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Application of Physical Sciences Scientific Language Register in Tshivenḓa to Shape Meaningful Learning

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ABSTRACT

This study employed a qualitative interpretative case study methodology, involving two teachers and one class of learners from two selected schools. The researcher used observation to address a critical question: How does the application of the Tshivenḓa scientific language register shape meaningful learning? The findings reveal that the application of the Tshivenḓa scientific language register in classrooms fosters interactive and meaningful learning experiences compared to when English is used. Therefore, this study recommends conducting further research and collaboration to develop a comprehensive Tshivenḓa scientific language register with standardized terminology. This would require input from linguists, educators, and other relevant stakeholders to ensure accuracy and consistency.

KEYWORDS

Meaningful learning; Tshivenḓa scientific language register; physical sciences.

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 responds to the imperative need to bridge this linguistic gap by developing a 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 scientific discourse, resulting in a scarcity of educational materials and resources that cater to the linguistic and cultural backgrounds of its speakers. The current education system allows mother tongue instruction in the Foundation Phase, transitioning to English from Grade 4 (DBE, 2013) and continuing to learn using the language (English) they are not familiar with until they reach universities (Shayne, 2020). Cummins (1981) highlights that children typically require five to seven years to develop Cognitive Academic Language Proficiency (CALP) needed for academic tasks, while Basic Interpersonal Communication Skills (BICS) are usually acquired within two years. The impact of this is evident in the results of the 2021 International Reading Literacy Study (PIRLS), which revealed that 81% of Grade 4 pupils in South Africa struggle with reading comprehension (Chabalala, 2023).

As learners progress further in their academic journey, a significant portion of South African learners struggle to articulate their scientific ideas in English, the language used for assessments, as posited by Probyn (2006). Offering education to learners in their native language is a beneficial practice, as it enhances the likelihood of learners remaining enrolled in school (Adedigba et al., 2023). The problem of language does not only affect learners; Probyn (2006) noted that many teachers in underprivileged schools lack proficiency in the language of instruction. This compromises curriculum delivery and hinders both teacher and learner language skills development, contributing to high failure rates and a decline in education standards (Alidou & Brock-Utne, 2006).

The Department of Basic Education (DBE) piloted a Mother Tongue-based Bilingual Education program in the Eastern Cape, 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. Integrating 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 (Mkhize & Ndimande-Hlongwa, 2014). Consequently, many learners who use English as a second language struggle to have a meaningful science education in their indigenous languages (Malcolm, 2010). This study investigated the effectiveness of the Tshivenḓa scientific language register in shaping meaningful learning in physical sciences classrooms.

LITERATURE REVIEW

Meaningful learning

Ntuli (2022) defines meaningful learning as a dialogic process wherein diverse ideas are synthesized and deliberated upon. 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 learning science. The application of a mother tongue, such as Tshivenḓa, in teaching science allows learners to integrate new information with prior knowledge, resulting in increased engagement and enhanced knowledge retention and application (Andrews et al., 2023). Therefore, the mother tongue bridges subject content knowledge with a learner's worldview and cognitive processes (Mweli, 2018).

Probyn (2006) highlights that many South African learners struggle to articulate their scientific ideas in English, the language used for assessments. This is because learners construct meaning through language (Shisanya, 2019). Language proficiency is crucial for acquiring the conceptual understanding necessary for learners to excel in future academic endeavors, particularly in scientific subjects (Prinsloo et al., 2018). Teaching may become meaningless if learners cannot perceive or understand information in the learning and teaching process (Gürlen, 2012). Therefore, applying the Tshivenḓa scientific language register in teaching physical sciences could facilitate communication and serve as a conduit for transmitting individuals' knowledge, practices, and cultural values (Manyike & Shava, 2018), resulting in meaningful learning.

Scientific language register

Halliday (1989) defines a register as speakers' conscious selection of vocabulary and grammatical structures, considering situational context, participants, and discourse purpose. Creating 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). Utilizing the learner's home language in classroom interactions fosters effective communication, empowering learners to take ownership of their learning.

However, some perspectives suggest 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. In their study, Motloung et al. (2021) noted that the language of instruction in science classes, particularly in physical sciences, poses ongoing challenges, negatively impacting both teachers and learners. According to Mavuru and Wilson (n.d.), learners perceive English as challenging, leading to underperformance in science subjects. As a result, they encounter difficulties associating scientific learning with everyday experiences (Fung & Yip, 2014).

