

THE EFFICACY OF TRANSLANGUAGING: A CRITICAL REVIEW OF SELECTED SOUTH AFRICAN MATHEMATICS AND SCIENCE INTERMEDIATE PHASE CLASSROOMS

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Article Info	Abstract
Article History Received: May 2023 Revised: June 2023 Published: July 2023	<i>The 2015 TIMSS and 2021 PIRLS results show the underachievement of our learners in reading comprehension, mathematics and science. Analysts of both assessments suggest the low performance is caused, chiefly, by the misalignment between learners' home languages and the language of instruction. Even though today's classrooms have become more and more culturally and linguistically diverse resulting in the majority of learners entering the classroom with a home language different from the language of instruction, the teaching of such learners still follows a monolingual trajectory. This has resulted in a drop- in the number of primary school learners exhibiting basic mathematics and scientific literacy in South Africa. Through semi-systemic review, the current study sought to explore the role language plays in concept comprehension among learners as well as examining the efficacy of translanguaging in mathematics and science classrooms. Eight studies were reviewed and results suggest that proficiency in the language of instruction plays a crucial role in comprehension of scientific and mathematical concepts. The study also shows the efficacy of translanguaging in enhancing the academic performance of learners and recommends the use of translanguaging within multilingual contexts. We therefore recommend the use of translanguaging in multilingual classrooms.</i>
Keywords Translanguaging; Multilingualism; Mathematics and science education; Monolingualism; Multiculturalism	
How to cite: Ndhlovana, S. N., & Charamba, E. (2023). The Efficacy of Translanguaging: A Critical Review of Selected South African Mathematics and Science Intermediate Phase Classrooms, <i>JOLLT Journal of Languages and Language Teaching</i> , 11(3), pp. 373-389. DOI: https://doi.org/10.33394/jollt.v%vi%i.7904	

INTRODUCTION

PIRLS results demonstrated the stark differences in reading literacy skills across South African learners based on the outcomes in 2016. The average score for learners attending well-resourced schools was 410, whereas the average score for learners in South African under-resourced schools was 294. The 2021 PIRLS results also indicated an decrease of 3%, as in 2016 78% of South African learners could not read for meaning with 2021 results suggesting that 81% of South African learners cannot read for meaning. According to the PIRLS and TIMSS assessments, the country's poor reading literacy and academic performance levels may be a result of monolingual pedagogies used in the classrooms. Studies suggest that monolingual pedagogies can provide serious learning difficulties for learners who may not speak nor understand the language of instruction, especially those from under-resourced backgrounds who have no exposure to the language. This is because these learners often receive very little exposure to the language outside of the classroom and may find it difficult to comprehend decontextualized reading texts written in a language they have low proficiency in. Although the majority of these learners are taught in a language in which they are not fluent and competent, the negative impacts of using an additional language exclusively as a medium of instruction in teaching and learning are disregarded (Charamba,

2023). This is a similar feature in the South African education system where about 80% of the learners are taught through a language different from their home language (Charamba, 2022).

Education in South Africa is divided into phases. The second phase of formal schooling in South Africa is called the Intermediate Phase (IP), with the first being the Foundation Phase. The IP includes learners who are between ten and thirteen years and would be attending Grades 4 to 6. According to Mgiijima and Makalela (2021) this is a crucial phase and likely the most difficult phase of education for learners who do not speak English in South Africa, a language that is used as the medium of instruction from Grade 4 upwards. This is mostly because in the previous phase, the Foundation phase, where learners would have been taught through their home language alongside a language of instruction. As they come into the IP, the *modus operandi* switches to monolingual pedagogy. Learners do not only have to deal with an increased number of subjects but also transition from using their mother tongue as the Language of Learning and Teaching (LoLT) in foundation phase, to using English as the medium of instruction. This sudden shift often results in what is known as the fourth grade reading slump (Best, Floyd & McNamara, 2004) which is when learners are spending their time and energy trying to decipher words in printed text rather than reading with fluency (smoothly, in a style that conveys meaning). Therefore, it is of paramount importance that learners are supported during this transition period to develop both their HL and (FAL) so as to understand some of the mathematics and scientific concepts better.

The central focus of this study was to investigate the efficacy of translanguaging in Mathematics and Science South African intermediate phase classrooms by evaluating previous research and drawing conclusions from the results. Reviewing existing literature yields a better understanding of the underlying problems that contribute to South Africa's low literacy rates, the role that language plays in the teaching and learning of mathematics and science in South African intermediate phase classrooms, and the ways in which translanguaging, a teaching strategy that employs a tapestry of the learners linguistic repertoire, can be used to foster the critical thinking abilities needed in intermediate phase mathematics and science classrooms.

