshivenda scientific language register. Examine how multimodal instructional strategies enhance learners' understanding and retention of scientific concepts.

Language Development Initiatives: Explore initiatives aimed at further developing the Tshivenda scientific language register, including the creation of specialized terminology and resources for teaching specific scientific domains beyond electricity. Investigate collaborative efforts involving linguists, educators, and community members to enrich the register.

Parent and Community Involvement: Investigate the role of parents and community members in supporting the implementation of the Tshivenda scientific language register. Explore strategies for engaging families in science education and promoting the use of indigenous languages outside the classroom.

Impact on Indigenous Language Revitalization: Examine the broader implications of incorporating the Tshivenda scientific language register into science education for the revitalization of indigenous languages and cultures. Investigate how promoting linguistic diversity in education contributes to cultural preservation and community empowerment.

Technology Integration: Explore the use of technology, such as digital platforms and mobile applications, to facilitate the integration of the Tshivenda scientific language register in science instruction. Investigate how technology-enhanced learning environments can support learners' access to resources and interactive learning experiences.

By addressing these areas in future research, scholars can deepen our understanding of the role of indigenous languages in science education and contribute to the development of culturally responsive pedagogies that empower learners from diverse linguistic and cultural backgrounds.

5.10 IMPLICATIONS FOR CURRICULUM REFORMS

By developing a scientific language register in Tshivenda, the study contributes to promoting linguistic diversity and inclusivity in science education. It enables learners who are proficient in Tshivenda to access scientific knowledge and engage effectively in learning processes. The use of the Tshivenda scientific language register has the potential to improve learners' academic performance in physical sciences, particularly in the domain of electricity. By providing instruction in a language familiar to learners, the register facilitates comprehension and conceptual understanding, leading to enhanced learning outcomes.

Incorporating indigenous languages like Tshivenda in science instruction validates learners' cultural identities and affirms the importance of linguistic diversity. It fosters a sense of pride and belonging among learners, especially those from Tshivenda-speaking communities, by recognizing and valuing their language and cultural heritage. The study highlights the importance of teacher training and professional development in effectively implementing the Tshivenda scientific language register. Educators need support and resources to develop proficiency in using the register and integrating it into their instructional practices to maximize its benefits for learners.

The findings of the study have implications for educational policies and curriculum development initiatives aimed at promoting multilingualism and indigenous language preservation in education. It underscores the need for policy frameworks that support the integration of indigenous languages into science education and provide resources for the development of language registers and instructional materials. The study emphasizes the importance of collaboration with community members, including parents and local stakeholders, in supporting the implementation of the Tshivenda scientific language register. Engaging communities in the development and implementation of language-based educational initiatives fosters a sense of ownership and sustainability. The study opens avenues for further research into the effectiveness of the Tshivenda scientific language register across different scientific domains, grade levels, and contexts. Future studies can explore its impact on learners' language proficiency, academic achievement, and attitudes towards science, as well as investigate strategies for its refinement and expansion.

Overall, the study underscores the potential of the Tshivenda scientific language register to facilitate meaningful learning experiences in physical sciences and advocates for its integration into science education practices to promote educational equity and linguistic empowerment.

5.11 LIMITATIONS OF THE STUDY

The study concentrated on three specific schools within the Vhembe West district, with one teacher, parents, and a single class of learners chosen from each school. While the study's focus on these specific schools limits its generalizability, the participants selected were considered to possess valuable insights and met the criteria outlined in the study design. Consequently, although the findings may not be universally applicable, there is potential for their relevance to extend to other educational settings.

5.12 CONCLUSION

The study sheds light on the significance of language in science education, particularly in the context of teaching electricity in Tshivenda. Through the development and application of a Tshivenda scientific language register, the study aimed to enhance meaningful learning experiences for learners. The findings of the study highlight several important aspects. Firstly, stakeholders, including teachers, learners, and parents, expressed positive perceptions towards the use of Tshivenda as a medium of instruction for teaching physical sciences. They emphasized the importance of using a language that learners are comfortable with to facilitate better understanding and engagement in the subject matter.

Additionally, the study revealed that the application of the Tshivenda scientific language register resulted in increased learner participation and interaction in the classroom compared to when English was used. Learners demonstrated greater confidence and enthusiasm when learning in their mother tongue, leading to more meaningful learning experiences. However, challenges were also identified, particularly regarding the development of Tshivenda scientific terminology. While efforts were made to create a multilingual term list and consult with various stakeholders, the lack of standardized scientific terminology in Tshivenda posed obstacles to effective communication and instruction.

Considering these findings, several recommendations can be made. Firstly, there is a need for further research and collaboration to develop a comprehensive Tshivenda scientific language register with standardized terminology. This would require input from linguists, educators, and other relevant stakeholders to ensure accuracy and consistency. Secondly, teacher training and professional development programs should be implemented to support educators in effectively utilizing the Tshivenda scientific language register in their teaching practices. This would include strategies for integrating the register into lesson plans and addressing any challenges or concerns that may arise.

Overall, the study underscores the importance of language in science education and the potential benefits of incorporating learners' mother tongue into the instructional process. By addressing the challenges and leveraging the strengths of the Tshivenda language, educators can create more inclusive and effective learning environments for all learners.

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APPENDICES

APPENDIX A: Proof of registration

UNISA university of south africa

1256

MADAVHA M K MR
P O BOX 1263
FONDWE
0969

STUDENT NUMBER : 64050963

ENQUIRIES TEL : 0861670411
FAX : (012)429-4150
eMAIL : mandd@unisa.ac.za

2023-04-26

Dear Student

I hereby confirm that you have been registered for the current academic year as follows:

Proposed Qualification: MED NATURAL SC EDU (90063)

CODE	PAPER	S	NAME OF STUDY UNIT	NQF crdts	LANG.	PROVISIONAL EXAM.DATE	EXAMINATION CENTRE(PLACE)
Study units registered without formal exams:							
DFNSE96			MEd - Natural Science Education (Dissertation)	**	E		

You are referred to the "MyRegistration" brochure regarding fees that are forfeited on cancellation of any study units.

\# Your attention is drawn to University rules and regulations (www.unisa.ac.za/register).
Please note the new requirements for reregistration and the number of credits per year which state that students registered for the first time from 2013, must complete 36 NQF credits in the first year of study, and thereafter must complete 48 NQF credits per year.
Students registered for the MBA, MBL and DBL degrees must visit the SBL's ESOnLine for study material and other important information.
Readmission rules for Honours: Note that in terms of the Unisa Admission Policy academic activity must be demonstrated to the satisfaction of the University during each year of study. If you fail to meet this requirement in the first year of study, you will be admitted to another year of study. After a second year of not demonstrating academic activity to the satisfaction of the University, you will not be re-admitted, except with the express approval of the Executive Dean of the College in which you are registered. Note too, that this study programme must be completed within three years. Non-compliance will result in your academic exclusion, and you will therefore not be allowed to re-register for a qualification at the same level on the National Qualifications Framework in the same College for a period of five years after such exclusion, after which you will have to re-apply for admission to any such qualification.
Readmission rules for M&D: Note that in terms of the Unisa Admission Policy, a candidate must complete a Master's qualification within three years. Under exceptional circumstances and on recommendation of the Executive Dean, a candidate may be allowed an extra (fourth) year to complete the qualification. For a Doctoral degree, a candidate must complete the study programme within six years. Under exceptional circumstances, and on recommendation by the Executive Dean, a candidate may be allowed an extra (seventh) year to complete the qualification.

\# Your study material is available on www.my.unisa.ac.za, as no printed matter will be made available for the research proposal module.
Study material can be accessed on the Unisa website. You must register on MyUnisa (https://my.unisa.ac.za/portal/) for this purpose. You are also reminded to activate your myLife email address since all electronic correspondence will be sent to this email address.

BALANCE ON STUDY ACCOUNT: 11740.00

Payable on or before:

Immediately:11740.00	2023/03/31:	0.00	2023/05/15:	0.00	2023/08/15:	0.00
	2023/11/15:	0.00	2024/03/15:	0.00		

Yours faithfully,

UNIVERSITEIT VAN SUID-AFRIKA
PRETORIA
UNIVERSITY OF SOUTH AFRICA

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Registrar

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APPENDIX B: INTERVIEW PROTOCOL (TEACHERS)

Section A. (Biographical information)

1. What is your home language?

2. How long have you been teaching grade 10 Physical Sciences?

3. What are the teaching qualifications you hold?

4. What are your major subjects?

Section B

Part A (Challenges and Opportunities)

1. Do you experience any challenges using English to teach Physical Sciences? If yes, kindly elaborate.

2. Are your learners experiencing problems when taught in English?

3. If yes, what kind of problems? Kindly elaborate.

4. What programmes do you have in place to assist those learners with difficulties in learning with English medium?

5. What is the Language spoken outside the classroom by your learners?

6. What is the language spoken by you and your learners inside the classroom?

7. Do you apply code-switching in your classroom? If yes, why?

8. What language do you normally code switch to and why?

9. What are the challenges you experienced in using the scientific language register?

10. And what are the opportunities did you identify in using the scientific language register?

11. How was your experience in using the scientific language register? And Why?

Part B (Perceptions)

1. What is your perception on the use of TshiVenda to teach Physical Sciences?

2. Why is your perception like that?

3. How is the general performance of Physical Sciences in your school? (Good or Bad)

4. Do you think the language used to teach Physical Sciences has an impact to that performance? And Why?

5. What language do you prefer to use when teaching Physical Sciences? And why?

6. What language do you think your learners would prefer to learn Physical Sciences? And why?

Part C (Interaction and discourses)

1. Does language influence learner's interactions and discourses in the classroom? If yes please elaborate?

APPENDIX C: INTERVIEW PROTOCOL (LEARNERS)

Semi-structured interview questions for learners

Section B

Part A (Challenges and Opportunities)

1. Do you experience any challenges in learning Physical Sciences in English? If yes, elaborate those challenges.

2. What language would you prefer to learn Physical Sciences? And why?

3. What is the language do you speak inside the classroom? And why?

4. What language do you speak outside the classroom? And why?

5. What are the challenges you experienced when learning Physical Sciences in TshiVenda?

6. What are the opportunities identified in learning Physical sciences in TshiVenda?

Part B (Perceptions)

1. What is your perception on the use of TshiVenda to teach Physical Sciences?

2. Why is your perception like that?

3. How is the general performance of Physical Sciences in your school? (Good or Bad)

4. Do you think the language used to teach Physical Sciences has an impact to the performance? If yes, Why?

Part C (Interaction and discourses)

1. Does a language influence your participation in the classroom?

2. If yes why/how, please elaborate

APPENDIX D: INTERVIEW PROTOCOL (PARENTS)

Semi-structured interview questions for SGB (parents)

Section B

Part B (Perceptions)

1. What is your perception on the use of Tshivenda to teach Physical Sciences?

2. Why is your perception like that?

3. How is the general performance of Physical Sciences in the school where your child attend?

4. Do you think the language used to teach Physical Sciences has an impact on the performance? And Why?

5. What language do you prefer your child to use to learn Physical Sciences? And why?

Part C (Interaction and discourses)

1. Do you think the language used to teach Physical Sciences influences learners' interactions and discourses in the classroom? If yes, how? Please elaborate

APPENDIX E: OBSERVATIONAL TOOL (TEACHERS)

THE TEACHER OBSERVATIONAL TOOL

Lesson observation schedule for Physical Science teachers on the use of scientific language register.