Bilingualism

Wright and Baker (2017) define bilingualism 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, aiding their literacy development. 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 leading to vocabulary loss in both languages. Nonetheless, some parents prefer that their children learn English from an early age rather than focus on their home language (Molteno, 2017). According to Nyimbili and Mwanza (2021), children enter school with extensive oral vocabulary and knowledge of their mother tongue's sound system but 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.

Translanguaging

Karlsson et al. (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 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, 2019).

Scholars such as 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. According to Vogel and Garcia (2017), 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 (Yilmaz, 2021) by honoring individuals' language backgrounds, cultures, and identities (Zorba, 2023). 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).

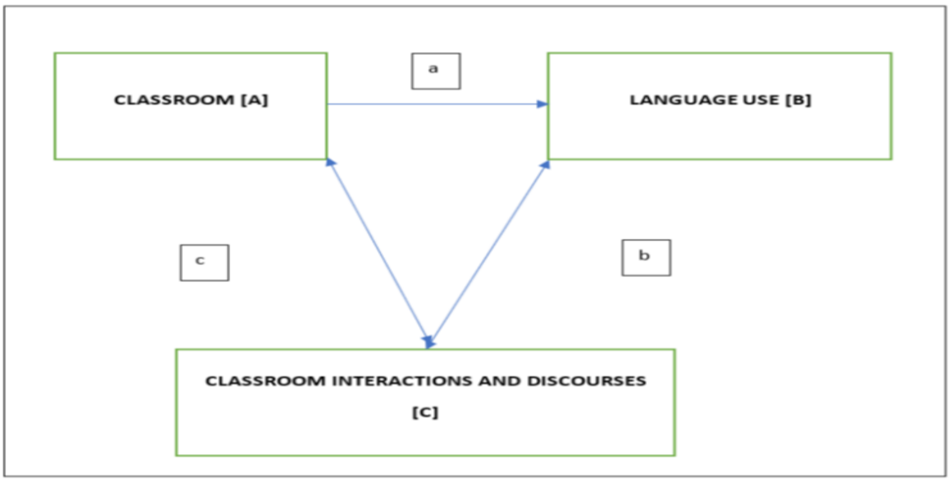
THEORETICAL AND CONCEPTUAL FRAMEWORK

This study is grounded in Vygotsky's social constructivism (1978), which 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). In 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 students (Degu, 2022).

This study adopted Ntuli's (2022) Classroom Language Analytical Framework (CLAF), which complements Vygotsky's theory by asserting that the language used in the classroom influences interactions between teachers and learners, as well as among learners themselves. The type of classroom discourse is shaped by the language employed by both teachers and learners. 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 debate and challenges. Reflective discourse allows teachers to gauge learners' proficiency levels in a subject.

Employing mother tongue instruction throughout schooling may not impede acquiring a second language (Yadav, 2014). Madriñan's (2014) adapted argument suggests that learners taught physical science concepts using registers in indigenous languages do not require English instruction, as the underlying processes remain the same. Thus, applying the Tshivenda scientific language register does not alter the content of the subject. Consequently, CLAF was utilized to analyze whether Tshivenda, as a social language in the science classroom, could facilitate meaningful learning.

Figure 1.
CLAF



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 learners and the teacher interact. Frame B denotes the languages utilized for teaching and learning in this study: Tshivenda and English. Frame C illustrates how the language used influences interaction and discourse (Frame B). Effective interaction and discourse, facilitated by the language used in the classroom, contribute to meaningful learning.

METHODS

This study employed a qualitative approach focusing on real-world issues to offer in-depth insights (Korstjens & Moser, 2017). This approach was used to understand how the application of the Tshivenda scientific language register in physical sciences shapes meaningful learning in the classroom. Tenny et al. (2017) noted that qualitative research does not quantify data but elucidates it through words. This approach allowed for diverse data collection techniques, such as observations, without altering the phenomenon of interest (Denzin & Lincoln, 2011). Data collection in qualitative research occurs in natural settings, and observations were used to explore how interactions among participants in the classroom, employing Tshivenda scientific language registers, influence meaningful learning.

