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A Case Study in Kgotsong of Grade 4 Learners' Performance in Natural Sciences Utilising English as A Medium of Teaching and Learning

Boniswa Mentoor
Central University of Technology,
SOUTH AFRICA

Ritu Bhagwandeen*
Central University of Technology,
SOUTH AFRICA

Wendy Setlalentoa
Central University of Technology,
SOUTH AFRICA

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Abstract: The study investigated the effects of utilising English as the primary teaching language on the academic development of Grade 4 (Gr4) learners, specifically focusing on the Life and Living (L&L) component of Natural Sciences (NS). Gr4 learners commonly transition to English as the Language of Learning and Teaching (LoLT), relegating native languages such as Sesotho to mere study subjects. This shift often results in comprehension and retention challenges, hindering students' academic achievements. By employing a quasi-experimental research design, the study used a purposefully selected sample of 80 Gr4 students from two primary schools. The control group (45 learners) received English instruction from Grade R to Grade 7, while the experimental group (35 learners) switched from Sesotho to English in Gr4. Both groups underwent pre-tests and post-tests, revealing statistically significant differences favouring the experimental group. These findings support the research hypothesis that introducing English as the LoLT as early as Grade R has a significant impact on learners' performance, particularly in NS. It is recommended that English be adopted as a medium of instruction for NS, as this better prepares students for future academic challenges.

Keywords: *English, language of learning and teaching, medium of instruction, natural sciences, quasi-experimental research.*

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Introduction

Language policy implementation significantly affects children's learning experiences. School Governing Bodies (SGBs) determine the language policy in schools, which can result in varying degrees of discretion being taken amongst different schools. Unfortunately, this can leave learners vulnerable, as they may not be adequately prepared for their current or subsequent grades. Macdonald (1990) conducted a study known as the Threshold Project. It examined the consequences of transitioning to English as LoLT after the first four years of mother tongue education in the Foundation Phase (FP) -Grade R to Grade 3- in primary schools. The findings of this study revealed that these learners were not adequately equipped to learn effectively in English when they entered the Intermediate Phase (IP) (Gr4). Specifically, their reading, writing, listening, and speaking skills were insufficient for successful learning beyond Gr3 (Macdonald, 1990).

Chick (1995) argues that the transition to English as LoLT in primary schools did not coincide with any adjustments to the English curriculum itself, leading to a lack of linguistic and conceptual preparation for Black primary school children. This lack of preparation resulted in learners being ill-equipped for the abrupt shift to English after their fourth year of schooling, which also coincided with an expansion of the curriculum to include a wider range of subjects.

Research by Adams (1996), Chick and McKay (2001), De Klerk (1996), Desai (2001), Heugh (2006), Maree and Erasmus (2006), and Webb (2006) show that Black learners, particularly those attending 'Black schools' face educational disadvantages when learning through a second language (L2) such as English. These learners struggle to comprehend the content of subjects taught in English due to limited previous exposure to the language. They also lack support at home, consequently negatively impacting their academic performance.

* **Corresponding author:**
R. Bhagwandeen, Central University of Technology, Welkom, South Africa. ✉ rgupta@cut.ac.za

Learners also face challenges in understanding scientific concepts due to language barriers, highlighting the need to explore the effects of using English as LoLT on science performance (Mawela & Mahlambi, 2021). Research shows that using the school language at home correlates with better science outcomes, emphasizing the importance of the language of instruction (Kisumbe & Mashala, 2020). While studies link language of instruction to academic performance, more research is needed on the impact English as LoLT on Gr4 Natural Science performance (Shubani & Mavuru, 2022). Understanding how language affects science comprehension can inform curriculum development and teaching practices.

However, while these studies have contributed significantly to understanding the impact of language transitions on learner performance in Gr4, none of them have specifically focused on the effects of language transition in the *Life and Living (L&L)* topic of Natural Sciences (NS). Therefore, this research study addresses the gap by examining how using English instead of Sesotho (the learners' home language [HL]) during the transition phase of Gr4 affects teaching and learning in NS.

Literature Review

Using English as LoLT for teaching NS to Gr4 learners has both pros and cons. It can be a barrier for learners whose home language is not English, affecting their grasp of scientific concepts and terms (Teane, 2019; Wilson & Mavuru, 2023). If English is not the home language of the teachers, they will also struggle to teach complex scientific ideas in English (Nel & Müller, 2010).

English is used in South African (SA) classrooms in two primary contexts. The first involves English native speakers studying alongside learners who do not have English as their first language (L1), with the teacher typically being a native English speaker. The second scenario, which is more prevalent, consists of learners who do not speak English at home, with teachers speaking English as a second or third language (L2). In the second scenario, learners in those schools are provided with an English curriculum that starts as an additional language but transitions to English as LoLT from Gr4 onwards, and consequently, the academic performance of English Second Language (ESL) learners is notably inferior to that of L1 speakers. This raises the question of whether language proficiency plays a pivotal role in the subpar academic outcomes of SA learners in Gr4 (Fleisch, 2008).

According to the Curriculum and Assessment Policy Statement (CAPS), the process of acquiring an additional language is like that of acquiring a HL, albeit occurring at a later stage in a child's development (DBE, 2011). Nevertheless, acquiring an L2 necessitates a more intentional and focused approach than learning an HL. The English First Additional Language (EFAL) curriculum is based on language development principles, albeit requiring distinct teaching methodologies to effectively impart language skills to learners.

It is essential to recognise that language abilities are interconnected, encompassing four key systems: phonology (sounds), semantics (meaning), syntax (sentence construction), and pragmatics (application) (Cox, 2008). These systems play a crucial role in the development of language skills and proficiency in EFAL for students in SA. To achieve fluency, it is essential to develop all four language systems (Cox, 2008). These systems, which are integral to language acquisition, are encompassed in CAPS as listening (sounds), speaking (vocabulary usage), reading (syntax and language structure), and writing (syntax and language structure) (DBE, 2011). The process and environment of acquiring L1 and L2 languages differ, despite the similarities in the way languages are acquired. L2 acquisition is characterised by repetition, hands-on engagement, and a supportive, encouraging atmosphere (Phatudi, 2014). The successful learning of EFAL is influenced by various individual and environmental factors, which can be categorised as affective, cognitive, and contextual, that play a role within and around the learner.

Primary school learners are required to navigate through unfamiliar subject-specific vocabulary and a new LoLT, English, when learning NS (Mji & Makgato, 2006; Van Laere et al., 2014). This places a significant responsibility on educators to devise efficient strategies for teaching not only the scientific language but also English as LoLT (Dockx et al., 2020).