School:____

Date:____

Grade:____

Number of learners in physical sciences classroom:

Boys: ___________ Girls: ____________Total:________________________

Teacher:____

Researcher:____

Role of Researcher:____

Time of observation: ____

Length of observation: ____

A. Challenges and opportunities

1. Did the teacher had any challenge in using the scientific language register

____
____
____
____
____
____
____

2. Did the teacher used TshiVenda through-out the lesson

____

____

____

3. Lesson properly planed and presented

____

____

4. Teachers understanding of concepts and presentation

____

____

____

B. Interaction and discourses

a) Learners'
participation____

____

b) Learners interactions and discourses

APPENDIX F: PERMISSION LETTER TO THE DISTRICT MANAGER
LETTER TO THE DISTRICT MANAGER

College of education

Department of science and technology education

Request for permission to conduct research at schools

Title: "Developing grade 10 physical sciences scientific language register for teaching electricity"

13 October 2023

The District Manager

Vhembe West District Department of Education

Dear Sir/ Madam

I, Madavha Mpho Kenneth, am doing research under the supervision of Dr T.G Ntuli and Prof A.V Mudau, lecturers in the Department of Science and Technology Education. I am working towards my master's degree in education with specialisation in Natural Sciences at the University of South Africa. There is no funding involved in this study. I am requesting a written permission to use the schools that will be interested to participate in the study entitled: "Developing grade 10 physical sciences scientific language register for teaching electricity".

The aim of the study is to develop the scientific language register for Physical Sciences in TshiVenda and its application in some classes in the Nzhelele East circuit. The study will also explore perceptions, challenges, and opportunities of developing this register and how it shapes the interactions and discourses in the classroom. Your department has been selected because the main objective of the study is to explore perceptions, challenges, and opportunities of developing this register and how it shapes the interactions and discourses in the classroom this objective can only be realised within your department. The study will request consent from Physical Sciences teachers, learners and parents of the Nzhelele East circuit to participate in this study, prior to interviews and observations, participants permission will be requested, a recording device will be used. Up on the granted permission from the participants to take part in the study, I will then work with them through-out the research process. In this study three schools will be selected to participate, one teacher from each school will be observed and interviewed, one class from each selected school will be interviewed and 5 parents from each selected school will be interviewed.

The benefits of this study will be for all schools situated in Nzhelele East circuit even the neighbouring ones. There are no known risks associated with this study. Confidentiality will be maintained by not disclosing the names of schools and participants. The data that will be collected from the participants will be kept confidential and will be strictly used for research purpose. Participants will not be reimbursed or receive any incentives for participating in this study. Up on request participants will receive the summary of the research findings.

For more information regarding the study, please contact me on: 072 796 8637 or email: madavhakenneth44@gmail.com and my supervisors Dr T.G. Ntuli can be reached at: 012 429 6353 or email: entulit@unisa.ac.za

Yours sincerely

Madavha M.k (Researcher)

APPENDIX G: PERMISSION LETTER TO THE CIRCUIT MANAGER
LETTER TO THE CIRCUIT MANAGER

university of south africa
UNISA

College of education

Department of science and technology education

Request for permission to conduct research at schools

Title: "Developing grade 10 physical sciences scientific language register for teaching electricity"

13 October 2023

The Circuit Manager

Vhembe West District Department of Education

Dear Sir/ Madam

I, Madavha Mpho Kenneth, am doing research under the supervision of Dr T.G Ntuli and Prof A.V Mudau, lecturers in the Department of Science and Technology Education. I am working towards my master's degree in education with specialisation in Natural Sciences at the University of South Africa. There is no funding involved in this study. I am requesting a written permission to use the schools that will be interested to participate in the study entitled: "Developing grade 10 physical sciences scientific language register in Tshivenda for teaching electricity".

The aim of the study is to develop the scientific language register for Physical Sciences in TshiVenda and its application in some classes in the Nzhelele East circuit. The study will also explore perceptions, challenges, and opportunities of developing this register and how it shapes the interactions and discourses in the classroom. Your department has been selected because the main objective of the study is to explore perceptions, challenges, and opportunities of developing this register and how it shapes the interactions and discourses in the classroom this objective can only be realised within your department. The study will request consent from Physical Sciences teachers, learners, and parents of the Nzhelele East circuit to participate in this study, prior to interviews and observations, participants permission will be requested, a recording device will be used. Up on the granted permission from the participants to take park in the study, I will then work with them through-out the research process. In this study three schools will be selected to participate, one teacher from each school will be observed and interviewed, one class from each selected school will be interviewed and 5 parents from each selected school will be interviewed.

The benefits of this study will be for all schools situated in Nzhelele East circuit even the neighbouring ones. There are no known risks associated with this study. Confidentiality will be maintained by not disclosing the names of schools and participants. The data that will be collected from the participants will be kept confidential and will be strictly used for research purpose. Participants will not be reimbursed or receive any incentives for participating in this study. Up on request participants will receive the summary of the research findings.

For more information regarding the study, please contact me on 072 796 8637 or email: madavhakenneth44@gmail.com and my supervisor Dr T.G. Ntuli can be reached at: 012 429 6353 or email: entulit@unisa.ac.za

Yours sincerely

Madavha M.K (Researcher)

APPENDIX H: PERMISSION LETTER TO THE PRINCIPALS
LETTER TO THE PRINCIPALS

College of education

Department of science and technology education

Request for permission to conduct research at schools

Title: “Developing grade 10 physical sciences scientific language register for teaching electricity”

13 October 2023

The principal

Vhembe West District Department of Education

Dear Sir/ Madam

I, Madavha Mpho Kenneth, am doing research under the supervision of Dr T.G Ntuli and Prof A.V Mudau, a lecturer in the Department of Science and Technology Education. I am working towards my master’s degree in education with specialisation in Natural Sciences at the University of South Africa. There is no funding involved in this study. I am requesting a written permission to use the schools that will be interested to participate in the study entitled: “Developing grade 10 physical sciences scientific language register for teaching electricity”.

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The benefits of this study will be for all schools situated in Nzhelele East circuit even the neighbouring ones. There are no known risks associated with this study. Confidentiality will be maintained by not disclosing the names of schools and participants. The data that will be collected from the participants will be kept confidential and will be strictly used for research purpose. Participants will not be reimbursed or receive any incentives for participating in this study. Up on request participants will receive the summary of the research findings.

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Yours sincerely

Madavha M.K (Researcher)

APPENDIX I: LETTER TO PHYSICAL SCIENCES TEACHER
LETTER TO PHYSICAL SCIENCES TEACHER

College of education

Department of science and technology education

Title: "Developing grade 10 physical sciences scientific language register for teaching electricity"

DEAR PROSPECTIVE PARTICIPANT

I, Madavha Mpho Kenneth, am doing research under the supervision of Dr T.G Ntuli and Prof A.V Mudau, lecturers in the Department of Science and Technology Education. I am working towards my master's degree in education with specialisation in Natural Sciences at the University of South Africa. There is no funding involved in this study. I am inviting you to participate in the study entitled: "Developing grade 10 physical sciences scientific language register for teaching electricity". The main objective of this study is to explore perceptions, challenges, and opportunities of developing this register and how it shapes the interactions and discourses in the classroom. You are requested to participate in this study because you are a suitable candidate as you are teaching Physical Sciences in one of the schools situated in Nzhelele East circuit where the study will be undertaken. I do not have your details.

I hereby request your permission to observe you while teaching Physical Sciences using the TshiVenda scientific language register in your classroom and use of audio recording during interviews. The time allocation for every interview will be 40 minutes maximum and research will be conducted for a period of one month.

Participating in this study is voluntary and you are under no obligation to consent to participation. If you 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. In this study there are no potential benefits for taking part. There are no negative consequences for any participant if they participate in this study. The information that you provide will not be disclosed to your colleagues or seniors your identity will be kept confidential. Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard/filling cabinet at the researcher's workplace 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 proposal. The researcher will destroy the information two years after the completion of study by shredding the hard copies and by permanently deleting the soft copies using software applications. In this study there will be no incentives and no receipt of payment for participation. Up on request participants will be provided with the summary of the research findings.

For more information regarding the study, please contact me on 072 796 8637 or email: madavhakenneth44@gmail.com and my supervisor Dr T.G. Ntuli can be reached at: 012 429 6353 or email: entulit@unisa.ac.za

Thank you for taking the time reading this information sheet.

Kind regards

____

Mpho Kenneth Madavha

APPENDIX J: LETTER TO PARENTS
LETTER TO PARENTS

College of education

Department of science and technology education

Title: "Developing grade 10 physical sciences scientific language register for teaching electricity"

DEAR PROSPECTIVE PARTICIPANT

I, Mpho kenneth Madavha, am doing research under the supervision of Dr T.G Ntuli and Prof A.V Mudau, lecturers in the Department of Science and Technology Education. I am working towards my master's degree in education with specialisation in Natural Sciences at the University of South Africa. There is no funding involved in this study. I am inviting you to participate in the study entitled: "Developing grade 10 physical sciences scientific language register for teaching electricity". The main objective of this study is to explore perceptions, challenges and opportunities of developing this register and how it shapes the interactions and discourses in the classroom. You are requested to participate in this study because you are a suitable candidate as your child is doing grade 10 in one of the selected schools in Nzhelele East circuit where the study will be undertaken. I do not have your details.

I hereby request your permission to interview you. The time allocation for every interview will be 40 minutes maximum and research will be conducted for a period of one month.

Participating in this study is voluntary and you are under no obligation to consent to participation. If you 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. In this study there are no potential benefits for taking part. There are no negative consequences for any participant if they participate in this study.

The information that you provide will not be disclosed to your colleagues or seniors your identity will be kept confidential. Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard/filling cabinet at the researcher's workplace 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 proposal. The researcher will destroy the information two years after the completion of study by shredding the hard copies and by permanently deleting the soft copies using software applications. In this study there will be no incentives and no receipt of payment for participation. Up on request participants will be provided with the summary of the research findings.

For more information regarding the study, please contact me on 064 845 2498 or email: madavhakenneth44 @gmail.com and my supervisor Dr T.G. Ntuli can be reached at: 012 429 6353 or email: entulit@unisa.ac.za

Thank you for taking the time reading this information sheet.

Kind regards

____

Mpho Kenneth Madavha

APPENDIX K: LETTER TO LEARNERS' PARENTS
LETTER TO LEARNERS' PARENTS

College of education

Department of science and technology education

Title: "Developing grade 10 physical sciences scientific language register for teaching electricity"

DEAR PROSPECTIVE PARTICIPANT

I, Madavha Mpho Kenneth, am doing research under the supervision of Dr T.G Ntuli and Prof A.V Mudau, lecturers in the Department of Science and Technology Education. I am working towards my master's degree in education with specialisation in Natural Sciences at the University of South Africa. There is no funding involved in this study. I am inviting you to participate in the study entitled: "Developing grade 10 physical sciences scientific language register for teaching electricity". The main objective of this study is to explore perceptions, challenges, and opportunities of developing this register and how it shapes the interactions and discourses in the classroom. I hereby request your child to participate in the study as she/he is a suitable candidate since she/he is doing grade 10 Physical Science in the selected schools around Nzhelele East circuit where the study will take place. I do not have your details. I hereby request your permission to interview your child. The time allocation for every interview will be 40 minutes maximum and research will be conducted for a period of one month.