Sample

According to Creswell (2012), a sample represents a subset of the population that researchers investigate to generalize about the broader population. Given that qualitative research is best suited for smaller samples (Langkos, 2014), it facilitates effective data management. Therefore, this study employed purposive sampling to select individuals based on specific attributes, such as expertise and experience (Etikan et al., 2016). Two teachers were selected due to their minimum of three years of experience teaching physical sciences at the Nzhelele East circuit and their qualifications in the subject. Additionally, one class of Grade 10 physical sciences learners was included. All participants were volunteers; since the study involved learners, parents signed consent forms on behalf of their children.

Data collection methods

Observation was used to collect data by providing authentic and unfiltered information from participants within their natural surroundings (Dźwigoł & Barosz, 2020). The researcher observed two teachers, one from each school, as they implemented both English and Tshivenda scientific language registers in their classrooms. The primary focus was on the interactions and discourse to assess how the use of each register contributed to meaningful lessons. According to Muzari et al. (2022), the observer documented observations in their own words to accurately represent the actions and interactions witnessed. Detailed notes were taken on language usage during the observations, with the researcher maintaining a non-participant role to avoid influencing classroom dynamics. To ensure rigor, each teacher was observed multiple times, with each observation lasting one hour. For 45 minutes, they used 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 examining how interactions unfolded and contributed to meaningful learning when employing these registers.

Data analysis

In qualitative research, data analysis involves transforming raw data into coherent facts and ideas (Alem, 2020). The data gathered from participant observations were consolidated and subjected to content analysis. This process helped the researcher examine the recorded data, which were transcribed from audio recordings after multiple listens. Thematic analysis was also employed to analyze the transcribed data. Thematic analysis is a systematic method used to identify, organize, and derive insights from emerging themes and patterns in the data (Dawadi, 2021). To ensure the validity of the findings, the data collected from observations were meticulously categorized and coded to uncover recurring themes and patterns.

RESULTS AND DISCUSSION

The findings of this study were obtained from two cases, each represented separately with the intention of avoiding a comparative study. Two types of registers were utilized: the Tshivenda scientific language register and the English scientific language register. Observation was employed as the method of data collection, as it is considered a crucial approach for classroom research involving teachers and learners (Saar et al., 2022). This method was used to examine how interactions and discourse during the implementation of both the Tshivenda and English scientific language registers contribute to 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."

The researcher observed the following in the application of the Tshivenda scientific language register.

Case 1: Tshifhiwa

The content was translated from Tshivenda to English, as it did not yield any additional findings.

Tshifhiwa *: Today we will talk about electricity in another way we call it electric circuit. In your opinion, where does electricity start at the electric current?*

Learners : In the battery

Based on the preceding observations, learners have prior knowledge of the concept of electricity. Effective learning requires connecting this prior knowledge with new information (Gürlen, 2012). Tshifhiwa further engages with the learners in the following extract:

Tshifhiwa: *Look into the components of an electric circuit, which component do you know?*

Learner *: Bulb*

Tshifhiwa *: What is the function of the bulb?*

Learner 1 *: To give us light*

Leaner 2 *:To shine at us*

Tshifhiwa *:Yes it shines at us or it gives us light*

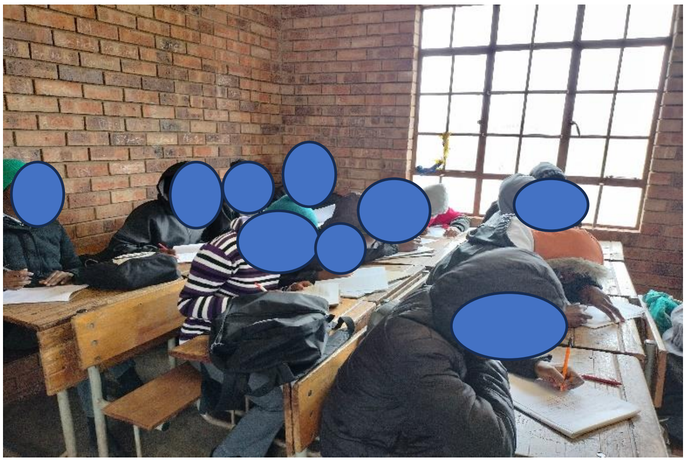
The researcher observed Tshifhiwa's use of dialogic discourse in the classroom, which facilitated active participation by the learners (Mudau, 2013). According to Ntuli (2022), meaningful learning involves a dialogic process where learners achieve a deep understanding of the subject (Gurlen, 2012). Limberg et al. (2008) suggest that interaction between teachers and learners, focused on learning goals and content, is crucial for meaningful learning.