The transition to English as LoLT in Gr4 is crucial for many South African learners, with about 80% using English as LoLT by this stage (Sibanda & Graven, 2018). This shift to English as the primary instructional language, especially in subjects like NS, presents challenges for educators in improving English proficiency (Fesi & Mncube, 2021). Explicit teaching of reading comprehension strategies has proven effective in enhancing critical thinking for ESL learners (Elston et al., 2022).

The language of instruction significantly impacts academic performance (Taylor & von Fintel, 2016). Addressing the challenges of using English as LoLT in Gr4 is vital for educational success. While some learners struggle with the transition, others appreciate English instruction (Phajane, 2021). However, English proficiency does not guarantee mastery of scientific language, and even proficient speakers may struggle with scientific concepts (Msipha & Mavuru, 2022).

To tackle the challenges of using English as LoLT in NS, strategies like integrating English across the curriculum, using visual aids, and scaffolding techniques are recommended (Coetzer et al., 2023; Mahan, 2022; Mpofu, 2024; Shubani & Mavuru, 2022). Teachers may also use code-switching to aid comprehension (Mawela & Mahlambi, 2021).

English proficiency is crucial for academic performance in various subjects, including NS (Kanamitie et al., 2023; Romero et al., 2023; Salazar et al., 2022; Teane, 2019). For instance, research has shown that proficiency in English predicts academic success in Biology (Kanamitie et al., 2023).

The above literature can be summarised into 4 key points, which are:

1. Language Barriers: The use of English, especially in a multilingual classroom, can create significant challenges for students who are not proficient in the language. This includes difficulties in understanding scientific concepts, reading, and writing, which ultimately hampers their overall comprehension of the subject (Wilson & Mavuru, 2023).
2. Scientific Language Complexity: Even for students who are somewhat proficient in English, the specialized vocabulary and terminology in science present additional barriers. Students struggle with the academic and authoritative nature of scientific language, making it harder for them to grasp and engage with the content (Msipha & Mavuru, 2022).
3. Transition Challenges: The transition from learning in their native language in earlier grades to English in Grade 4 is often difficult for students. This shift can negatively impact their ability to learn and understand Natural Sciences effectively, leading to a reliance on code-switching and other coping strategies by both teachers and students (Emsley, 2020).
4. Teacher Strategies: Teachers often employ strategies such as code-switching, the use of visual aids, and hands-on activities to help mitigate the challenges posed by using English as LoLT. These strategies are essential for making scientific concepts more accessible to learners (Motloung et al., 2021).

Research Questions

Considering the literature above, this study aims to address the question *What are the effects of English as a LoLT on the teaching and learning of NS, particularly in the transition phase of Gr4, with a focus on L&L*? To further investigate the research problem, three sub-questions were posed, namely:

What is the learners' understanding of L&L after the lessons were carried out in English?

Will learners perform better in an assessment test after being taught in English? and

Will the learners' performance in NS influence their future studies in NS?

Hypothesis Testing

Majaski (2020) explains that the primary objective of hypothesis testing is to assess the validity of a proposition by analysing sample data. In developing a hypothesis, the researcher typically assumes that there will be no disparity between their experimental group and the overall population (known as the null hypothesis [H_0]). On the other hand, a research hypothesis (H_1) is proposed which can be formulated using different methods. This study puts forth the hypotheses discussed in the next sub-section to resolve the primary research question.

Main hypothesis

H_0*: Teaching the NS topic of L&L in English does not affect the performance of learners in the subject.*

(H_1*): Teaching the NS topic of L&L in English affects the performance of learners in the subject.*

Methodology

Research Design

The research was conducted in two primary schools in Kgotsong, Bothaville, in the Lejweleputswa District, Free State, spanning two weeks from 4th to 14th April 2022. A purposeful and convenience-based sampling technique was employed (McMillan & Schumacher, 2006). Patton (1990) emphasises the effectiveness of purposeful sampling in selecting information-rich cases for in-depth study.

The study focused on evaluating the performance of NS learners by analysing the use of English as LoLT in the two selected schools. The researcher adopted a mixed-method research approach, incorporating quantitative, qualitative, and experimental research methodologies to collect data.

Merriam (1998) describes research design as a foundational framework highlighting the systematic process of collecting, organising, and analysing data. This study employed three distinct research designs: qualitative, quantitative, and mixed methods (Figure 1).

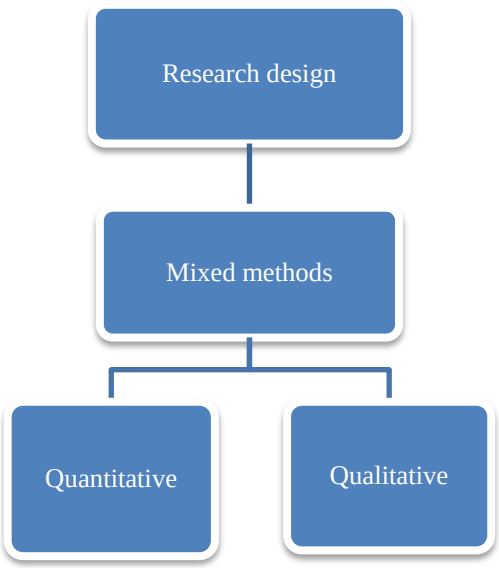

Figure 1. Research designs

The distinction between research designs can be observed through two main approaches. Firstly, the interpretation-based approach, which forms the basis of the qualitative method, recognises that reality is socially constructed, complex, and constantly changing. This approach emphasises the importance of understanding the subjective interpretations and meanings attributed to phenomena (Henning et al., 2004). Alternatively, the quantitative approach operates under the assumption that there is a single physical reality that can be objectively observed and measured; this approach focuses on empirical observation and factual quantification (Henning et al., 2004). Lastly, the mixed-methods research design combines both qualitative and quantitative approaches to provide a more comprehensive understanding of the research problem. This integration allows researchers to avoid relying solely on one approach and instead gain a more holistic perspective. Creswell and Plano Clark (2011) emphasise the benefits of using mixed methods in research.

A mixed-method approach was deemed suitable for this study due to its aim of combining the strengths of qualitative and quantitative methodologies while mitigating their respective limitations, rather than substituting one for the other (Johnson et al., 2007). This approach was chosen to facilitate the exploration of the interrelationships between the quantitative and qualitative data collected. By delving into the participants' perspectives and experiences, the researcher was able to identify correlations between the research inquiries (Shorten & Smith, 2017). Moreover, the mixed-method approach enabled the participants to articulate their thoughts and share their experiences throughout the research process while allowing the researcher to analyse the data using a diverse range of research techniques.