Participating in this study is voluntary and you are under no obligation to consent to participation. If you 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. In this study there are no potential benefits for taking part. There are no negative consequences for any participant if they participate in this study. The information that you provide will not be disclosed to your colleagues or seniors your identity will be kept confidential. Hard copies of your answers will be stored by the researcher for a period of five years in a locked cupboard/filling cabinet at the researcher's workplace 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 proposal. The researcher will destroy the information two years after the completion of study by shredding the hard copies and by permanently deleting the soft copies using software applications. In this study there will be no incentives and no receipt of payment for participation. Up on request participants will be provided with the summary of the research findings.

For more information regarding the study, please contact me on 072 796 8637 or email: madavhakenneth44@gmail.com and my supervisor Dr T.G. Ntuli can be reached at: 012 429 6353 or email: entulit@unisa.ac.za

Thank you for taking the time reading this information sheet.

Kind regards

.____________________

Madavha Mpho Kenneth

APPENDIX L: CONSENT FORM FOR TEACHERS
CONSENT FORM FOR PHYSICAL SCIENCES TEACHERS

I,____(participant name), confirm that the researcher asking for my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconveniences of participation.

I have read and (or had explained to me) and understand the study as explained in the information sheet.

I have had sufficient opportunities 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.

I am aware that the findings of this study will be processed into research report, journal publications and/or conference proceedings, butt that my participation will be kept confidential unless otherwise specified.

I agree to be recorded in the interviews and observations.

____

I have received a signed copy of the informed consent agreement.

Participant Name & Surname (please print)

____

APPENDIX M: CONSENT FORM FOR PARENTS (SGB)
CONSENT FORM FOR PARENTS (SGB)

I, ____

(participant name), confirm that the researcher asking for my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconveniences of participation.

I have read and (or had explained to me) and understand the study as explained in the information sheet.

I have had sufficient opportunities 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.

I am aware that the findings of this study will be processed into research report, journal publications and/or conference proceedings, butt that my participation will be kept confidential unless otherwise specified.

I agree to be recorded in the interviews.

____

I have received a signed copy of the informed consent agreement.

Participant Name & Surname (please print)

____

APPENDIX N: CONSENT FORM FOR LEARNERS (PARENTS)
CONSENT FORM FOR LEARNERS (PARENTS)

I, ____

(participant name), confirm that the researcher asking for my consent to take part in this research has told me about the nature, procedure, potential benefits and anticipated inconveniences of participation.

I have read and (or had explained to me) and understand the study as explained in the information sheet.

I have had sufficient opportunities 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.

I am aware that the findings of this study will be processed into research report, journal publications and/or conference proceedings, butt that my participation will be kept confidential unless otherwise specified.

I agree that my child be recorded in the interviews.

____

I have received a signed copy of the informed consent agreement.

Participant Name & Surname (please print)

____

APPENDIX O: Tshivenḓa physical sciences scientific language register

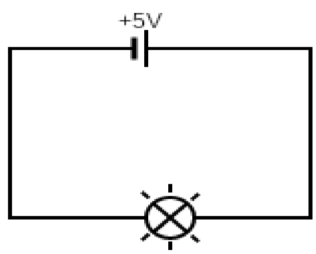
TSHIVENDA PHYSICAL SCIENCES REGISTER

Muḓagasi

Ḽiisela la muḓagasi

Ḽiisela la muḓagasi ndi mini?

Ndi nḓila ine mulilo wa muḓagasi kana lutsinga lwa mulilo lwa isa phanḓa u sudzuluwa lwa mona lwa do vha hafhu wa vhuya afho he wa bva u hone.

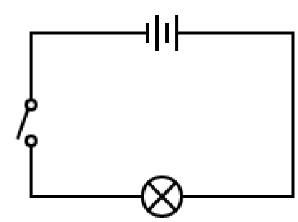


Zwiimo zwi tevhelaho ndi zwa ndeme uri lutsinga lwa mulilo lu kone u elela

- Tshiko tsha fulufulu
- Tshifhirisa fulufulu kha ḽiisela
- Ḽiisela ḽo valiwaho

Tshifanyiso 1. Tsumbo ya ḽiisela yo leluwaho

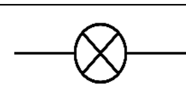
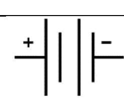
Arali ḽiisela ḽo vulea, lutsinga lwa mulilo a lu nga koni u elela, izwi zwi ḓivhiwa sa ḽiisela ḽo vuleaho.

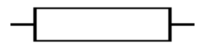
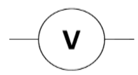
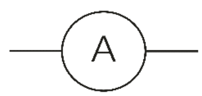


Tshifanyiso 2. ḽiisela ḽo vuleaho

Kha murole wa vhu ṱahe no guda nga ha zwivhumbi zwa ḽiisela na tswayo dzadzo

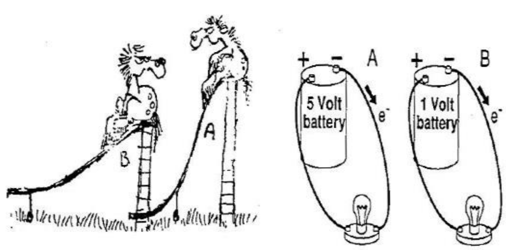
Zwivhumbi zwa ḽiisela la muḓagasi

Zwivhumbi	Tswayo	Mushumo
Ḽivhone		Li a penya musi mulilo u tshi fhira khalo
Tshiko tsha fulufulu		Tshi fha Maanḓa mulilo uri u kone u sudzuluwa

Tshilanga mulilo wa mudagasi		Tshi tendela mulilo uri ufhire kana u songo fhira kha ḽiisela
Tshifhungadza-nyelelo ya mulilo		tshi thivhela u elela ha mulilo
Tshikala Maanḓa nyelelo a mulilo		Tshi shumiswa u kala Maanḓa nyelelo a mulilo
Tshikala Lutsinga lwa mulilo		tshi kala lutsinga lwa mulilo wa muḓagasi kha liisela
Tshifhirisa fulufulu		tshi ṱanganya zwivhumbi zwoṱhe zwire kha liisela

Maanḓa nyelelo a mulilo

Maanḓa nyelelo a mulilo a ri sumbedza phambano ya fulufulu ḽo imaho vhukati ha khuḓa mbili. Mulilo u sudzuluwa u va kha hure na maanḓa nyelelo a mulilo manzhi uya kha hune havha na maanḓa nyelelo a mulilo maṱuku.



Tshifanyiso 3.

Tsumbo 1.

a. Afho kha tshifanyiso 3 huna zwi fanwiso zwivhili, tshifanyiso tsha u thoma bere mbili dzo ima kha Vhulapfu vhu sa ḽḓani. Ndi Ifhio bere ine ya do tavhanya u swika fhasi?

b. Kha tshifanyiso tsha vhuvhili, ndi ḽifhio liisela line phungudza mulilo wa zwilavhi zwa do tavhanya u sudzuluwa?

Thandululo

a. Bere A, ngauri I kha vhulapfu vhu hulwane ubva fhasi zwi do ita uri I sudzuluwe nga u tavhanya

b. liisela A, ngauri maanḓa nyelelo a mulilo ubva kha tshiko tsha fulufulu ndi manzhi ezwo zwi ita uri phungudza mulilo wa zwilavhi dzi sudzuluwe nga u ṱavhanya.

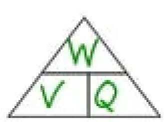
Ndi mini tshine tsha khou ita uri mulilo u sudzuluwe?

Zwine ra tea u ḓivha zwone ndi hezwi, huna maanḓa ane a kharamedza phungudza mulilo wa zwilavhi uri zwi mone na liisela, ayo maanḓa a vha a khou bva kha tshiko tsha fulufulu. Tshiko tsha fulufulu tshi shandukisa fulufulu la khemikhala yo vhulungiwaho kha yo uya kha fulufulu la muḓagasi. E lo fulufulu la muḓagasi li a kona u ita uri mulilo (phungudza mulilo wa zwilavhi) u sudzuluwe u mona na liisela. Oyo mulilo u khou sudzuluwaho, u na tshifhungudza-nyelelo tshine tshi u Shandukisa uya kha fulufulu la mufhiso, fulufulu la tshedza kana fulufulu ḽinwe na ḽinwe line ra nga li shumisa kha zwi shumiswa zwa nḓuni. Sa tsumbo, tshiṱofu tshi shumisa fulufulu la mufhiso, ḽivhone lone li shumisa fulufulu la tshedza. Ezwi zwi ri thusa hafhu u talukanya mulayo wa u vhulunga fulufulu une wari: Fulufulu a li sikiwi kana u kwashiwa, fhedzi ḽi to kona u bva kha tshinwe tshi vhumbeo uya kha tshinwe.

Maanḓa nyelelo a mulilo

Ṱhalutshedzo: Maanḓa nyelelo a mulilo vhukati ha fhethu hu vhili kha ḽiisela ndi mushumo wo itwaho u sudzulusa mulilo u bva kha vhunwe vhuimo uya kha vhunwe.

$V = \frac{W}{Q}$



Hune V – maanḓa nyelelo a mulilo a kaliwa nga khala mulilo (V)

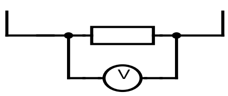
W- fulufulu lo sudzuluswaho li kaliwa nga dzi joules (J)

Q – mulilo u kaliwa nga dzi coulombs (C)

Tshikala Maanḓa nyelelo a mulilo

Tshikala Maanḓa nyelelo a mulilo ndi tshi shumiswa tshine tshi shuma u kala maanḓa nyelelo a mulilo vhukati ha fhethu hu vhili kha liisela ḽa muḓagasi. Tshifanyiso 4 tshi ri sumbedza uri lurumbu lwa u dzhenisa mulilo kha tshikala maanda nyelelo a mulilo (tswuku) lwu tuṅwa kha sia li re tsinisa na lurumbu lwa u bvisa mulilo kha tshiko tsha fulufulu, ngeno lurumbu lwa u bvisa mulilo kha tshikala maanda nyelelo a mulilo (ntswu) lu tuṅwa kha sia li re tsinisa na lurumbu lwa u vhuisa mulilo kha tshiko tsha fulufulu. tshikala maanda nyelelo a mulilo tshi dzulela u ṱumiwa tsho vhambelana na zwinwe zwi vhumbeo nga uri ina phungudza-nyelelo ya mulilo nnzhi zwine zwi ita uri lutsinga lwa mulilo lu sa kone u fhira (tshifanyiso 5).

Tshifanyiso 4. tshikala maanda nyelelo a mulilo

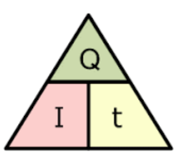


tshifanyiso 5. Ṱhumanyo ya tshikala maanda nyelelo a mulilo kha ḽiisela

Lutsinga lwa mulilo wa muḓagasi

Ṱhalutshedzo: tshifhinga tsha u elela ha mulilo.