Additionally, the researcher noted the following occurrences while Tshifhiwa assigned an activity to the learners:

Tshifhiwa *: Assume we are given work of 240J and the charge of 10C. calculate the voltage.*

Figure 2.

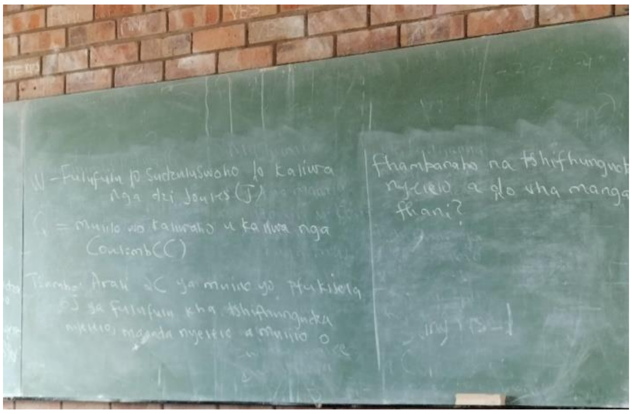
Learners working on an activity



From the scenario, the researcher observed that learners were given the opportunity to seek answers independently while the teacher monitored their progress. This approach is characterized as interactive-authoritative, as described by Mudau (2013), where the teacher primarily seeks correct answers from the learners. Mudau (2013) and Chin (2006) define this approach as one where the teacher circulates around the classroom to ensure learners provide accurate responses. However, this method does not significantly promote interaction among the learners. Interaction and discourse between the teacher and learners are crucial in the science classroom for creating meaning (Mortimer & Scott, 2003; Mudau, 2013). Without such interaction, the lesson may lack significance. Nevertheless, the researcher observed that Tshifhiwa acknowledged the learners' difficulties and subsequently engaged them in additional group activities.

Figure 3.

Learners additional activity



Immediately after completing their work, the teacher directed volunteers to present their written work on the board. This method fosters interaction among learners: while one learner writes on the chalkboard, others observe and provide corrections. The teacher's role is primarily to validate the accuracy of the content. This approach enhances communication, as learners use a language in which they are fluent. Language serves not only as a means of communication but also as a critical factor influencing comprehension and the development of new ideas (Ramulumo, 2023). Consequently, this approach contributes to meaningful learning. Following the observation of the implementation of the Tshivenda scientific language register, the researcher also noted the use 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?

The researcher noted that the teacher did not take the learners’ prior knowledge into account at the beginning of the lesson. Prior knowledge plays a pivotal role in engaging learners (Dong et al., 2020). The teacher assumed that the learners were unfamiliar with electric circuits, so they posed a question and provided the answer, as illustrated.

Learner *: Light bulb*

Tshifhiwa *: What is its function?*

Learner *: The bulb gives us light*

Tshifhiwa *: Another component?*

Learner *: Switch*

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 due to the lack of interaction among the learners. This approach does not promote significant learner interaction. Interactions and discourse between the teacher and learners are crucial in the science classroom for facilitating meaning-making (Mortimer & Scott, 2003; Mudau, 2013). Without such interaction and discourse, the lesson may lack significance.

Case two: Peter

The following observations were made during the implementation of the Tshivenḓa scientific language register. While using the Tshivenḓa scientific language register, the teacher was observed to employ English terminology rather than Tshivenda equivalents when teaching physical sciences.

Peter : *Where are those charges coming from?*

Learners: *From the cell*

Peter: *In the cell or what?*

Learners: *In the battery*

Peter : Yes, kha battery. *What is this? (Showing learners on the board*)

Learners: *Is the bulb*

Peter : Correct

This issue may be due to either insufficient lesson preparation or a lack of familiarity with Tshivenda scientific terminology. Despite these challenges, the specific English terms used by the teacher during the Tshivenda lesson were not unfamiliar to the learners, as they had been introduced to them in Grade 9 Natural Sciences, as the teacher noted at the start of the lesson. The researcher focused on how the application of the Tshivenda scientific language register influenced meaningful learning. From the use of the Tshivenda scientific language register, the researcher observed two types of discourse that impacted how learners connected concepts with meaning. In this instance, the teacher employed the Initiation, Response, and Feedback (IRF) model (Ntuli, 2022; Netshivhumbe, 2022). The teacher initiated communication by posing questions to the learners, who then responded, followed by the teacher providing feedback. However, the questions posed by the teacher were all straightforward and did not encourage critical thinking among the learners.