The mixed-methods approach used in this study mainly consisted of the conversion parallel design, and data gathering that took place in two concurrent strands. These are discussed below.

Quantitative Strand: Quasi-Experimental, Pre-Test and Post-Test Approach

The quantitative phase of the study involved the collection and analysis of numerical data to explore the relationship between the intervention and the measured outcomes. An experimental design was implemented to investigate this cause-and-effect relationship, allowing the researcher to compare the results of learners who underwent intervention simulations with those who did not (McMillan & Schumacher, 2001). During this phase of the research, a quasi-experimental design was used to address the initial research question, namely *What are the effects of English as a LoLT on the teaching and learning of NS, particularly in the transition phase of Gr4, with a focus on L&L.* Pre- and post-assessment tests were conducted to evaluate the impact of this teaching approach on the student's learning outcomes.

The study employed a two-phase design, consisting of a pre-test and post-test, to investigate the effects of the experimental intervention. In this design, the same group of participants was assessed both before and after the intervention. Before the intervention, all participants underwent a pre-test to establish a baseline. Subsequently, the treatment group received the experimental intervention, while the control group did not. Finally, a post-test was administered to all participants to evaluate the effectiveness of the intervention. This design was specifically chosen as it was deemed most appropriate for assessing the impact of English medium instruction on the teaching and learning of NS in Gr4, specifically focusing on *L&L.*

Qualitative Strand

Qualitative research, which is closely associated with constructivism, emphasises the interpretations made by participants regarding their individual and collective experiences (Creswell, 2009). It posits that there are multiple realities or perspectives of a single event, rather than a singular observable reality (Merriam, 2009). Johnson and Christensen (2012) highlight that qualitative research involves direct engagement with the people, situation, and phenomenon being studied, with the researcher's personal experiences and insights playing a crucial role in understanding the phenomenon. Additionally, qualitative research offers a holistic perspective that aims to comprehend the entire phenomenon as a complex system that is greater than the sum of its parts (Johnson & Christensen, 2012).

In the qualitative phase of this study, a case study approach was employed to investigate two main aspects, namely i) whether learners have a better understanding of *L&L* in NS for Gr4 when taught in English, and ii) whether learners' performance in NS has any influence on their inclination to pursue a science career in future. This approach combined various sources of data to provide comprehensive insights into research phenomena within real-world contexts. The researcher aimed to uncover the teacher's perspectives, emotions, mental images, and beliefs regarding the teaching of NS in English (Harmon, 2016). Furthermore, observations were conducted in the classroom setting in School A, where the behaviours of both the teacher and students were observed in their natural setting.

Research Sample

The current study utilised a purposive sampling technique, where participants were intentionally selected based on specific characteristics identified by the researcher. This method was chosen to ensure that the sample group would provide valuable insights into the research questions. The selection of the two schools for the case study was deliberate, as they were conveniently located in the same community where the researcher both resided and worked. This proximity facilitated easy access to the schools and the learners, streamlining the data collection process.

With a total population size of approximately 80 Gr4 learners in the year 2022, the sample size was distributed across two schools and the final sample for the study consisted of 35 learners from School A (experimental group) and 45 learners from School B (control group), this is due to School A having a low pupil enrolment in Gr4 than School B. Although the initial plan was to involve two teachers in the study, a logistical issue arose during the interview session. The Gr4 teacher from School B was absent on the day of the interview, resulting in only one teacher from School A being interviewed.

Data Collection

Data collection is the process of acquiring information relevant to a research study by identifying data sources and choosing appropriate methods. This process unfolds in distinct stages, including planning, initiation of data collection, conclusion of data collection, and finalisation. In this study, a mixed-method research design was employed, incorporating both quantitative and qualitative data. The quantitative aspect involved an experimental design with pre- and post-tests conducted on Gr4 students in both the experimental and control groups. The variables examined were the students themselves (independent variable), the test scores obtained in the assessment tasks (dependent variable), and the distinction between the control group (School B) and the experimental group (School A). To ensure the reliability and validity of the research, the same assessment test was administered as both a pre- and post-test. Notably, the post-test for the experimental group was administered after the intervention, which involved teaching *L&L* in NS to Gr4 students over two weeks. The assessment test consisted of a standardised evaluation worth 20 marks (or percentage) for the Gr4 students. Data collection tools are listed below.

Classroom Observations

Data was collected through classroom observations of one teacher in School A, to gain insights into the dynamics of science education in an English-medium school. The primary objective of these observations was to examine the pedagogical approaches and methodologies employed during NS lessons on *L&L*. Additionally, the interactions between the teacher and learners were closely observed. The Gr4 class in School A was observed on four separate occasions over two weeks (5/04/22, 7/04/22, 11/04/22, and 13/04/22) to capture a comprehensive understanding of the teaching and learning process.

The researcher noted how lessons were carried out on a descriptive observation tool, which noted which teaching methods and strategies were employed, and the feedback from learners during the class session. The observed lessons were prepared by both the teacher and researcher using the Natural Science and Technology (NST) Annual Teaching Plan (ATP) in conjunction with the textbook written by Barnard et al. (2013).

Interviews

There were two interview tools used in this study; one for the teacher and one for the learners in the form of an open-ended form, all interviews were semi-structured. The teacher interview tool consisted of seven sections, each section containing several questions ranging from two to five. This tool allowed the researcher to gather information such as personal details, the teacher's perspective on the language policy in schools, their educational background, and other subject-related matters. The teacher had the freedom to respond in their own words and provide additional details on relevant topics (Choak, 2011). One-on-one interview sessions were employed by the researcher, and the answers were noted in the teacher interview tool next to the relevant question. Since only one teacher was interviewed, it took place after school on 8/ 04/22 and lasted for approximately one hour.

The learner's open-ended form also comprised seven sections, each with a range of two to five questions. These interviews enabled the researcher to acquire information regarding the learners' details, their feelings about being taught NS in English, their overall performance in the subject, the availability of learning resources, parental support, and their future interests and career aspirations. For the learner open-ended question form, each learner was given the open-ended question form, which had spaces on it, allowing for answers to be noted down by the learners. The researcher went through the document question-by-question, explaining the different questions to the learners so that they could answer appropriately. After the session, the interview tools were collected from the learners. The session took place on 12 /04/22 after school and lasted approximately two hours.

The purpose of interviewing the teacher was to understand his interactions with the learners' comfort level in using English in the classroom, and the challenges he encountered. Both interview sessions, with learners and the teacher, were carried out in a controlled environment; thus, the data obtained from these interviews is considered reliable and authentic.