I= $\frac{Q}{\Delta t}$



Hune **I**- lutsinga lwa mulilo lwu kaliwa nga dzi Ampere (A)

Q – mulilo u kaliwa nga coulomb (c)

Δt- u Shanduka ha tshifhinga, hune hu kaliwanga dzi sekende (s) hezwi zwi amba uri coulomb nthihi I talutshedzwa sa mulilo wo rumelwaho kha tshifhirisa fulufulu nga sekende nthihi arali lutsinga lwa mulilo lu ampere nthihi (Q=IΔt).

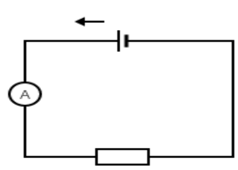
Uri lutsinga lwa mulilo lu kone u tshimbila, liisela li tea u vha lo fhelelaho na hone ḽi tea u wana nḓila ine ḽa do tshimbila ngayo. Lutsinga lwa mulilo hafhu lu ṱoḓa u kharamedzwa uri lu kone u sudzuluwa, oho u kharamedzwa hu bva kha tshiko tsha fulufulu. Lutsinga lwa mulilo lu fhambana na maanḓa nyelelo a mulilo nga uri ari koni u amba uri lutsinga lwa mulilo lwo shumiswa lwo fhelela, sa izwi lu sa kaliwi sa mulilo une u a fhelela, lwone lwu ri sumbedza uri mulilo u khou ongolowa kana u tavhanya naa u mona na liisela.

Tshikala lutsinga lwa mulilo

tshifanyiso 6. Tshikala Lutsinga lwa mulilo

Ndi tshi shumiswa tsho no shuma u kala nyelelo ya Lutsinga lwa mulilo kha liisela. tshifanyiso 6 tshi ri sumbedza uri lurumbu lwo no bvisa mulilo (ntswu) kha Tshikala lutsinga lwa mulilo lwu tuṅwa kha sia la lurumbu lwa u vhuisa mulilo kha tshiko tsha fulufulu ngeno lurumbu lwa u dzhenisa mulilo kha Tshikala lutsinga lwa mulilo (tswuku) lu

t



tshifanyiso 7. Kuṱumele kwa tshikala Lutsinga lwa mulilo kha ḽiisela

kha sia la lurumbu lwa u bvisa mulilo kha tshiko tsha fulufulu. Tshikala lutsinga lwa mulilo lu tuṅwa nga u tevhelelana na zwinwe zwivhumbeo kha ḽiisela ngauri tshina phungudza-nyelelo ṱhukhu, ezwo zwi kona u ita uri lutsinga lwa mulilo lwothe lukone u fhira kha Tshikala lutsinga lwa mulilo hu sina u konḓeliwa (tshifanyiso 7).

Dzhielani nzhele zwi tevhelaho: lutsinga lwa mulilo lu a fana hoṱhe hoṱhe kha liisela musi zwivhumbeo zwo tevhelelana ezwi zwi khou itwa nga uri lutsinga lwa mulilo a lu fhandekani sa izwi nḓila I nthihi ine lwa khou tshimbila khayo (tshifanyiso 7).

Tsumbo

mulilo ure na tshivhalo tsho no eḓana na 45 C wo sudzuluwa u fhira fhethu hu re kha ḽiisela nga sekende nthihi. Lutsinga lwa mulilo lu re kha ḽiisela ndi vhu gai?

Thandululo

Zwe ra ṋewa Q= 45C

Δt= 1s

I =?

U bva kha zwe ra ṋewa

$$I = \frac{Q}{\Delta t}$$

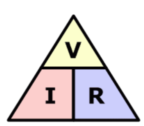
$$= \frac{45}{1}$$

= 45 A

Phungudza nyelelo ya mulilo

Phungudza nyelelo ya mulilo ndi khanedzo ya u elela ha dzi mulilo.

$R = \frac{V}{I}$



Hune R- phungudza nyelelo ine I kaliwa nga dzi ohms Ω

V- maanḓa nyelelo a mulilo a kaliwa nga khala-mulilo (V)

I- Lutsinga lwa mulilo lu kalwa nga ampere (A)

Figara 8. Tsumbo ya tshifhungudza-nyelelo

Zwinwe zwa zwi shumiswa zwa u tshimbidza muḓagasi kana mulilo ndi zwi tevhelaho, siḽiva, koporo, musuku, fhedzi tshi shumiswa tsho dowelwaho ndi koporo, sa izwi I sa ḓuri u fana na ezwo zwiṅwe. Na ho ezwi zwi shumiswa zwi tshi tshimbidza muḓagasi, zwi ḓivha na phungudza nyelelo ya mulilo. Arali tshifhungudza-nyelelo ya mulilo tsha vha na phungudza nyelelo ya mulilo nnzhi zwi fha vhukonḓi mulilo uri u elele. Ezwi zwi itiswa ngauri dzi phungudza mulilo wa zwilavhi zwi khou sudzuluwaho kha tshifhirisa fulufulu zwi khou kuḓana na zwilavhi zwo shumiswaho u ita tshifhirisa fulufulu ezwo zwi sudzulusa fulufulu li no sudzuluwa. Ezwo zwi ita uri fulufulu li khou sudzuluwaho li fhelelwe nga maanḓa, zwa ita uri huvhe na u fungudzea ha mulilo u khou fhiraho.

Figara 9. lurale lwa ḽivhone

Zwi fhirisa fulufulu zwoṱhe zwina phungudza-nyelelo. Ḽivhone na ḽo ḽiwela kha tshifhungudza-nyelelo sa izwi lo itiwa nga lurale lusekene lwo monwaho nga ngilasi. Sa izwi lurale ulwo lwo itaho ḽivhone lwo sekena, zwi ita uri phungudza mulilo wa zwilavhi dzi konḓelwe u fhira, zwine zwi fhedza zwi khou ita uri hu vhe na tsudzuluwo ya fulufulu li no sudzuluwa ḽi kha tshivhumbeo tsha mufhiso. Fulufulu eḽi ḽi vha lo linganela u ita uri lurale u lwo lu duge ri wane tshedza.

Phungudza-nyelelo I ri thusa zwinzhi kha zwi shumisa zwa nḓuni, I ita uri lutsinga lwa mulilo lune lwa vha lu kho uda kha tshiṱofu na geḓela lwu shanduke lwuvhe fulufulu la mufhiso, line ri bika ngalo zwiḽiwa ra dovha ra vhilisa maḓi.

zwivhangi zwa u kwama phungudza-nyelelo

Lushaka lwa zwishumiswa- zwi shumiswa u ya nga u fhambana zwi na phungudza nyelelo isa fani

Vhudenya ha tshifhirisa fulufulu- tshifhirisa fulufulu tsha vhesa tshi denya, phungudza-nyelelo I vha thukhu

Vhulapfu ha tshifhirisa fulufulu- tshifhirisa fulufulu tsha lapfesa phungudza-nyelelo I a engedzea

Thempharetsha ya tshifhirisa fulufulu – tshifhirisa fulufulu tsha fhisesa phungudza-nyelelo I a engedzea

Nḓowedzo

1.1. Ṱalutshedzani zwi tevhelaho

1.1.1. Tshifhungudza-nyelelo

1.1.2. Tshikala Maanḓa nyelelo a mulilo

1.1.3. Tshikala lutsinga lwa mulilo

1.2. Ri vhudzeni yunithi ya phungudza-nyelelo na tswayo yayo

2.

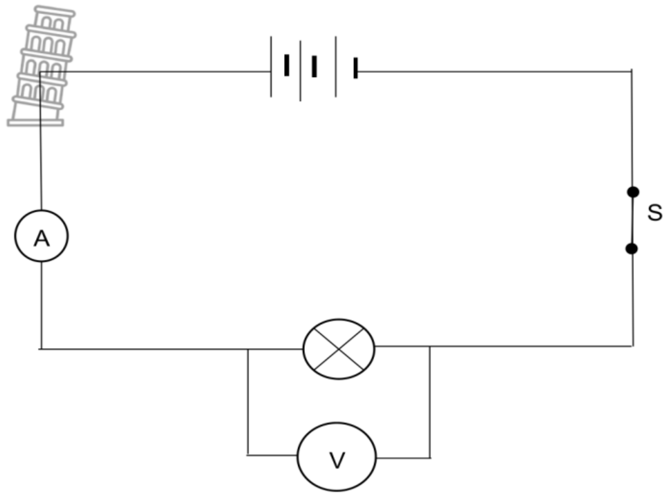
2.1. Ṱalutshedzani uri Tshikala lutsinga lwa mulilo tshi ṱumiswa hani kha ḽiisela

2.2. Ṱalutshedzani uri ndi ngani I tshi ṱuṅwa nga eyo nḓila?

2.3. Mushumo wa tshifhungudza-nyelelo ndi mini? Neani tsumbo mbili

2.4. Olani ḽiisela lire na zwivhumbi zwi tevhelaho: sele mbili, zwifhungudza-nyelelo zwivhili zwi khou tevhelelana, tshilanga mulilo tsho vuleaho, Tshikala lutsinga lwa mulilo tshi khou kalaho lutsinga lwa mulilo wa ḽiisela ḽoṱhe na tshikala Maanḓa nyelelo a mulilo tshi khou kalaho maanḓa a maanḓa nyelelo a mulilo a iṅwe ya tshifhunga-nyelelo kha ezwo zwiivhili

3.1. Nyolo ya ḽiisela ire a fho fhasi yo katela tshiko tsha fulufulu, tshilanga mulilo, Tshikala lutsinga lwa mulilo na ḽivhone li khou dugaho, zwothe ezwo zwo ṱumanwa nga u tevhelelana. Tshikala Maanḓa nyelelo a mulilo tshone tsho vhambelana na ḽivhone.



Ṱalutshedzani maipfi a tevhelaho

3.1.1. Maanḓa nyelelo a mulilo

3.1.2. Lutsinga lwa mulilo

3.2. Tshivhalo tsha lutsinga lwa mulilo lu khou fhiraho kha Tshikala lutsinga lwa mulilo, A ndi 0.6A. fulufulu la 486j lo sudzuluswa u ya kha ḽivhone nga mithethe miraru. Rekanyani tshivhalo tsha maanḓa nyelelo a mulilo are kha tshikala maanḓa nyelelo a mulilo ?

APPENDIX P: English physical science register

ENGLISH PHYSICAL SCIENCES REGISTER

UNIT 4 Electric circuits

Moving electric charges

Electrostatics is about charges that are stationary most of the time. However, when charged conducting spheres are brought into contact, charge moves from the one to the other over a very short time interval. By contrast, the flow of charge in electric circuits is continuous.

In this unit we review what you were taught in previous grades about electric circuits.

An electric circuit

An electric circuit is a continuous conducting path along which electric charges can flow. The rate of flow of electric charge is called the **current**.