Another approach observed was the Initiation, Response, Feedback, Response, and Feedback (IRFRF) model. In this approach, the teacher began the lesson by asking probing questions, which were then answered by the learners. The teacher responded to these answers with additional questions, based on the learners' responses, and finally provided a concluding feedback on the learners' contributions (Ntuli, 2022). The following illustrates the application of the IRFRF model in the classroom:

Peter*: The light can be on and off, but there is something that makes that to happen. What do we call that?*

Learner: *A switch*

Peter: *(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: *It is opened, electricity cannot pass through*

Peter: *When it is closed, what happens to it?*

Learners: *Electricity can pass through*

Peter: *yes it is correct, charges can pass through when it is closed*

Peter facilitates the expression of learners' ideas, leverages the information they provide, and draws on their experiences to guide them toward deeper levels of understanding (Sharan, 2018). Using an indigenous language to teach African learners allows them to better understand and connect with concepts within their own language and cultural context (Ntuli, 2024). Furthermore, Peter employed the IRFRF model to encourage critical thinking and reflective dialogue among learners, thereby promoting meaningful learning.

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

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)*

The exclusive use of English during question-and-answer sessions in the classroom can impede learners' active engagement in interactions. Struggles with English often lead to peers reacting with laughter, which undermines learners' self-confidence and sense of belonging (Owen-Smith, 2010). The manner in which a teacher poses questions is crucial, as it can enhance motivation, foster critical thinking, and encourage active participation in the learning process. However, this skill was not evident in Peter's use of the English scientific language register.

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

Learners: *Is to opposes the 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 the voltmeter, which measures the voltage*.

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

CONCLUSION

The results of this study revealed that Tshifhiwa employed varied approaches when delivering lessons in Tshivenda, effectively engaging the learners and fostering interaction between them and their teacher. The use of Tshivenda instruction in the classroom significantly enhances meaningful learning. However, during the observation of the English scientific language register, only a few learners showed interest in responding to questions, and the teacher did not provide as thorough explanations as when using the Tshivenda scientific register. This suggests proficiency issues with English among both learners and teachers when utilizing the English scientific language register.

Despite facing challenges with the Tshivenda scientific language register, Peter effectively used the IRFRF method to engage learners in science teaching. Learners participated actively, though they encountered difficulties with English terminologies during the Tshivenda lesson. In contrast, the English scientific language register resulted in lower engagement levels, with learners not being given opportunities to think independently, and questions posed by the teacher failing to stimulate critical thinking.

Implementing the Tshivenda scientific language register provides learners with a more accessible and comprehensible means of learning scientific concepts. Teaching science in Tshivenda respects and acknowledges learners' cultural and linguistic diversity, promotes inclusivity, and aligns educational practices with students' cultural backgrounds, fostering a sense of belonging and identity. The study demonstrated that using the Tshivenda scientific language register led to increased learner participation and interaction in the classroom compared to using English. Learners showed greater confidence and enthusiasm when learning in their mother tongue, resulting in more meaningful learning experiences.

Based on these findings, several recommendations can be made. Firstly, further research and collaboration are needed to develop a comprehensive scientific language register in Tshivenda with standardized terminology. This effort should involve 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 includes strategies for integrating the register into lesson plans and addressing any challenges that may arise.

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REFERENCES

Adedigba, O., Soretire, O. O., & Ajayi, O. A. (2023). Teachers' Perception of the Role of Indigenous Languages for Culture Preservation and Improved Teaching and Learning in Kwara State, Nigeria. *East African Journal of Education and Social Sciences* (EAJESS), 4(2), 1-9. https://doi.org/10.46606/eajess2023v04i02.0270

Alem, D. D. (2020). An overview of data analysis and interpretations in research. *International Journal of Academic Research in Education and Review*, *8*(1), 1-27. https://doi.org/10.14662/IJARER2020.015

Alidou, H., & Brock-Utne, B. (2006). Experience I–Teaching practices–Teaching in a familiar language. Optimizing learning and education in Africa-the language factor: *A stock-taking research on mother tongue and bilingual education in sub-Saharan Africa*, 159-184. *Paris: ADEA*.