Assessment Tests

Standardised assessment tests (March test) used in this study were obtained from Dr. Kenneth, Kaunda District in North-West Province, from the Natural Science and Technology *Subject Advisor:* This was done to maintain the validity of the study. The tests were structured according to Bloom's Taxonomy, encompassing various types of questions such as naming, describing, analysing, and applying concepts.

The Gr4 assessment tests consisted of a standardised test out of 20 that consisted of six questions:

- Question 1 was a multiple-choice question made up of a combination of topics such as structures of animals and plants, living and non-living things, and what plants need to survive
- Question 2 was a match-column question made up of a combination of topics such as structures of animals and plants, living and non-living things, and what plants need to survive
- Question 3 was made up of questions about living and non-living things
- Question 4 was made up of questions about the habitats of animals
- Question 5 was made up of questions about the structures of plants
- Question 6 was made up of questions about the structures of animals

The data collection for this research took place at the beginning of Term 2, making the lessons that formed part of the classroom observation data a form of revision. All lessons and teaching materials were developed, and English was used as a medium of instruction. The post-test was administered following the same procedure as the pre-test, involving the same sample of Gr4 learners 35 from School A and 45 from School B. It assessed whether teaching NS in English had a positive impact on the learners' performance and test scores. This was compared to their initial baseline (pre-test) scores. The pre-test and post-test were administered as described below.

Pre-test

The initial assessment was conducted in the form of a printed test, which was administered to both the experimental and control Gr4 groups, consisting of a sample of 80 learners. The administration of the pre-test took approximately 1.5 hours and was arranged so as not to disrupt regular schooling. The main objective of the pre-test was to establish the baseline performance of all participants. These results were later compared to the post-test results, to determine the impact of teaching NS in English on the learners' performance.

To ensure the validity of the research, several measures were implemented. Firstly, the same tests were used for pre- and post-tests, and learners were not informed in advance about the timing of the pre-test, preventing them from preparing for it. Secondly, the pre-test was conducted in a controlled environment, with the researcher and subject teacher invigilating the session. The learners were seated at their desks, and once they had completed the test, they were allowed to leave the venue. The presence of the researcher during the pre-test ensured that the teacher did not

provide any assistance to the learners. Additionally, to maintain consistency between the pre-test and post-test, the researcher made sure that the learners did not retain the question paper after completing the test.

These procedures were implemented in both the control and experimental group schools. This ensured that the research was conducted in a standardised manner.

Post-test

In the experimental group, students were instructed in NS using English as the medium of instruction. The researcher and the subject teacher from School A collaborated to determine the content that would be covered in the upcoming lessons. Over two weeks, four lessons were planned and prepared based on the ATP for NST for Gr4. The structure of these lessons was carefully guided by the ATP to ensure comprehensive coverage of the required material. Each student in the experimental group was provided with a textbook written by Barnard et al. (2013), which served as a primary resource during the lessons. Additionally, a variety of posters were utilised to enhance the learning experience and reinforce key concepts.

The lessons were structured according to four topics. These included Lesson 1: Living and non-living; Lesson 2: Structures of plants and animals; Lesson 3: Habitats of animals and Lesson 4: Structures for animal shelters.

Analysing Data

A one-way ANCOVA test was used in the Statistical Package for the Social Sciences (SPSS version 27) to compare the mean scores of the two groups' pre-and post-test scores. ANCOVA detects the changes in the dependent variable that result from modifications in the covariate variable, separating these from the changes due to variations in the qualitative variable. This approach reduces the random fluctuations in the variance of the dependent variable (error), leading to more precise results and improved analytical strength. In order to use this test, the data must meet the following assumptions, the dependent variable must be a continuous quantitative variable with a normal distribution, and the covariate should also be continuous. The levels of the qualitative variable must be independent. A linear relationship between the dependent variable and covariate is required; if non-linear, Multivariate ANCOVA can treat the covariate as a secondary dependent variable, or linear transformations can be used with ANCOVA. The correlation between the dependent variable and covariate should be consistent across all levels of the qualitative variable, indicating uniform slopes in regression lines. Finally, the independent variable must not influence the covariate to maintain the integrity of the relationship between the dependent variable and the covariate (Khammar et al., 2020).

The researcher used thematic analysis to analyse the qualitative information associated with interviews and observations related to answering a) whether learners grasp the content better if they are taught in English or not, and b) if they will consider pursuing a science career in the future. According to Evans and Lewis (2018), thematic analysis is a process whereby patterns and themes are identified in the data. This process emerged inductively during the data collection phase and continued throughout the transcription process, which included familiarisation with the data, coding, generating themes, reviewing themes, defining and naming themes, and writing up (Caulfield, 2023).

Reliability of Research Data

For qualitative data, the researcher administered a set of interview questions to the teacher and another set of interview questions to the learners, the same for School A and School B learners, involved in the study.,

For quantitative data, the same assessment test was used as both a pre-test and post-test measure with the 80 learners. This approach aimed to maintain uniformity in the evaluation process and ensure comparability of results across the two testing phases.

Also, the Cronbach's alpha test and Kuder-Richardson Formula 21 (KR21) test were employed to evaluate the reliability of the gathered data. This statistical measure assesses the internal consistency of a set of items, with values ranging from 0 to 1.

A Cronbach's alpha measures the internal consistency of a related set of data, and a Cronbach's alpha value of .70 or higher is considered indicative of good reliability, while values close to .70 are deemed minimally acceptable but not ideal, suggesting potential issues with data reliability that can prove the data to be unreliable. The results of the Cronbach test conducted are depicted below in Table 1.

Table 1. Gr4 Cronbach's Alpha Values

Cronbach's Alpha	Cronbach's Alpha Based on Standardised Items	N of Items
,804	,811	20

Note. For Gr4 learners in Schools A and B, the items are sufficiently consistent to indicate the measure is reliable with a value of .804. Therefore, reliability could be determined.

A KR21 test measures the reliability of a test with binary values, and the reliability is rated from excellent to unacceptable, whereby ≥.9 is deemed excellent, .08-.89 is deemed good, .70-.79 is deemed acceptable, .60-.69 is deemed questionable, .50-.59 is deemed poor and <50 is deemed unacceptable. The results of the KR21 test conducted are depicted below in Table 2.