The main components of a circuit are:

- Energy source (sometimes called a power source): When using mains electricity the source of energy is the energy transfer that takes place in a power station. However, in our investigations we shall use torch batteries which have chemical potential energy. This is the "stored" energy of the chemicals inside the battery.
- Connecting wires (conductors): These are made of a metal that conducts well and allow the current to flow from component to component. Very, very little energy is lost here.
- Resistance (or load): Resistance is the opposition to the flow of current. This is where there is a transfer of electrical energy out of the circuit. **Resistors** such as the element of a kettle convert electrical energy to heat. Light bulbs convert it to both light and heat.

New words

current (electricity): rate of flow of charge

resistor: component that is present in a circuit because of its resistance

switch (electricity): electrical component that can make a break in an electrical circuit

Additional components for electric circuits

- A **switch** controls whether a current flows or not. An open switch breaks the circuit so current cannot flow. If you close the switch it completes the circuit and current flows.
- Insulators such as plastic and air ensure that the charges stay in the circuit and do not take any short cuts. Such short cuts are called a short circuit.

Conservation of charge

It follows from the principle of conservation of charge that the total amount of charge in the circuit stays constant. The energy source does not produce charges, it transfers energy to them. This means that charges in different parts of the circuit have different amounts of energy.

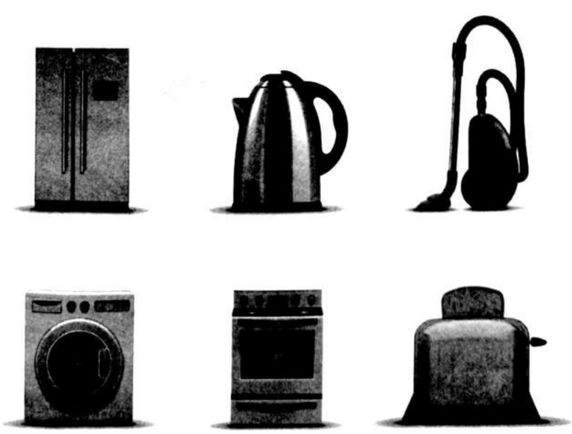
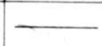
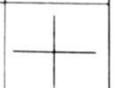
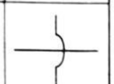
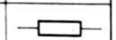
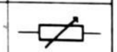
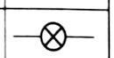
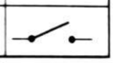


Figure 1 Electrical appliances make use of electric circuits to convert an input into the output we want.

Circuit diagrams

A circuit diagram is drawn with symbols for each component. This makes it easy to see how they are connected together.

Table 1 Circuit symbols

Component	Symbol
Battery	
Connecting wire	
Connecting wires (joined)	
Connecting wires (crossing)	
Resistor	
Variable resistor	
Light bulb (or lamp)	
Switch	

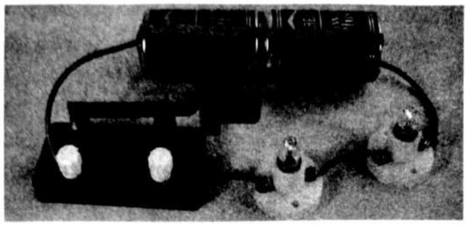


Figure 2 An electric circuit where two light bulbs and two batteries are connected in series.

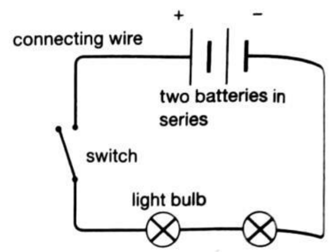


Figure 3 Circuit diagram of the circuit in Figure 2.

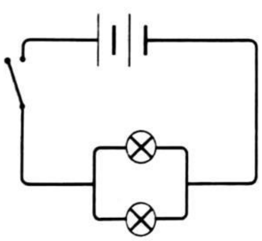


Figure 4 In this circuit, the two bulbs are connected in parallel. The current divides and, if you disconnect one bulb, the other one still burns.

Series and parallel connection of components

- **Series connection:** Components connected in series are connected one after the other in such a way there is a single path for the current to take. The circuit in Figure 2 is a series circuit. If a switch is opened, then all of the components switch off. A disadvantage is that if a component breaks, no current flows through the other components either.
- **Parallel connection:** Components are connected in parallel if there is more than one path for the current to take. Figure 4 is a circuit diagram of a parallel circuit. The current divides so that some goes through one bulb and the rest goes through the other one. An advantage is that if a component in one branch breaks, there is still a current in the other branches. Those components continue to operate.

Switches in series and parallel circuits

A switch in the series part of the circuit controls the entire circuit and is called a main switch. A switch in a branch of a parallel connection controls the current in that branch only.

Activity 1 Answer questions on electric circuits

1 Describe what an electric circuit is.
2 List the three basic types of component that are found in a circuit.
3 The following questions refer to the circuit in Figure 2.
3.1 Is it a series or a parallel circuit? Explain your answer.
3.2 Explain the purpose of a switch in a circuit.
3.3 Identify the energy transfers (conversions) that take place in the circuit.
3.4 Explain why conducting wires need insulation.
3.5 Name a disadvantage of connecting two light bulbs in series.
4 Draw a circuit with three batteries connected in series and two light bulbs connected in parallel. Show two switches that are connected in the circuit in such a way that each bulb can be switched on and off without affecting the other one.

UNIT 5 Emf and potential difference

MODULE 5

Why charges flow around a circuit

The electric charges flowing around a circuit are like water flowing down a hill. Water flows to where the potential energy is lower. In the same way, electric charges go to where their potential energy is less. As they do so, they transfer energy, such as the heat and light emitted by a light bulb.

Just as it requires energy to pump water up a hill, an energy source – such as a battery or generator – continuously transfers energy to electric charges to keep them moving around the circuit.

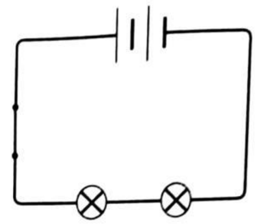


Figure 1 The battery continuously provides electrical energy to the charges which they transfer to the light bulbs.

Potential difference (voltage)

In a shop we compare prices in "rand per kilogram". With electricity we compare "energy per coulomb". This is the energy which one coulomb of charge gains from an energy source such as a battery, or loses when it passes through a component such as a light bulb. This "energy per coulomb" is called the potential difference or **voltage**.

New words

voltage: emf or potential difference measured in volts

volt: unit of measurement of emf and potential difference

The electrical potential difference *(V)* between two points is the change in electrical potential energy per unit charge.

This definition is summed up in the equation:

$$\text{Potential difference between two points} = \frac{\text{energy transferred between two points}}{\text{charge moving past the two points}}$$

In symbols:

$$V = \frac{W}{Q}$$

where V = potential difference, measured in volts (V)
W = the energy transfer, measured joules (J)
Q = charge, measured in coulombs (C)

If the potential difference between two points in a circuit is one **volt**,then there is a transfer of one joule of energy for each coulomb of charge that moves between the two points. If 2 coulombs transfer 8 joules of energy, the potential difference is 4 volts.

Figure 2 A torch battery stores chemical potential energy.

! Know the difference

We refer to the voltage *of* a battery, *across* or *over* a component or *between two points* in a circuit.

The voltmeter

Figure 3 A voltmeter and its circuit symbol.

To measure the voltage or potential difference between two points in a circuit connect a **voltmeter** to each of the two points.

- Always connect a voltmeter in parallel with the component(s).
- Connect the negative terminal of the voltmeter to the side of the component that leads to the negative terminal of the battery.
- Connect the positive lead to the largest range of the voltmeter and to the other side of the component. If you connect to a range that is too small it could damage the meter. Connect to a smaller range if the reading on the large range is low.
- The voltmeter uses such a small current that it makes no noticeable difference to the current in the main circuit.

Practical demonstration 1 Measure and compare the voltage of a battery

In this demonstration you will measure and compare the voltage of a torch battery when *no* current is flowing with its voltage when current *is* flowing.

MATERIALS

- 1,5 V torch battery
- voltmeter
- two 3 V light bulbs
- connecting wires
- battery holder (or elastic band)

METHOD

Voltage of a battery when no current is flowing

Step 1 Use the voltmeter to measure the voltage across the terminals of a battery that is not connected to a circuit (see Figure 4).

Step 2 Read the voltage and record your answer.

Voltage of a battery when current is flowing

Step 3 Connect the battery to a light bulb.

Step 4 Measure the voltage across the battery when a current is flowing.

Step 5 Read the voltage and record your answer.

Step 6 If you have another light bulb available, connect it in parallel with the first one. Measure the new voltage across the battery (see Figure 5).

New word

voltmeter: instrument used to measure the potential difference between two points

Caution

Connect to the largest scale of the voltmeter first.


Figure 4 Measure the voltage across a battery when no current is flowing. The voltmeter reads 1,6 V. This is the emf.

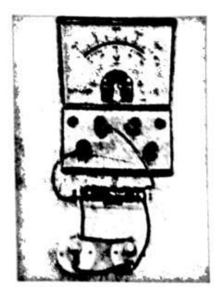


Figure 5 Measure the voltage across the same battery while it is supplying a current. It reads 1,3 V. This is the battery's terminal potential difference in this closed circuit.

DISCUSSION

The voltage across the battery when no current is flowing is higher than when current is flowing.

Emf

The **emf** is the voltage measured across the terminals of a battery when no current is flowing. It is measured in volts. The results of Practical demonstration 1 on page 164 show it is the maximum voltage of a battery. We say emf out loud by sounding out the letters e–m–f.

New word

emf: voltage measured across the terminals of a battery when no current is flowing

MODULE 5

Terminal potential difference across a battery

The terminal potential difference (p.d.) across a battery is the voltage measured across the terminals of the battery when current is flowing through the battery. Practical demonstration 1 shows that a battery's terminal potential difference is less than its emf. Some energy is required to move charge through the battery and is not available for the rest of the circuit.

Table 1 Approximate voltages for various items. Note that smaller values are measured in millivolt (mV).

Items	Approximate voltages
Powerlines	Up to 500 000 V
Household mains in SA	220 V
Pocket calculator	3 V
Cellphone charger	3–9 V
Human nerves	70 mV

Activity 2 Answer questions on potential difference and emf

1 Explain the meanings of:
1.1 emf
1.2 potential difference
1.3 terminal potential difference of a battery.
2 In a circuit, what causes charges to gain energy and what causes them to lose energy? *Hint*: Refer to Figure 1.
3 Suggest why the concept of "potential difference" is useful.
4 Calculate the potential difference across the terminals of a battery if 3 C of charge gains 27 J of energy passing through it.
5 How many coulombs of charge must pass through a light bulb with a potential difference of 220 V across it for it to radiate 4 200 J of energy?
6 Explain how to use a voltmeter to measure potential difference across a light bulb in a circuit. Include a diagram with your answer.
7 A voltmeter is connected across a battery that is connected to a circuit in which there is a light bulb and a switch.
7.1 State whether the switch is open or is closed when measuring:
7.1.1 the emf of the battery
7.1.2 the terminal potential difference across the battery.
7.2 Which of the two readings is higher, the emf or the terminal potential difference of the battery? Suggest a reason for your answer.
7.3 In a closed circuit the switch is closed and a current is flowing. Is the voltage across the battery the same as the voltage across the circuit connected to it?

Exam word

suggest: give ideas, solutions or reasons for something

Answers to numerical questions
4 9 V; **5** 19,09 C

UNIT 6 Current

Did you know?