With eleven official languages (English, Afrikaans, isiNdebele, isiZulu, Sesotho, Sepedi, siSwati, Xitsonga, Setswana, Tshivenda, and isiXhosa, even South African sign language) scripted in the current South African Language in Education Policy (LiEP) and allowing any of these official languages to be used as the medium of instruction, in many schools around the nation, monolingualism continues to be the standard pedagogical approach (Hattingh, McKinney, Msimanga, Probyn & Tyler, 2022; Charamba, 2023). All but two South African official languages are actively excluded from the curriculum (Charamba, 2021) and the home languages of about 19.7% of the country's total population, English and Afrikaans, are used to teach mathematics and science from the fourth grade upwards. This clearly shows that though the LiEP was developed to promote additive multilingualism as an approach to language in education in order to address historical imbalances and grant freedom of choice (Department of Education, 1997) it has not been successfully implemented in many educational contexts as evidenced by the existing gap between policy and practice.

Even after 26 years of implementing the South African Language in Education Policy (LiEP), which aims to increase educational access, engagement, and achievement for all students, there is still a need to promote the use of mother tongues and translanguaging in our classrooms especially mathematics and science classrooms. Hattingh et al., (2022) argue that multilingual students' ability to fully understand scientific and mathematical concepts is hampered by monolingual oriented pedagogies practiced in the classroom. Schoeman, Geertsema, le Roux and Pottas (2023) concur and add that the epistemological consequences of monolingualism is evidenced in the underwhelming results of national and international tests of mathematical and scientific proficiency. This means that learners acquire academic

expertise and abilities communicated using a decontextualised school language which they frequently do not yet completely understand. This affects their performance in classroom, national and international assessments. For them to comprehend concepts better, this calls for the dissemination of knowledge in bilingual and multilingual contexts as monolingual approaches hinder academic progress (Li, 2018).

Over the past few decades, curiosity regarding the interrelationships between language and the teaching and learning of mathematics and science has grown greatly (see for example Robertson & Graven 2020; Ortiz 2022; Hattingh et al., 2022). However, in South Africa not much research has been focused on how we can use language as a useful tool in our mathematics and science classroom especially in intermediate phase. Turning to international assessments such as the Trends in International Mathematics and Science Study (TIMSS), South African grade 5 and 9 learners performed below average. In their analysis of the TIMSS 2015 results, Reddy, Visser, Winnaar, Arends, Juan, Prinsloo, and Isdale (2016) identified the difference in mother tongue and medium of instruction as the primary reason for the participants' underachievement.

TIMSS is an assessment of mathematics and science knowledge of fourth and eighth-grade learners from selected countries around the world. South Africa however participated at fifth and ninth grades (Reddy et al., 2016). Of the 39 countries selected in the year 2015, South Africa was the 39th out of 39 countries that took part in the ninth-grade science assessment. TIMSS 2019 which was the seventh assessment cycle, was conducted in 64 countries with 8 benchmarking systems and South African learners again performed below average. Even though there might be many factors that contribute to this dismal performance, the most notable of these is the language of teaching used in classrooms (South African Parliamentary Monitoring Report, 2017).

To ameliorate this, scholars have reported higher levels of participation and improved academic results in classes that permit and make use of translanguaging practices (Charamba, 2022). This suggests that translanguaging is the most effective strategy for teaching mathematics and science students whose home language is different from the school's language of instruction as Bonomi (2020) asserts that through translanguaging, learners become proficient multilinguals without compromising the English language development.

In addition to the TIMSS is the Progress in International Reading Literacy Study (PIRLS) conducted every five years and assesses international trends in the reading comprehension of learners in their fourth year of schooling--an important transition point in children's development as readers. PIRLS was designed to complement the International Association for the Evaluation of Educational Achievement's TIMSS assessments of mathematics and science at the fourth grade. According to the PIRLS 2016 study, South Africa scored the lowest among benchmarking participants with a score of 320, which is significantly lower than the PIRLS center point of 500. With a score 94 points below the global average, South Africa ranks among the bottom five nations on the PIRLS scale. In the past four cycles (from 2001 to 2021) South Africa's rating stood at 24%; 22%; and 19% respectively (Howie, Combrinck, Tshele, Roux, McLeod Palane & Mokoena, 2017). The 2021 PIRLS results show that only 19% of South Africa's Grade 4 learners can read for comprehension (Reddy et al., 2022). Several analysts have singled out the exclusion of learners' home languages as the major cause of low academic performance among these multilingual learners and advocate for the adoption of multilingual pedagogies such as translanguaging.

The term "translanguaging" was coined in the 1980s by Cen Williams describing the practice of using two languages in the same lesson (Stroupe, Moon & Michaels, 2019). Over the years, the idea of translanguaging has been extended and scholars have yet grounded it on the notion that it is an extension of the concept of languaging, where many languages are

frequently used at once (Li,2018). Multilingual speakers overcome challenging social and cognitive challenges in a dynamic way by strategically using various languages to enhance their understanding. Similarly, Vogel and García (2017) states that translanguaging is a theoretical lens that provides a distinct perspective on bilingualism and multilingualism. The theory claims that all language users, including bilinguals and multilinguals, choose and use specific features from a unitary linguistic repertoire (Garcia, 2009) to make sense of and navigate different communicative contexts rather than having two or more autonomous language systems as has been traditionally believed.