Table 2. Gr4 KR21 values

Schools		n	Mean (M)	Variance (Var)	n/(n-1)	1-(M*(n-M)/(n*Var))]	KR21 Value
School A	Pre-test	20	4.2	11.6	1.05	.72	.76
	Post-test	20	7.0	17.4	1.05	.74	.78
School B	Pre-test	20	11.6	15.1	1.05	.68	.71
	Post-test	20	11.4	10.2	1.05	.52	.54

Note. KR21 values were obtained by using KR21 formula [n/(n-1) * [1-(M*(n-M)/(n*Var))]

All KR21 values for the pre-test and post-test in School A were within acceptable perimeters, and the KR21 values in School B for the pre-test were acceptable, and for the post-test, they were unacceptable.

An item discrimination index was undertaken to distinguish for each item the performance of learners who performed well and those who performed poorly. To calculate item discrimination, a test is scored, and scores are ranked, and 33% of the highest and lowest scores are selected (Azzopardi & Azzopardi, 2019)

The following criteria displayed in Table 3.1 is used by Azzopardi and Azzopardi (2019), to classify the difficulty and discrimination item index.

Table 3.1 Classification of discrimination index values

Discrimination Index (D) if	Description
D = negative	Defective item
D between 0 - 0.19	Poor discrimination
D is between 0.2 – 0.29	Acceptable discrimination
D is between 0.3 – 0.39	Good discrimination
D = 0.4	Very good discrimination
D > 0.4	Excellent discrimination

Table 3.2 below lists the actual discrimination index values obtained from the raw marks of Gr4 learners pre- and post-tests.

Table 3.2 Item discrimination index for Gr4 pre- and post-tests scores

	Discrimination Index D	
Item	Pre-test	Post-test
A1	0.52	0.34
A2	0.67	0.41
A3	0.64	0.49
A4	0.68	0.64
B1	0.89	0.59
B2	0.5	0.46
B3	0.82	0.78
B4	0.79	0.89
C1	0	0.04
C2	0.41	0.44
C3	0	0.04
C4	0.67	0.48
C5	0	0.04
C6	0.71	0.59
D1	0.5	0.43
E1	0.82	0.63
E2	0.89	0.74
E3	0.7	0.56
F1	0.95	0.63
F2	0.46	0.18

The discrimination index values provided in Table 3.2 are generally above .4, indicating that all items have good discrimination except C1,C3, and C5, indicating that learners didn't know the questions or the difficulty level was higher

for Gr4, however, for similar items, the post-test values for the discrimination index were improved suggesting that intervention assisted learners in understanding the content or answering the questions. Most of the other items have discrimination index values that range from .4 and above for pre and post-test , indicating a good level of acceptance. Post-intervention values for the discrimination index were found to be lowered for most of the items, indicating that learners' understanding of content improved when they were taught in English. The lesson related to L&L. Table 4 below depicts the assumption of equal variance for analysing techniques

Table 4 Levene's Test of Equality of Error Variances

Dependent Variable	**Post Test Score**		
F	df1	df2	Sig
.42	1	78	.839

a. Design: Intercept + G1 Pre-test TOTAL + group

Note. Tests the null hypothesis that the error variance of the dependent variable is equal across groups.

Levene's test of Equality of Error variance depicted in Table 4.1 suggests that the assumption of the equality of variance was not violated as the significant value is .839, which is greater than the cut-off value of .05, suggesting that the variance in the study was equal, and none of the assumptions were violated.

Findings

Qualitative Data Findings

Below are the findings obtained from qualitative data:

Classroom Observations

For the Gr4 class observations, several data points were noted and observed. For the Gr4 experimental group (School A), the environment in the class was relaxed, and the learners showed confidence during the lesson. However, recollection of content was somewhat challenging, as the content was covered in Term 1, and the observation was conducted in Term 2. The teacher was comfortable using English as a medium of instruction, but the learners were not. For this reason, learners were not active or participative during the lesson. The teacher used question-mediated teaching whereby the teacher would pose a question to learners, await feedback, and take it from there. The lesson relied heavily on code-switching as a form of scaffolding to evoke a response from the learners; alternatively, the lesson would simply become a monologue. The teacher also based their lesson on language comprehension as much as the lesson was content-based to ensure that learners felt comfortable and used to the LoLT in the hopes of increasing retention and, by extension, the learning and understanding of concepts in English. Based on this observation, the researcher engaged in an informal conversation after the lesson with the teacher to ascertain which issues they perceived.

In this session, the teacher said that teaching Sesotho in the FP (School A) hinders learners when transitioning to IP. Learners struggle with content comprehension, and their general performance in the subject decreases drastically. It must be noted that only one teacher is responsible for teaching NS Gr4 in School A, which can be advantageous to both the teacher and learners as the teacher needs to prepare for only one subject in one grade, thus allowing for extra preparation. However, preparation alone will not remedy the current issues within this experimental group.

The learners and teachers used textbooks written by Barnard et al. (2013) as their source of learning material. Most of the experiment(s) done in class did not require a lot of scientific apparatus, hence they were chosen. This is because the school has neither a laboratory nor laboratory equipment.

Teacher Interview

The Gr4 teacher in School A holds an Advance Certificate in Education (ACE) in sports development but did not specify whether they did science in high school. They have 25 years of teaching experience and no formal training in NST/NS, except for the training received during workshops organised by the Department of Basic Education (DBE).

During the interview, the teacher admitted to lacking profound academic knowledge in the field of science. Their sole training was provided by the DBE during NST content training, which included practical work. These workshops functioned as brainstorming sessions, strengthening their competency in content and pedagogy, before educating learners in NST.

The current study was centered on the implementation of language-in-education policies; thus, the researchers' interview questions were focused on the participants' awareness of these concerns. The teacher was asked specifically about language policies in their respective schools which guide their choice of LoLT.

The teacher response revealed that in School A, they have a language policy that is primarily formulated by the SGB, with input from teachers and parents. Moreover, the teacher indicated that she possesses some knowledge of the current SA Language-in-Education Policy. It was noted by the teacher that English is used as LoLT in School A. However, English is only primarily utilised as a LoLT from Gr4 upwards. Furthermore, in School A, the FP predominantly uses Sesotho (HL) as a LoLT, except for the subject of English. The teacher also stated that several attempts have been made to engage the FP in using English as a LoLT, but the status quo remains unchanged, and this could be due to the existing language policy in School A.

The teacher was asked how he engages with his students utilising English as the LoLT in science to determine the importance of language in the classroom. The teacher who taught in School A claimed that some translation/code-switching took place in her respective classroom to further increase comprehension of content and that the amount and frequency of code-switching decreased as the learners moved up the IP. This is substantiated by the discussion in the previous section during classroom observations.