A flash of lightning that is over in an instant gives us the wrong idea about current in a conductor. By contrast, the flow of charges in a conductor is extremely slow – only millimetres per second. This is because conductors are crammed full with charges!

Electric current

The movement of charge in a circuit reminds us of a current or flow of water in a river.

Current (I) is the rate of flow of charge.

The word "rate" means "how much per second". So the size of an electric current is how much charge flows past a point each second. This can be written as an equation:

$$\text{Electric current} = \frac{\text{charge passing a point}}{\text{time taken (seconds)}}$$

In symbols: $I = \dfrac{Q}{\Delta t}$

where Q = electric charge that passes a point, measured in coulombs (C)
Δt = time taken, measured in seconds (s)
I = current, measured in amperes (A)

New words

ampere: unit of measurement of current; same as a coulomb per second

ammeter: instrument used to measure the electric current in a circuit

An **ampere** (A) is the same as a coulomb per second. Do not use "amp" as an abbreviation for ampere. We can rewrite the formula to calculate the charge which passes a point in a circuit (or cross-section of a conductor).

Charge = current × time

$$Q = I \times \Delta t$$

For current, the following submultiple is often used:

1 milliampere (1 mA) = 1×10^{-3} A

For example: 380 mA
= 380×10^{-3} A
= 0,38 A

From this equation, you can see that if a steady current of one ampere flows for one second, then the amount of charge that passes a point in the circuit is one coulomb. In a metallic conductor, the charges that flow are electrons, and one coulomb of charge represents over 6×10^{18} electrons – that is, 6 with 18 zeros after it!

The ammeter

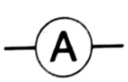


Figure 1 An ammeter and its circuit symbol.

We use an **ammeter** (see Figure 1) to measure the electric current at a point in a circuit. When working with an ammeter:

- Connect the ammeter into a circuit in series at the point where you wish to measure the current.
- Connect the negative terminal of the ammeter to the side of the circuit that leads to the negative terminal of the battery.
- Connect the positive lead to the largest range of the ammeter and to the side of the circuit that leads to the positive terminal of the battery. If the reading on the large range is low it is safe to connect to a smaller range.
- Never connect an ammeter in parallel across the terminals of a battery, or circuit component, because the high current will cause damage to it.

Current direction

The direction of an electric current is the direction in which positive charges would flow in a circuit (see Figure 4). This is from the positive terminal of the battery, through the circuit and back to the negative terminal of the battery. It is sometimes called the conventional current direction.

Figure 2 An ammeter connected in series in a circuit.

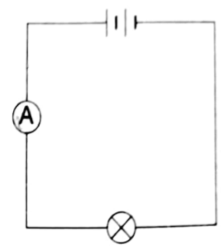


Figure 3 A circuit diagram for the circuit in Figure 2.

Why a battery goes flat

The size of the current supplied by a battery depends on the components it is connected to. In a circuit where it is easy for the current to flow there is a high current. A high current transfers more energy in the same time than a small current does from the same battery.

A battery only stores a certain amount of energy and goes *flat* (does not supply current) once the energy has been transferred to the circuit. If a battery is connected to a circuit in which there is a high current, it will go flat sooner than if the current is low.

Know the difference

We refer to the current *in* or *through* a component or *at a point* in a circuit.

Activity 1 Answer questions on current

1 Define and give the symbol for electric current.
2 Give the name and unit of measurement of current.
3 Connecting an ammeter:
3.1 Give reasons why an ammeter is connected in series in a circuit.
3.2 Why should you not connect an ammeter in parallel across a battery?
4 What reading will an ammeter show if 100 C pass through it in 5 s?
5 An ammeter shows a reading of 6 A. What quantity of charge flows through the instrument in one minute?
6 What are the current readings on the ammeters in Figures 5 and 6?
7 Express 0,75 A in milliamperes.
8 Express 550 mA in amperes.
9 Draw a circuit diagram which has a battery, two identical resistors and a switch connected in series. Include an ammeter to measure the current in the circuit as well as a voltmeter over one of the resistors. Does it matter where you place the ammeter?

Answers to numerical questions
4 20 A; **5** 360 C

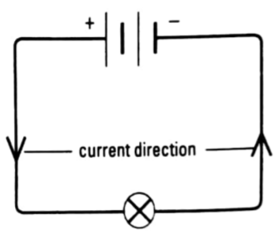


Figure 4 Current direction is from the positive terminal of the battery through the circuit to the negative terminal.

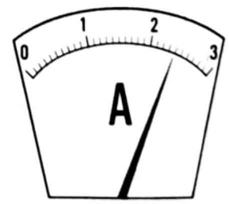


Figure 5 Figure for Question 6

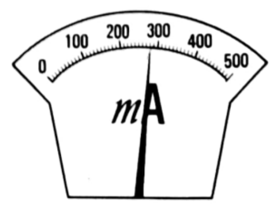


Figure 6 Figure for Question 6

Know the difference

- A voltmeter is connected in parallel so that it measures the potential difference between the two points to which it is connected.
- An ammeter is connected in series in a circuit so that it measures the current at the point where it is connected.

Resistance

Gold, silver, and copper are excellent conductors. However, an alloy of nickel and chromium called nichrome does not conduct well. We say that nichrome offers more resistance to the current than copper does. Resistance is the opposition to the flow of current. The factors that affect the resistance of a resistor are: the type of material of which it is made, the length and thickness of resistance material, as well as the temperature of the resistor.

Transfer of energy in a resistor

Did you know?

At low temperatures, some substances become superconductors, offering no resistance at all to a current.

When charges – such as electrons – move through a conductor with high resistance, they collide with the particles in the conductor. The electrons transfer kinetic energy to these particles and make them vibrate more. In this way a resistor converts electrical energy into heat and, sometimes, to light. In a good conductor the moving charges lose hardly any kinetic energy.

We need to be able to establish what effect resistance has on the current in a circuit for a given potential difference.

Measuring resistance

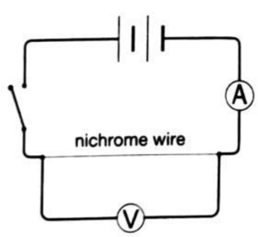


Figure 1 Circuit diagram that shows how a voltmeter measures the potential difference across the piece of nichrome wire and the ammeter measures the current through it.

Figure 1 shows how to measure the voltage across and the current in a piece of nichrome resistance wire. Table 1 gives the results for two lengths of wire.

Table 1 Readings and calculations for two pieces of nichrome wire

Measurement	First wire (800 mm × 0,5 mm)	Second wire (1 600 mm × 0,5 mm)
Potential difference, V	3,0 V	3,0 V
Current, I	0,6 A	0,3 A
Ratio $\frac{V}{I}$	5 $V.A^{-1}$	10 $V.A^{-1}$

We expect the second piece of nichrome wire that is twice as long to have twice the resistance of the shorter one. Table 1 shows that its ratio $\frac{V}{I}$ is also twice that of the shorter one. This ratio is a good way of calculating resistance.

Resistance (*R*) is the ratio of the potential difference across an electrical component to the current passing through it.

In symbols: $R = \frac{V}{I}$

Resistance is measured in ohms (symbol Ω).

One ohm (Ω) is one volt per ampere.

A conductor has a resistance of 1 Ω if a potential difference of 1 volt applied across its ends gives rise to a current of 1 ampere through it. The first wire in Table 1 therefore has a resistance of 5 Ω and the second wire has a resistance of 10 Ω.

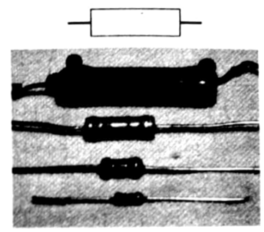


Figure 2 Resistors are components whose resistance keeps currents and voltages in circuits at the desired levels.

Current is inversely proportional to resistance

The equation $R = \frac{V}{I}$ can also be rearranged to give:

$V = IR$ and $I = \frac{V}{R}$

The equation $I = \frac{V}{R}$ shows that, for the same voltage, the current in the battery and circuit is inversely proportional to the resistance of the circuit. Table 1 on page 168 confirms this, the current in the 10 Ω resistor is half that in the 5 Ω resistor. This holds true for the total resistance of the circuit.

Worked example 1

1 Calculate the current in a length of wire if its resistance is 5 Ω and the potential difference across it is 20 V.

2 What will the current be if the 5 Ω resistor is replaced with a 20 Ω resistor and the voltage is kept the same across it?

Answers

1 $I = \frac{V}{R}$

$= \frac{20\ \text{V}}{5\ \Omega}$

$= 4\ \text{A}$

2 The resistance is 4 times bigger so the current will be $\frac{1}{4}$ of what it was. It becomes 1 A.

Variables for Question 1
$V = 20$ V
$R = 5$ Ω
$I = ?$

Variables for Question 2
$V = 20$ V
$R = 20$ Ω
$I = ?$

Activity 1 Answer questions on resistance

1 Define resistance and the ohm.

2 Suggest reasons why a long length of nichrome wire has more resistance to a current than a short one of the same thickness.

Use the definition of resistance in the following calculations:

3 A car tail-light bulb is connected across the terminals of a 12 V car battery. The current is 0,6 A. Calculate the resistance of the tail light.

4 A 40 Ω resistor is connected across a 12 V battery. Calculate the:

4.1 current in the circuit

4.2 the current if the resistor is replaced by a 20 Ω resistor and the voltage remains the same.

5 Determine the voltage across a 100 Ω piece of nichrome wire if the current in it is 5 A.

6 Explain how the conversions of energy in a battery and in the resistors of a circuit eventually make the battery go flat. (Hint: Refer to page 167).

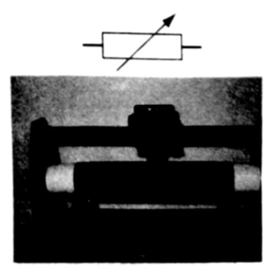


Figure 3 A variable resistor – or rheostat – for use in the school laboratory. Moving the knob changes the length of resistance wire connected to the circuit.

Answers to numerical questions
3 20 Ω; **4.1** 0,3 A; **4.2** 0,6 A; **5** 500 V

UNIT 8 Resistors in series

In Grade 9 you investigated the current in and voltage across resistors connected in series. In the following experiment you will confirm these relationships.

Experiment 1 Investigate current and voltage in series circuits

In this experiment you will measure the current in and voltage across light bulbs in a series connection and record what changes, if any, occur.

MATERIALS

- two 1,5 V batteries
- two 3,0 V light bulbs (or lengths of resistance wire or resistors)
- ammeter
- voltmeter
- connecting wires
- switch

Caution

Connect to the largest ranges of the ammeter and voltmeter first.

METHOD

Step 1 Set up the apparatus as shown in Figure 1 with the light bulbs connected in series.

Ammeter readings:

Step 2 Connect the ammeter to the circuit to measure the current at point A. Close the switch, take the reading I_A and record it (see Table 1 on page 171).

Step 3 Repeat Step 2 to measure I_B at B and I_C at C (see Figure 2).

Voltmeter readings:

Step 4 Connect the voltmeter across the first light bulb. Close the switch, take the reading V_1 and record it (see Table 2 on page 171).