Andrews, D., van Lieshout, E., & Kaudal, B. B. (2023). How, Where, And When Do Students Experience Meaningful Learning? *International Journal of Innovation in Science and Mathematics Education*, 31(3), 28-45.

Chabalala, J. (2023, May 16). *Grade 4 pupils have difficulty in reading with understanding*. SowetanLIVE; SowetanLIVE. https://www.sowetanlive.co.za/news/south-africa/2023-05-16-grade-4-pupils-have-difficulty-in-reading-with-understanding/

Charamba, E. (2023). Translanguaging as bona fide practice in a multilingual South African science classroom. *International Review of Education*, 1-20. https://doi.org/10.1007/s11159-023-09990-0

Chin, C. (2006). Classroom interaction in science: Teacher questioning and feedback to students' responses. *International journal of science education,* 28(11), 1315-1346. https://doi.org/10.1080/09500690600621100

Chin, C. (2006). Classroom interaction in science: Teacher questioning and feedback to students' responses. *International journal of science education*, *28*(11), 1315-1346. https://doi.org/10.1080/09500690600621100

Clerk, D. (2010). Science Education 2: Language and Learning. Course Notes: Division of Mathematics & Science Education, School of Education, *University of the Witwatersrand.*

Creswell, J. (2012). Educational Research, 4th edition. University of Nebraska - Lincoln

Cummins, J. (1981). Empirical and theoretical underpinnings of bilingual education. *Journal of Education*, 163(1), 16-29. https://doi.org/10.1177/002205748116300104

Cummins, J. (2001). HER classic reprint: Empowering minority students: A framework for intervention. *Harvard Educational Review*, 71(4), 649-676. https://doi.org/10.17763/haer.71.4.j261357m62846812

Dawadi, S. (2021). Thematic analysis approach: A step by step guide for ELT research practitioners. *Journal of NELTA*, *25*(1-2), 62-71.

Degu, T. G. (2022). Learning Science Through the Mother's Tongue In Ethiopian Primary School: Its Scientific Benefits And Challenges. *Journal of Positive School Psychology*, 6(8), 9038-9050.

Denzin, N. K., & Lincoln, Y. S. (Eds.). (2011). The Sage handbook of qualitative research. sage.

Department of Basic Education. (2011). Curriculum and Assessment Policy Statement (CAPS): FET physical sciences.

Department of Basic Education. 2013a. National Education Evaluation and Development Unit (NEEDU). National Report 2012: The State of Literacy Teaching and Learning in the Foundation Phase. Pretoria: DBE.

Dong, A., Jong, M. S. Y., & King, R. B. (2020). How does prior knowledge influence learning engagement? The mediating roles of cognitive load and help-seeking. *Frontiers in psychology*, *11*, 591203. https://doi.org/10.3389/fpsyg.2020.591203

Dźwigoł, H., & Barosz, P. (2020). Observation as a research method in social science. *Scientific Papers of Silesian University of Technology (Organization & Management Series)* (148), 141-149.

Etikan, I., Musa, S. A., & Alkassim, R. S. (2016). Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, 5(1), 1-4. https://doi.org/10.11648/j.ajtas.20160501.11

Ezeokoli, F. O., & Ugwu, E. O. (2019). Parents', teachers' and students' beliefs about the use and study of mother-tongue in the secondary schools in Akinyele Local Government Area, Oyo State, Nigeria. *International Journal of Education and Literacy Studies*, 7(2), 82-93.

Fung, D., & Yip, V. (2014). The effects of the medium of instruction in certificate-level physics on achievement and motivation to learn. *Journal of Research in Science Teaching*, *51*(10), 1219-1245. https://doi.org/10.1002/tea.21174

Gort, M., & Sembiante, S. F. (2015). Navigating hybridized language learning spaces through translanguaging pedagogy: Dual language preschool teachers' languaging practices in support of emergent bilingual children's performance of academic discourse. *International Multilingual Research Journal*, 9(1), 7-25.