The interviews/ questionnaires were distributed to 35 Gr4 learners in the experimental group (School A) and 45 in the control group (School B). The primary objective was to discern learners' sentiments regarding the use of English as LoLT in NS, while also considering classroom data. The researcher also sought to determine if learners would want to pursue a career in science in the future. It was hypothesised that how learners interacted with one another and with their educators in the NS classroom, as well as their performance on NS assessment evaluations, would be correlated with their perceptions of English as a medium of instruction.

Learner Open-Ended Question Form

The learner's interviews were conducted using an open-ended question format, and the data collected from both schools were analysed according to several themes. They are discussed as sub-headings below.

Theme 1: Learning science through the medium of English (do they understand and have good command of the English language?)

Questions in this theme were related to: What problems do they encounter when using English in the classroom? and What support do they receive in solving the problems they face while using English in the classroom?

The majority of the learners indicated that they did not mind being taught NS in English; they said that they preferred it. They found it easier to complete assessments when they were in English only.

The minority of the Gr4s in the experimental group indicated that they struggled in their command of the English language, as it was the first time they had been exposed to it in their schooling life. Thus, they found learning challenging.

They mainly relied on their teachers to repeat what they had taught previously, and during lessons, they also often depended on code-switching. They mentioned that their teacher was always there to help in that regard. Learners from School A added that their teacher encouraged them to come forward if they were struggling with a particular word or concept.

Theme 2: Learners' academic performance with English as LoLT

The question in this theme was: Does it make learning easier or harder, especially for a Gr4 learner?

It is important to note that the research study took place at the beginning of Term 2, thus English was relatively new for the Gr4s in the experimental group. Therefore, the majority indicated that they were currently struggling in the subject, however, they were hopeful that they would perform better in the upcoming terms as they became used to the use of English as a LoLT.

Half of the learners said that they did not experience any hardship when learning NS using English as LoLT. The other half confessed that learning through English was proving to be very difficult for them as they were not familiar with some words in English, ultimately making it harder to grasp the content.

Theme 3: Gaining knowledge

The question in this theme was: What kind of resources do the learners have access to make them perform better in the subject?

The experimental group indicated that every learner had been issued a textbook (*Oxford Successful NST Gr4*) and they mainly relied on the prescribed textbook for content knowledge (Lemmer et al., 2008). They also shared that experiments were also done for them to help them better understand the content, although they indicated that this did not happen regularly. Some even shared that they often use Google if homework is given, and they cannot find answers

in the textbook. Very few learners from Gr4 indicated that they used the local library to get extra resources for the subject

Theme 4: Parental support

The question in this theme was: *What kind of assistance do learners get from their parents, and if they cannot help, what do they do?*

The majority of learners doing Gr4 in both schools have specified that their parents were highly involved in their schoolwork, that they acted as a secondary source of information, and were always willing to help. In addition, in cases where the parents/guardians were unable to help, they often sourced the information from other adults or the Internet.

Theme 5: Learner's thoughts, perspective, and interests

The questions relating to this theme were: *What do they like about the subject?; Are they more likely to take science in the future?* and *What career paths would they like to pursue when they complete their Grade 12?*

All the learners indicated that they love the subject despite the challenges previously highlighted. This is because they often love their NS teachers and also because they get to learn about food, plants, and how their bodies work, which is relatable to them.

Learners have their sights on becoming medical professionals, engineers, and information technology (IT) specialists (95% of the learners in Gr4 have specified that taking science as a subject is of paramount importance if they want to pursue the abovementioned career paths.

Quantitative Data Findings

The descriptive statistics for the control group (School B) and the experimental group (School A) in the Gr4 pre-test and post-tests are presented below. To decrease type I error ANCOVA test was conducted. It is crucial to highlight that data cleaning procedures were utilised during the analysis of the statistical data due to the disparity in the number of learners who took the Gr4 pre-test compared to those who took the post-test in both schools. This measure was implemented to guarantee the accuracy and validity of the results obtained.

An analysis of covariance (ANCOVA) was conducted to compare scores of 'Teaching L&L in English' using a pretest as a covariate. Univariate analyses of variance conducted by using IBM SPSS 29 are reported in Tables 5.1 to 5.3.

Table 5.1 Descriptive Statistics

	Group	Mean	Std. Deviation	N
Pretest	control	11,76	3,839	45
	experimental	4,4	3,423	35
	Total	8,54	5,17	80
Post test	control	11,38	3,221	45
	experimental	7,03	4,232	35
	Total	9,48	4,266	80

Note. The results from Table 5.1 suggest that there exists a statistically significant difference between pre-test scores of Gr4 learners in School A (experimental group) (*M = 4.40*, *SD = 3.42*) and post-test scores of Gr4 learners (*M = 7.03*, *SD = 4.23*). This suggests that there is a significant difference in the mean scores of the dependent variable in the two groups. Therefore, the H_0 is rejected, and the H_1 is accepted.

Table 5.2 ANCOVA results of Scores of teaching L&L in English for experimental and control group (Tests of Between-Subject effects)

Dependent Variable: G1 (Post TOTAL)						
Source	**Type III Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**	**Partial Eta Squared**
Corrected Model	956.269[a]	2	478.135	76.433	.000	.665
Intercept	133.931	1	133.931	21.410	.000	.218
G1PretestTOTAL	583.869	1	583.869	93.335	.000	.548
group	12.780	1	12.780	2.043	.157	.026
Error	481.681	77	6.256			
Total	8620.000	80				
Corrected Total	1437.950	79				

a. R Squared = ,665 (Adjusted R Squared = ,656)

Note. In Table 5.2 F (1,77) = 2.04, p = .157, partial eta squared = .026, because the *p*-value is less than .005, this suggest that there's no significant difference between the two intervention groups on post intervention scores of Teaching the NS topic of L&L in English. The partial eta squared value in this case is only .026, indicating a small effect size using Cohen's guidelines. This value also indicates how much of the variance in the dependent variable is explained by the independent variable (which is only 2.6 percent). There is a significant relationship between the covariate and the dependent variable while controlling the independent variable as indicated by the significant value of .000, since this value is lesser than .005, this suggests that Gr4 learners being taught NS in the topic of L&L in English have an impact in assessment the test scores of Gr4 learners in the experimental group after the post-intervention.

Table 5.3 Estimated marginal means

Dependent Variable: G1 (Post TOTAL)				
			95% Confidence Interval	
group	**Mean**	**Std. Error**	**Lower Bound**	**Upper Bound**
control	8.974[a]	.448	8.082	9.867
experimental	10.119[a]	.530	9.063	11.174

a. Covariates appearing in the model are evaluated at the following values: G1 Pre-test TOTAL) = 8.54.