Step 5 Measure the voltage across the second light bulb V_2 and then across the entire circuit V_S. (The "S" stands for series circuit.) In this circuit, the terminal potential difference across the battery is the same as the voltage V_S across the series connection (see Figure 3).

Step 6 Calculate the sum: $V_1 + V_2$

Step 7 Compare your readings and draw conclusions about the size of the current and the voltages in a series circuit.

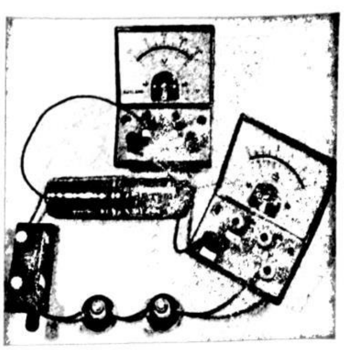


Figure 1 Apparatus set up for the practical activity (measuring V_S and I_C).

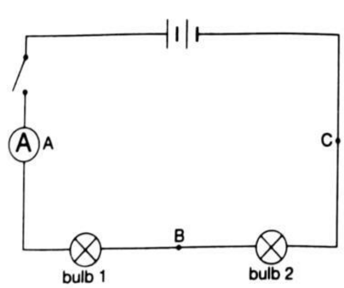


Figure 2 Circuit diagram for measuring the current at points A, B and C in the circuit.

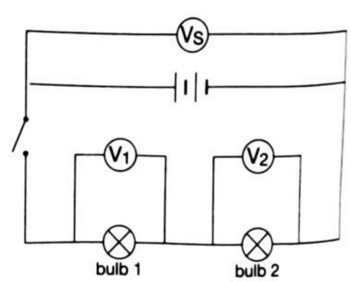


Figure 3 Circuit diagram for measuring the voltage across each light bulb and across the entire series circuit.

Table 1 Current measurements

Position	Current (A)
A: I_A	
B: I_B	
C: I_C	

Table 2 Voltage measurements

Component	Voltage (V)
Light bulb 1: V_1	
Light bulb 2: V_2	
Sum: $V_1 + V_2$	
Battery: V_S	

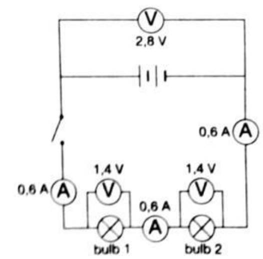


Figure 4 Possible results for a series circuit

DISCUSSION

Compare your results with Figure 4.

- The current readings are the same.
- The sum of the voltages over the resistors equals the total potential difference.

VERIFY YOUR RESULTS

Repeat the experiment with light bulbs or resistors having a different resistance to see if the results are the same before finally drawing a conclusion. Compare your results with other groups in the class.

New words

voltage divider: resistors in a series circuit divide the voltage proportionately

equivalent resistance: resistance of a single resistor that can take the place of a number of resistors connected together

Current and voltage for a series circuit

The results of Experiment 1 on page 170 show the following:

- The current through each resistor and in each part of a series circuit is the same and is constant. This is because the current does not split up anywhere in the circuit.
- Add another light bulb in series and you will see that the current reduces.
- The total potential difference V_S across the battery and the circuit is equal to the sum of the potential differences across the individual resistors in the circuit: $V_S = V_1 + V_2$.
- In a series circuit, the resistors divide the voltage and are called **voltage dividers**.

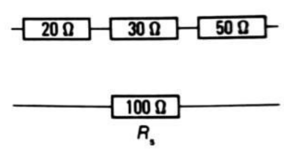


Figure 5 Resistors in series can be replaced with a single resistor which has equivalent resistance: $R_S = R_1 + R_2 + \ldots$

Resistance in a series circuit

If we substitute $V = IR$ into the equation $V_S = V_1 + V_2$ it becomes $IR_S = IR_1 + IR_2$. Current I is the same throughout the circuit so I is a common factor. Remove I and the equation becomes $R_S = R_1 + R_2$.

The total or **equivalent resistance** of a series circuit, R_S, is equal to the sum of the resistances: $R_S = R_1 + R_2 + \ldots$

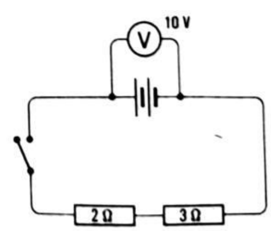


Figure 6 Circuit diagram for Worked example 1

Worked example 1

Two resistors of 2 Ω and 3 Ω respectively, are connected in series to the terminals of a battery with a terminal potential difference of 10 V (see Figure 6). For the purposes of the calculations the switch is closed.

1. What is the equivalent (total) resistance of the circuit?
2. Compare the size of the current in the 2 Ω with the current in the 3 Ω resistor. Explain your answer.
3. If the potential difference across the 3 Ω resistor is 6 V, calculate the potential difference across the 2 Ω resistor.

Variables for Question 1

$R_1 = 2\ \Omega$

$R_2 = 3\ \Omega$

$R_S = ?$

Variables for Question 3

$V_S = 10$ V

$V_{across\ 3\ \Omega} = 6$ V

$V_{across\ 2\ \Omega} = ?$

Answers

1 $R_S = R_1 + R_2$

$= 2\ \Omega + 3\ \Omega$

$= 5\ \Omega$

2 The current in both resistors is the same. It is a series circuit and so the current does not split up anywhere in the circuit.

3 The sum of the voltages across the resistors equals the voltage across the circuit.

$V_{across\ 2\ \Omega} + 6\ V = 10\ V$

$V_{across\ 2\ \Omega} = 4\ V$

Activity 2 Answer questions on resistors in series

1 Explain what is meant by:

1.1 resistors in series

1.2 voltage divider

1.3 equivalent resistance.

2 Two resistors – 3 Ω and 5 Ω respectively – are connected in series to the terminals of a battery which has a terminal potential difference of 12 V.

2.1 Draw a labelled circuit diagram of the circuit.

2.2 What is the equivalent (total) resistance of the circuit?

2.3 If the potential difference across the one resistor is 4,5 V, calculate the potential difference across the other resistor.

2.4 Explain which resistor has the larger potential difference across it.

2.5 Briefly explain how to connect an ammeter to measure the current in the circuit.

2.6 Explain whether it matters where the ammeter is connected in the circuit.

3 Three resistors of 20 Ω, 30 Ω and 50 Ω respectively are connected in series to the terminals of a battery which has a potential difference of 9 V when the switch in the circuit is closed.

3.1 Draw a circuit diagram of the circuit. Include one voltmeter connected across the battery and another one across the 50 Ω resistor.

3.2 If the switch is opened will the reading across the battery *increase*, stay the *same* or *decrease*?

3.3 State the term given to describe the voltage across the battery when the switch is open.

3.4 State and explain the reading on the voltmeter connected across the 50 Ω resistor when the switch is open.

3.5 Explain the effect on the current in the circuit (with the switch closed) if a 100 Ω resistor is connected in series with the circuit.

Answers to numerical questions
2.2 8 Ω; **2.3** 7,5 V

UNIT 9 Resistors in parallel

Do you remember the current and voltage relationships for a parallel circuit that you investigated in Grade 9? Confirm these relationships in the following experiment.

Experiment 1 Investigate current and voltage in parallel circuits

In this experiment you will measure the current in and voltage across the branches in a parallel circuit and record what changes, if any, occur.

MATERIALS
- two 1,5 V batteries
- two 3,0 V light bulbs
- ammeter
- voltmeter
- connecting wires
- switch

Caution

Connect to the largest ranges of the ammeter and voltmeter first.

METHOD

Step 1 Set up the apparatus as shown in Figure 1 with the light bulbs in parallel.

Ammeter readings:

Step 2 Measure the current at points A, B and C (see Figure 2). Record the readings I_1, I_2 and I_P respectively in a table.

Voltmeter readings:

Step 3 Measure and record the voltage across each resistor (V_1 and V_2) and across the entire parallel connection V_P (see Figure 3). (The "P" stands for parallel circuit.)

Step 4 Compare your readings and draw conclusions about the size of the current and the voltages in a parallel circuit.

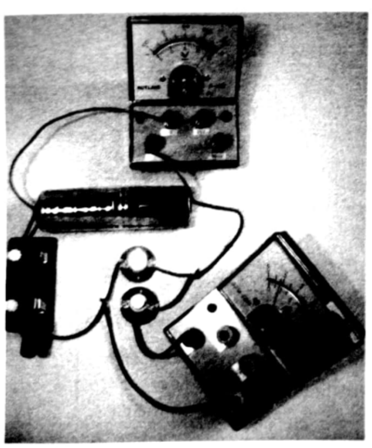


Figure 1 Apparatus set up for the practical activity (measuring V_p and I_2).

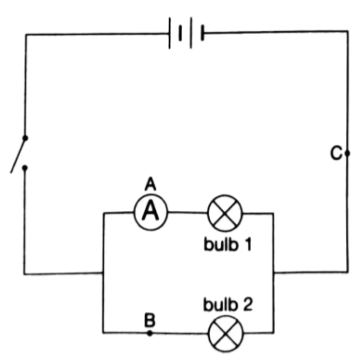


Figure 2 Circuit diagram for measuring the current at points A, B and C in the parallel circuit.

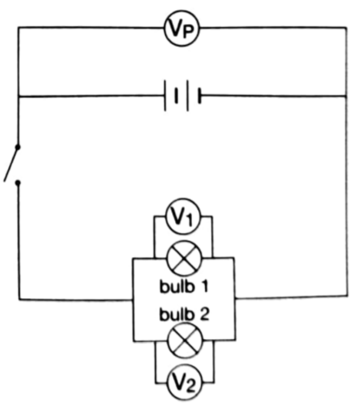


Figure 3 Circuit diagram for measuring the voltage across each light bulb and across the entire parallel circuit.

DISCUSSION

Draw a conclusion after repeating the experiment with other resistances.
- $I_P = I_1 + I_2$
- The voltage readings are the same.

Current and voltage for a parallel connection

- The voltage across each resistor connected in parallel is the same.
- The sum of the currents through the resistors equals the current in the rest of the circuit.
- Resistors in a parallel connection are called **current dividers** because the sum of the branch currents equals the total current in the circuit: $I_P = I_1 + I_2$
- The effect of connecting more resistors in parallel is to open up additional pathways for the current. The resistance decreases and the current increases.

New word

current divider: resistors in parallel divide the current in inverse proportion

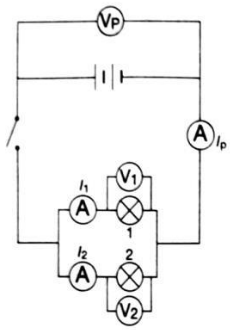


Figure 4 For a parallel connection: $V_P = V_1 = V_2$ and $I_P = I_1 + I_2$. The equivalent resistance of resistors in parallel is $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$

Resistance of resistors in parallel

If we substitute $I = \frac{V}{R_P}$ into the equation $I_P = I_1 + I_2$ then $\frac{V}{R_P} = \frac{V}{R_1} + \frac{V}{R_2}$.