Gürlen, E. (2012). Meaningful learning and educational environment. *Journal of Education and Future*, (1), 21.

Halliday, M.A.K. (1989). *Spoken and written language*. Oxford: Oxford University Press.

Jawad, N. A. M. M. (2021). Bilingual education: Features & advantages. *Journal of Language Teaching and Research*, 12(5), 735-740. https://doi.org/10.17507/jltr.1205.12

Karlsson, A., Nygård Larsson, P., & Jakobsson, A. (2020). The continuity of learning in a translanguaging science classroom. *Cultural Studies of Science Education*, 15, 1-25. https://doi.org/10.1007/s11422-019-09933-y

Korstjens, I., & Moser, A. (2017). Series: Practical guidance to qualitative research. Part 2: Context, research questions and designs. *European Journal of General Practice*, *23*(1), 274-279. https://doi.org/10.1080/13814788.2017.1375090

Langkos, S. (2014). CHAPTER 3-RESEARCH METHODOLOGY: Data collection method and Research tools. *Retrieved May*, *22*, 2018.

Limberg, L., Alexandersson, M., Lantz-Andersson, A., & Folkesson, L. (2008). What matters? Shaping meaningful learning through teaching information literacy. https://doi.org/10.1515/libr.2008.010

Madriñan, M. (2014). The Use of First Language in the Second-Language Classroom: A Support for Second Language Acquisition. *Gist Education and learning research journal*, 9, 50-66.

Makalela, L. (2019). Uncovering the universals of ubuntu translanguaging in classroom discourses. Classroom Discourse, 10(3-4), 237-251. https://doi.org/10.1080/19463014.2019.1631198

Malcolm, S. A. (2010). A Discussion on Developing Scientific Registers in Indigenous Languages or Developing English Communication Skills to Improve English Second-Language Learners' Performance in Science.

Manyike, T. V., & Shava, S. (2018). The decolonial role of African indigenous languages and indigenous knowledges in formal education processes. *Indilinga African Journal of Indigenous Knowledge Systems*, 17(1), 36-52.

Mavuru, L., & Wilson, N. (n.d). Multilinguial learners' perceptions of the role of english and scientific language on natural sciences learning.

Mkhize, N., & Ndimande-Hlongwa, N. (2014). African languages, indigenous knowledge systems (IKS), and the transformation of the humanities and social sciences in higher education. *Alternation*, 21(2), 10-37.

Molteno, A. (2017). The effect of LoLT on learner performance in disadvantaged schools in the Western Cape (Master's thesis, University of Cape Town).

Mortimer, E., & Scott, P. (2003). Meaning Making In Secondary Science Classroomsaa. *McGraw-Hill Education* (UK).

Mose, P. N. (2017). Language-in-education policy in Kenya: Intention, interpretation, implementation. *Nordic Journal of African Studies*, 26(3), 16-16. https://doi.org/10.53228/njas.v26i3.86

Motloung, A. N., Mavuru, L., & McNaught, C. (2021). Teachers' beliefs and practices when teaching life sciences using their second language. *South African Journal of Education*, 41(sup1), S1-S15.

Mudau, A. V. (2013). Teaching difficulties from interactions and discourse in a science classroom. *Journal of Educational and Social Research*, 3(3), 113. https://doi.org/10.5901/jesr.2013.v4n3p113

Musanti, S. I., & Rodríguez, A. D. (2017). Translanguaging in bilingual teacher preparation: Exploring pre-service bilingual teachers' academic writing. *Bilingual Research Journal*, 40(1), 38-54. https://doi.org/10.1080/15235882.2016.1276028

Muzari, T., Shava, G. N., & Shonhiwa, S. (2022). Qualitative research paradigm, a key research design for educational researchers, processes and procedures: A theoretical overview. *Indiana Journal of Humanities and Social Sciences*, *3*(1), 14-20. https://doi.org/10.5281/zenodo.12808466

Mweli, P. (2018). Voices of grade four teachers in response to mazibuye izilimi zomdabu!(bring back African languages!): A decolonising approach. *Journal of Education (University of KwaZulu-Natal)*, (72), 38-54. http://dx.doi.org/10.17159/2520-9868/i72a03

Netshivhumbe, N. P. (2022). Developing and using the Tshivenda scientific register for Physical Science submitted in accordance with the requirements for the degree of Doctor of Philosophy in Natural Sciences Education). Pretoria: University of South Africa.