Note. Table 5.3 provides us with the adjusted means on the dependent variable for the groups where adjusted refers to the fact that the effect of covariance has been statistically removed.

There is a slight increase in the post-test scores of the experimental group that is different from the value obtained in descriptive statistics; this can suggest that the post-intervention improved the assessment test scores.

Discussion

A sample of analysis of covariance (ANCOVA) test was conducted to compare pre-and post-test scores of Gr4 learners at Schools A and B to answer quantitative questions. Furthermore, interviews with one Gr4 teacher and learner open-ended forms assisted with answering qualitative questions.

Qualitative Data Analysis

Qualitative data analysis was based on classroom observations and interviews with teachers and learners.

Classroom Observations

The teacher in School A heavily relied on using code-switching in the lessons, especially in the 1st two class observations, despite the teacher being conversant, fluent, and confident in using English as LoLT. This was mainly because the teacher saw that they were losing learners in the lessons when they didn't often switch to Sesotho to elucidate certain concepts. However, the latter lessons observed that this heavy reliance decreased, although it was still used time after time. The more confident learners got in learning English as LoLT, the more they started participating in the lesson; these findings are supported by the study done by Sanchez and Saranza (2023), which made a conclusion that better English proficiency leads to increased class participation.

Teacher Interview

The teacher who was interviewed from School A is a qualified teacher but not qualified to teach NS and has no formal training in science education. The only knowledge of science education they have is what was provided by DBE during content workshops which seems to be limited but sufficient. If this is the case in other schools, this could have a negative impact on the teaching and learning of science in primary schools, as certain topics and concepts may not be translated properly for the learners, hindering the process of effective teaching and learning, these findings are supported by the study of Luft et al. (2020), that is highlighting the overlooked problem of out-of-field teaching in science, that has an effect on the subject matter and the delivery of content and that has the potential to influence the cultivation of next-generation Science Technology Engineering and Mathematics (STEM) graduates.

Findings from the teacher interview revealed that Gr4 learners have a problem with English reading, writing, and comprehension, and this results in the over-reliance on code-switching by the teachers when conducting lessons, this is supported by the study done by Fesi and Mncube (2021) that highlight the challenges of teaching using English as LoLT and the Gr4 teachers' perspectives. The findings of the study aim to highlight the importance of using English as LoLT in the academic performance of Gr 4 learners and the role that Gr4 teachers play in effectively implementing the usage of English as LoLT.

Learner Open-Ended Questions

Learners in both schools essentially didn't have any contention in learning NS in English, as some are fascinated by the idea, and with the support they get from home and proximity to facilities such as the library, and the internet, they tend to extend their knowledge and vocabulary when they get home as teaching and learning does not stop when they leave the classroom. With that being said, there is still the minority that finds it difficult. This is fueled by the fact that they only encounter English in a classroom setting, there is no support at home, and they live far from facilities such as the local library, so they rely on their teachers, which proves to be insufficient at times, these findings are supported by the study of Jaiswal and Choudhuri (2017), where they give a review of the relationship between parental involvement and the impact it has on student's academic performance, they argue that a general conclusion cannot be made when it comes to parental involvement as there are numerous inconsistencies and contradictions that exist in the empirical research literature, however, they found some positivity that lies in student's academic performance in relation to the parent's home-based involvement and school involvement.

Learners predominantly depend on their teachers for elevated proficiency in English, as revealed in the open-ended questions that the majority of the learners only encounter English in a classroom setting and nowhere else therefore, the responsibility heavily lies with the teachers to transfer the language to the learners and if the proficiency of the teacher is found wanting that can have a negative effect on the learners' proficiency in Gr4 as language transference on that level takes place syntactically (modeled by the teacher), this is supported by the study of Nel and Müller (2010), which found that teachers' limited English proficiency affected learners' acquisition of English as an L2 negatively and subsequently their learning.

Quantitative Data Analysis

Quantitative data in this study was based on pre-and post-assessments, fulfilling the conditions linked to the reliability of assessments such as Cronbach alpha and KR21.

Assessment tests

A one-way between groups analysis of covariance was conducted to compare the effectiveness of Teaching the NS topic of L&L in English does affect the performance of learners in the subject. The independent variable was the pretest score, while the dependent variable consisted of the post-test score after the intervention was completed. Learners' scores on the preintervention administration on Teaching the NS topic of L&L in English were used as covariates in this analysis.

Preliminary checks were conducted to ensure that there was no violation of the assumption of normality, linearity, homogeneity of variance, homogeneity of regression slopes, or reliable measurement of the covariate. After adjusting for preintervention scores, a small increase was observed in the experimental group of 2.63 of the mean scores of the assessment tests post-intervention of Teaching the NS topic of L&L in English.

A one-way between-groups analysis of covariance was conducted to compare the effectiveness of Teaching the NS topic of L&L in English does not affect the performance of learners in the subject. The independent variable was the pretest score, while the dependent variable consisted of the post-test score after the intervention was completed. Learners' scores on the preintervention administration on Teaching the NS topic of L&L in English were used as covariates in this analysis. After adjusting for preintervention scores, there was no significant difference between the two intervention groups on post-intervention scores of Teaching the NS topic of L&L in English $F(1, 77) = 2.04$, $p = .16$, partial eta squared=.026. This can be attributed to the small mean increase of the post-test in the experimental group. The partial eta squared value in this case is only .026, indicating a small effect size using Cohen's guidelines. This value also indicates how much of the variance in the dependent variable is explained by the independent variable (which is only 2.6 percent). There is a significant relationship between the covariate and the dependent variable while controlling the independent variable as indicated by the significant value of .000. Since this value is lesser than .0005, the covariant is significant in this study as explained by the value of partial eta squared of .548 or 54.8%, this suggests that there exists some degree of association between the Gr4 learners being taught the topic of L&L in NS and the test scores obtained in the post-assessment tests. There was a medium relationship between the pre-intervention and post-intervention scores on teaching the NS topic of L&L in English, as indicated by the partial eta-squared value of .026 (Pallant, 2016).

From the ANCOVA test alone, we can say that utilizing English as LoLT bears no statistical significance in the learners' academic performance in the N.S topic of L&L, however, based on other factors like the covariate p-value of .001 and the partial eta squared value of .026 observed in the post-test scores, are all in favor of the experimental group because of the partial eta squared obtained in the covariate of 5.48 or 54.8%, which indicates some level of comfort with the use of English as LoLT. This translates to a slightly better performance in the post-test amongst the learners in School A (experimental group). Consequently, the results in the post-test phase support the belief that using English as LoLT has a positive impact on learners' ability to understand the subject and, therefore, can increase learner performance in the subject of NS's *L&L* section. The findings above are supported by studies done by Kanamitie et al. (2023), who performed the Pearson product-moment correlation analysis and found a positive correlation between English proficiency and academic accomplishment in biology.