Remove the common factor V and the equation becomes:

- The equivalent resistance of resistors connected in parallel is $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$
- For *two* resistors:

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$= \frac{R_2 + R_1}{R_1R_2}$$

$$= \frac{R_1 + R_2}{R_1R_2} \text{ (rearrange)}$$

$$R_P = \frac{R_1R_2}{R_1 + R_2} \text{ (invert) i.e. for two resistors, } R_P = \frac{\textit{product of resistors}}{\textit{sum of resistors}}$$

Worked example 1

Refer to the circuit diagram in Figure 5. The voltmeter reads 1,2 V.

1. Calculate the equivalent resistance of the parallel connection.
2. Write down the terminal potential difference of the battery.
3. Of the two resistors, which resistor has the larger current in it? Give a reason for your answer.
4. If the reading on the ammeter is 0,25 A and the current in the one resistor is 0,15 A, calculate the current in the second resistor.

Variables for Question 1

$R_1 = 8\ \Omega$
$R_2 = 12\ \Omega$
$R_P = ?$

Answers

1

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_P} = \frac{1}{8\ \Omega} + \frac{1}{12\ \Omega}$$

$$= \frac{3 + 2}{24}$$

$$= \frac{5}{24}$$

$$R_P = \frac{24}{5} \text{ (invert both sides)}$$

$$R_P = 4{,}8\ \Omega$$

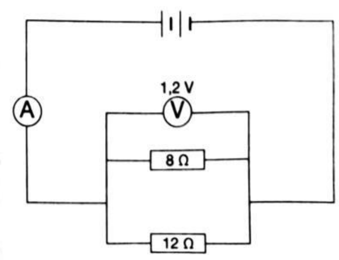


Figure 5 Circuit diagram for Worked example 1

Calculator hint for Question 1:
Use the inverse key x^{-1}

8 | x^{-1} | + | 12 | x^{-1} | = | x^{-1}

Check the answer to Question 1 using $R_P = \dfrac{R_1 R_2}{R_1 + R_2}$

2 1,2 V

3 The 8 Ω resistor has the larger current in it. It is the smaller of the two resistors connected in parallel and so it offers less opposition to the flow of current.

4 $I_P = I_1 + I_2$

$0{,}25\text{ A} = 0{,}15\text{ A} + I_2$

$I_2 = 0{,}1\text{ A}$

Variables for Question 4

$I_p = 0{,}25$ A
$I_1 = 0{,}15$ A
$I_2 = ?$

MODULE 5

Activity 2 Answer questions on resistors in parallel

1 Write the relationships for a parallel connection of resistors:
1.1 The current in the branches of the connection compared with the current entering or leaving it.
1.2 The potential difference (voltage) across the branches of the connection.
2 Write the equation for calculating the equivalent resistance of a parallel connection of resistors.
3 Calculate the equivalent resistance of the resistors in:
3.1 Figure 6 (Check your answer with a second method.)
3.2 Figure 7
3.3 Figure 8.

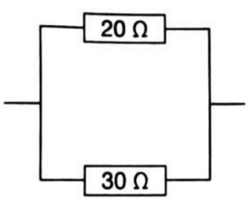


Figure 6 Diagram for Question 3.1

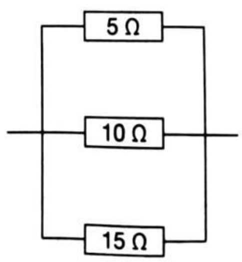


Figure 7 Diagram for Question 3.2

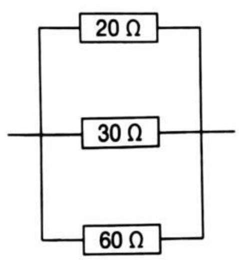


Figure 8 Diagram for Question 3.3

4 Refer to the circuit diagram in Figure 9. The terminal potential difference of the battery is 2,4 V.
4.1 Calculate the equivalent resistance of the parallel connection.
4.2 State the potential difference across the resistors.
4.3 If the reading on the ammeter is 0,3 A, give the sizes of the currents in the 12 Ω and 24 Ω branches respectively. Explain how you arrived at your answers.
4.4 If another resistor is connected in parallel with the others will the reading on the ammeter *increase*, stay the *same* or *decrease*? Explain your answer.

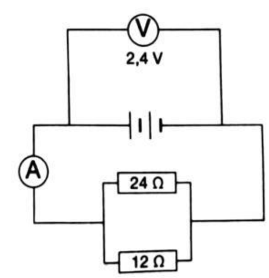


Figure 9 Parallel connection for Question 4

Answers to numerical questions
3.1 12 Ω; **3.2** 2,73 Ω; **3.3** 10 Ω; **4.1** 8 Ω; **4.3** 0,2 A and 0,1 A respectively

APPENDIX Q: Data Analysis Scheme (DAS)

The data was analysed using the following Data Analysis Scheme (DAS)

Theme	**Categories**	**Characteristics**
The development and application	Perceptions (Teachers, learners and parents)	How stakeholders perceive the need to develop Tshivenda scientific register for electricity concept.
	Challenges	challenges of developing Tshivenda scientific register for electricity concept
	Opportunities	Opportunities in the development of Tshivenda scientific register
	Meaningful learning	learning approach that influence meaningful learning

APPENDIX R: CODED ENGLISH OBSERVATION TRANSCRIPT

OBSERVATION
Teacher : What is a circuit? I am sure you all know what a circuit is. So let us talk about the components of a circuit. What are the components of a circuit?
Learner : Light bulb
Teacher : What is its function?
Learner : The bulb gives us light
Teacher : Another component?
Learner : Switch
Teacher : What is a function of a switch?
Learner : Is to turn on and off

Commented [MM1]: Interactive/authoritative

APPENDIX S: CODED TSHIVENDA OBSERVATION TRANSCRIPT

Teacher	: Tsha vhuraru ndi Tshilanga mulilo tsha mudagasi. Nitshi lavhelesa tshifanyiso ni vhona unga tshi shuma mini? (*The third component is the switch), what is the function of the switch when you look at the symbol?)*
Learner 1	: U imisa muḓagasi uri u sa tshimbila (*to stop electricity from flowing)*
Teacher	: Ndi zwone mara,Tshi to u I miisa fhedzi? (does it stop electricity only?)
Learner 2	: Tshi langa mulilo uri u tshimbile kana usa tshimbile (*It controls the flow of current)*
Teacher	: Ee, na dzina latsho li khou to di amba. Zwino tshilanga mulilo tsho sumbedziwaho afho kha bambiri tsho fungiwa kana tsho tsimiwa? (*Yes, even its name says it. The switch on the paper, is it closed or opened?)*
Learners	: Tsho tsimiwa (*opened)*
Teacher	: zwiamba uri arali tsho vulea (tsimiwa) mulilo a u koni u tshimbila kana a u tshimbila?
Learners	: U a tshimbila (it flows)
Teacher	: Tshivhumbi tshi tevhelaho ndi tshifhungudza nyelelo tsha mulilo, dzina latsho litodi amba zwiamba uri uya ngaha vheiwe tshishuma mini? (*This implies that when it is opened current cannot flow through it. Another component is the resistor, according to you what is the use of a resistor?)*
Learners	: Tshi shuma u fhungudza mulilo. (*To reduce the flow of current)*

Commented [MM1]: Interactive/dialogic discourse

APPENDIX T: CODED INTERVIEW TRANSCRIPT

Researcher:	**What is your perception on the use of tshivenda to teach physical science?**
Participant 1:	I think it is ok. It will be easier to use our own language, though I find that some terms they will still give learners difficulty because most of learning areas are in English. So, for beginners, they might find a challenge to use Tshivenda. In the physical science area and also, it's a new thing that is going to be introduced to them. So, learning new things remains difficult, but I think as we go on it will be an advantage because they will have to understand a lot of things and most of the things they do. Speak about them thinking of physical sciences in everyday life, they do know most of the things in their daily lives, but when it comes to a physical science in class, it becomes as if it's something different since they are learning in a foreign language. But when they're using their own language, I think it will be very helpful and useful.

Commented [MM1]: perception

APPENDIX U: CODED DIARY

07 September 2023	4. 5. 6. 7. 8. 9. 10	I had a discussion with my colleague, principal Dr Peter Makhado about developing Tshivenda scientific register, he shared with me the multilingual natural sciences and technology terminology list translated in Afrikaans, Tshivenda and Xitsonga. The document was useful to start developing the register although some of the words were directly translated from English to Tshivenda. Therefore, I had to make further consultation.
15 September 2023	11. 12. 13. 14.	I made a call to Mr Maphiri from CPRR whom I got the contact details from my supervisor. He told me to send the list of those words I find difficult via WhatsApp among them were words like voltmeter, ammeter, switch and battery.
16 september 2023	15. 16. 17. 18. 19.	I received a message from Mr Maphiri on the words that I sent to him. he responded by saying there are technical terms which may not have the equivalent in our indigenous languages. Example voltmeter- volithimitha, ammeter-amitha, switch-switshi

Commented [MM1]: opportunity

Commented [MM2]: challenge

Commented [MM3]: challenge

Commented [MM4]: challenge

APPENDIX V: ETHICAL CLEARENCE CERTIFICATE

UNISA university of south africa

UNISA COLLEGE OF EDUCATION ETHICS REVIEW COMMITTEE

Date: 2023/09/06

Ref: **2023/09/06/64050963/21/AM**
Name: Mr MK MADAVHA
Student No.:64050963

Dear Mr MK MADAVHA

Decision: Ethics Approval from 2023/09/06 to 2026/09/06

Researcher(s): Name: Mr MK MADAVHA
E-mail address: 64050963@mylife.unisa.ac.za
Telephone: 0676697301

Supervisor(s): Name: DR T.G NTULI
E-mail address: entulit@unisa.ac.za
Telephone: 0782091017

Name: PROF A. V Mudau
E-mail address: mudauav@unisa.ac.za
Telephone: 0727062710

Title of research:

Developing physical sciences scientific language register in Tshivenda for teaching electricity

Qualification: MEd Natural Science Education

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 2023/09/06 to 2026/09/06.

*The **medium risk** application was reviewed by the Ethics Review Committee on 2023/09/06 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.

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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 **2026/09/06**. Submission of a completed research ethics progress report will constitute an application for renewal of Ethics Research Committee approval.

Note:

The reference number **2023/09/06/64050963/21/AM** *should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.*

Kind regards,

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APPENDIX W: TURNITIN REPORT

Developing Physical Sciences scientific language register in Tshivenda for teaching electricity

ORIGINALITY REPORT

10%	8%	5%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

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3	Ndivhuwo P Netshivhumbe, Awelani V. Mudau. "Challenges in the application of the Tshivenda scientific register in the teaching and learning of state of matter and the kinetic	<1 %

APPENDIX X: EDITOR'S CERTIFICATE

Shiraz 16
50 Quail Avenue
Thatchfield Close
Centurion, Pretoria
0157

Date: 10 February 2024

To whom it may concern

This letter confirms that the dissertation entitled: **DEVELOPING PHYSICAL SCIENCES SCIENTIFIC LANGUAGE REGISTER IN TSHIVENDA FOR TEACHING ELECTRICITY** written by **MPHO KENNETH MADAVHA** has been edited by Sam Ramaila.

Sincerely,

Sam Ramaila (PhD)
Cell: 0646566387