Ntuli, T. G. (2024). The influence of natural science scientific register in isiNdebele on classroom practices. *Eurasia Journal of Mathematics, Science and Technology Education*, *20*(4), em2429. https://doi.org/10.29333/ejmste/14417

Ntuli, T.G. (2022). Developing the scientific language register for natural sciences in isiNdebele and its application in some classes of the Siyabuswa 2 Circuit. (Submitted in accordance with the requirements for the degree of Doctor of Philosophy in Natural sciences Education). Pretoria: University of South Africa.

Nyimbili, F., & Mwanza, D. S. (2021). Translanguaging challenges faced by teachers and learners in first grade multilingual literacy classrooms in Zambia. *International Journal on Studies in English Language and Literature (IJSELL)*, 9(3), 20-31.

Owen-Smith, M. (2010). The language challenge in the classroom: A serious shift in thinking and action is needed. Focus, 56(7), 31-37.

Prinsloo, C. H., Rogers, S. C., & Harvey, J. C. (2018). The impact of language factors on learner achievement in science. *South African Journal of Education*, *38*(1), a1438. https://doi.org/10.15700/saje.v38n1a1438

Probyn, M. (2006). Language and learning science in South Africa. *Language and Education*, 20(5), 391-414. https://doi.org/10.2167/le554.0

Prophet, R. B., & Badede, N. B. (2009). Language and Student Performance in Junior Secondary Science Examinations: The Case of Second Language Learners in Botswana. *International Journal of Science and Mathematics Education,* 7(2), 235–251. https://doi.org/10.1007/s10763-006-9058-3

Ramulumo, M. (2023). Science Students' Attitudes Towards the Use of Indigenous Language in Understanding Visual Representations. Journal of Innovative Science Education, 12(2), 125-140. https://doi.org/10.15294/jise.v12i2.72094

Romanowski, P. (2020). Perceptions of translanguaging among the students and teachers of EMI classrooms in Poland. *Lenguas Modernas*, (55), 151-165.

Saar, M., Prieto, L. P., & Rodríguez Triana, M. J. (2022). Classroom data collection for teachers' data-informed practice. *Technology, Pedagogy and Education*, *31*(1), 123-140. https://doi.org/10.1080/1475939X.2021.1989024

Schafer, M. (2010). Mathematics Registers in Indigenous Languages: Experiences from South Africa. *Mathematics Education Research Group of Australasia.*

Sharan, Y. (2018). Meaningful learning in the cooperative classroom. In Learning to Learn together (pp. 79-90). *Routledge*.

Shayne, V. (2020, March 10). OVERCOMING LANGUAGE BARRIERS IN SOUTH AFRICAN CLASSROOMS. E-Classroom.Co.Za. https://e-classroom.co.za/blog/overcoming-language-barriers-in-south-african-classrooms

Shisanya, C. (2019). Epistemological paradigms in social research. *Conducting Research and Mentoring Students in Africa*, *39*.

Tenny, S., Brannan, J. M., & Brannan, G. D. (2017). Qualitative study.

Vogel, S., & García, O. (2017). Translanguaging. [Online] Available at: https://academicworks.cuny.edu/gc_pubs/402/

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Cambridge, MA: *Harvard University Press*.

Wright, W. E., & Baker, C. (2017). Key concepts in bilingual education. *Bilingual and Multilingual Education*, 65-79.

Yadav, M. K. (2014). Role of mother tongue in second language learning. *International Journal of Research*, 1(11), 572-582.

Yilmaz, T. (2021). Translanguaging as a pedagogy for equity of language minoritized students. *International Journal of Multilingualism*, *18*(3), 435-454.

Zhou, S., & Landa, N. (2019). Translanguaging as foundational pedagogy: Disrupting hegemonies for academic access in multilingual spaces. *Alternation*, *26*(2), 290-310. https://doi.org/10.29086/2519-5476/2019/v26n2a13

Zorba, M. G. (2023). A text-based approach to developing EFL learners' intercultural awareness in higher education. *Turkish Journal of Education*, *12*(2), 106-121. https://doi.org/10.19128/turje.1186875