Reliability

The two reliability tests, the Cronbach and KR21 tests, were utilised in the research study so that the reliability of the data could be determined. The results from the two tests proved that data can be taken as reliable, especially the data derived from the experimental group (School A).

For the discrimination index in the pre-test, most values were .5 and above, indicating a high difficulty index in those items prior to the intervention. After the intervention, the discrimination index values in the post-test decreased to .4 and above, indicating that the difficulty index in those items decreased after the intervention.

Conclusion

Based on the analysis of the classroom observations, teacher interviews, and learners 'interviews/questionnaires, there was some contention among learners in having English as the LoLT, especially in Gr4 learners in the beginning. However, as the learners got used to being solely taught in English, the contention was almost eradicated, and learner participation in class improved. This further translated into the improvement seen in the post-assessment test, especially in the experimental group, with a mean score that improved from 4.4 to 7.03, which gives an increase of 2.63. From Table 5.1, it is evident that the mean score of the control group is higher than the mean score of the experimental group by a difference of 4.35. This suggests that being taught and learning NS in English works in favour of the learners as their performance is better.

The ANCOVA tests yielded results with a *p*-value of .157, which suggested that there exists no statistical significance between learning N.S in English as LoLT and improved academic performance of learners, which dispute the above-obtained results, however, factors like the covariate *p*-value of .001 and the partial eta squared value of .026 suggested that there's a small degree of association between learning N.S topic of L&L in English as LoLT and academic performance of Gr4 learners.

Effective teaching and learning in NS are a team effort that requires teachers who are qualified to teach science and the DBE to provide ongoing support for those who are not in order to ensure that effective teaching and learning takes place in NS classrooms.

Recommendations

Based on the results of this study, the following recommendations should be considered by schools and school management:

Recommendation One: Poor Learner Science Background and Lack of Teaching/Learning Resources

Teachers should take learners on science excursions and expose them to opportunities to conduct practicals in the classroom either physically or through the use of animations such as PhET Simulations. This would spark interest in the subject and could positively affect the teaching and learning of NS. They should also invite guest teachers with relevant expertise to come and teach the students.

Learners should be encouraged to watch science shows on television or YouTube. This is supported by Amos and Booham as cited in Mtsi and Maphosa (2016), who state that audio-visual materials help to bring the real world to learners through the use of sound and video.

Also, schools resource shortages should be addressed. The DBE should provide funds, science materials, and equipment to schools or schools should try and raise funds for these.

Recommendation Two: English as a Language Barrier for Learners

Learners in NS must be able to use LoLT when communicating using written, oral, visual, graphic modes and other forms of communication to make information available to others (CAPS, 2011). According to Setati and Hlabane as cited in Ngema (2016), this has been a challenge for L2 learners because they are not proficient in English, which is the LoLT. As a result, Ngema asserts that science terms and English should be explicitly taught to learners so that they can express themselves and analyse scientific information, as there is no other way for them to succeed academically other than being proficient in English.

Recommendation Three: Teachers' Lack of Adequate Subject Knowledge

When a teacher is appointed, the ability of the candidate to teach the subject must be considered according to the Employment of Educators Act (1998). According to a study conducted by Cho et al. (as cited in Ngema, 2016), there is still many underqualified or unqualified teachers who teach NS.

To develop teachers, both internal and external teacher training/workshops should be used. The DBE and the school should provide internal training. Tertiary institutions and non-governmental organisations (NGOs) should provide

external training. The DBE should provide teachers with intensive and focused professional development gives teachers the necessary training to make teaching and learning effective.

Recommendation Four: Language Policy in Schools

According to The Language in Education Policy (LiEP) of 14 July 1997 (Department of Education, 1997) should be used as the LoLT from Gr4 onwards. However, when it comes to implementation, there is a significant gap and/or disjunction between policy prescription and actual classroom practices of teachers and learners. Transitioning from HL to L2 at an early stage does not produce successful results (Heugh, 2006). This is because when the HL is abruptly removed (at this early stage), there can be long-term damage in social and cognitive areas (Heugh, 2006).

Recommendation Five: Undertaking Longitudinal Studies

It is recommended that future studies should be conducted longitudinally, which will include a higher number of participants from a wider group of schools. That will be translated into obtaining higher mean scores samples that will provide statistically significant results because the smaller sample of participants yields small sample of data that proves to be statically significant even though a difference can be observed due to the nature of the difference is so small that is can be ruled out as being statistically insignificant (Faber & Fonseca, 2014).

Limitations

This research was constrained to learners currently in the IP (Gr4s) only. The study explored the outcomes of teaching and learning using English in NS, predominantly in Sesotho-speaking learners distributed in two schools in Kgotsong, Bothaville in Lejweleputswa District, in the Free State Province of SA.

Ethics Statements

Consent was obtained from the head of the department, the district manager, the circuit manager, and the principals of the two schools involved in the research paper. The participants involved in the research study all signed consent forms, and parents signed them on behalf of their children. Ethical clearance was provided by the Central University of Technology and DBE upon the approval of the study.

Declaration

This research paper was derived from a MEd student thesis currently enrolled in the University of Technology, under the supervision of the co-authors.

Authorship Contribution Statement

Mentoor, was responsible for concept and design, data acquisition, drafting of the manuscript, data interpretation. Bhagwandeen was responsible for statistical analysis, data analysis and interpretation securing funding and supervision, revision of the manuscript. Setlalentoa, was responsible for critical revision of manuscript.

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Appendix

Acronym List

ACE	Advanced Certificate in Education
ATP	Annual Teaching Plan
CAPS	Curriculum and Assessment Policy Statement
DBE	Department of Basic Education
EFAL	English First Additional Language
ESL	English Second Language
FP	Foundation Phase
Gr4	Grade 4
H_0	Null Hypothesis
H_1	Research Hypothesis
HL	Home Language
IBM	International Business Machines
IP	Intermediate Phase
IT	Information Technology
KR21	Kuder-Richardson Formula
L1	First Language
L2	Second Language
L&L	Life and Living
LoI	Language of Instruction
LoLT	Language of Teaching and Learning
NGO	Non-Governmental Organisations
NS	Natural Sciences
NST	Natural Science and Technology
PHeT	Physics Education Technology
SA	South Africa
SGB	School Governing Body
SPSS	Statistical Package for the Social Sciences