In defining translanguaging, drawing from the above definitions, it is a general term for a communication encounter in which multilingual interlocutors employ multiple semiotic techniques to express ideas that is combining resources from several languages, paying little attention to what we would call the 'boundaries' of named languages to improve communication. As opposed to focusing on language itself, translanguaging is about communication. For instance, there are times when we must act as language teachers, emphasising precision in order for our learners to pass exams and be accepted as proficient English speakers in society at large. But most of the time, we help learners explore ideas, expand their knowledge, connect disparate concepts, and gain the confidence to speak up in front of others. Often, this is about communicating, and in this case, making use of all of our linguistic resources can be very beneficial.

LITERATURE REVIEW

Cognisance of the fact that English has been accepted as the country's primary language of learning and teaching (LoLT), learners who struggle with their English communication abilities may find it challenging to excel academically. The academic achievement of language learners will undoubtedly be impacted and improved by their ability to communicate effectively in an additional language (English).

History of Monolingual Education in South Africa

Language barriers stemming from apartheid legislation plague the multilingual nation of South Africa. Its two super-official language groups, Afrikaans and English, are at odds with the ethnic European minority and the country's majority-black population. This is most evident regarding the language of instruction in educational institutions and according to Maseko (2014) can be traced back to the heart of the colonial history of the country. In the pre-colonial era, education was provided in one's native language and was interwoven into young people's socialisation with the goal of creating a capable and responsible adult. The structure of this type of education allowed for the introduction of a wide range of social, cultural, economic, linguistic, medical, and other essential knowledge traditions to the apprentices (Charamba, 2021). Having a strong command of a language was essential for facilitating this socialisation process because it served as the primary means of passing on knowledge (Mkhize & Ndimande-Hlongwa, 2014). English was then thought to be a cultured language due of colonial dominance, and because of its prestige. In 1925, The right to receive education in Afrikaans was won by the Afrikaners and thirty years later a policy of teaching English and Afrikaans on a 50–50 basis was adopted by the colonial government.

Despite the fact that the South African government has now granted the School Governing Bodies the authority to determine the language of teaching for their local schools, around 80% of them continue to utilise English in their multilingual schools (Republic of South Africa, 1996; Statistics South Africa,2017) showing the biases in the hegemony of English. As a result of this, the majority of schools discourage both learners and teachers from using any language other than English for educational purposes (Zano & Phatudi, 2019) and this has been proven by research to have negative academic effects on South African learners (see, for example, Omidire, 2019; Probyn 2019; Mgijima, 2021; Charamba, 2023).

Currently, from grade R through the third grade, South African learners are taught in their native tongue in addition to English or Afrikaans. Education adopts a monolingual tendency from the fourth grade onward, with lessons being taught in either English or Afrikaans (Omidire, 2019). Even if this is the case, Carrim and Nkomo (2023) argue that several school policies in the foundation phase do not devote enough time to teaching English to First Additional Language students. This monolingual practice extends to higher education where 72% of students are black and just one in twenty graduates in a timely manner, with language of instruction being a contributing factor especially among first year university students (Statistics SA, 2017). In responding to this low throughput rate, The Council for HE (2015) calls for a significant revision of the HE curricula in response to this poor throughput rate, citing language of teaching as a significant contributing factor. Neville Alexander (2005), a South African educationist, claims that the combined use of English and Afrikaans disadvantages predominantly black African students, leading to what Charamba (2021, p.115) terms 'self-colonisation' of a nation state.

Language as a Tool for Epistemic Access in South African Mathematics and Science Classrooms

The development of science literacy in English, which is the second language of approximately more than 80% of students and teachers in SA, has received the majority of attention. Bilingual learners' science achievement has been discussed at various levels, including adaptability in science teaching (Charamba, 2020). Today's expanding multicultural student body has led to new communication hurdles for both teachers and students, calling for the use of instructional materials written in home languages and allowing translanguaging practices in the classroom in order to improve learners' comprehension of concepts and performance in mathematics and science assessments.

Language thus plays a central role in mental development and learning. Among social interactions and funds of knowledge students bring to class, is their language (Charamba, 2021). Focusing on the crucial role that language plays in concept development, giving students access to and practicing their native language could help them advance their linguistic and scientific knowledge (Grosjean, 2010). Funds of knowledge emphasise the value of appreciating learners' culturally coded information that they bring to the classroom and the significance of creating multilingual spaces in scientific classes so that systematization can occur. Thus, allowing translanguaging in education provides a more complete picture of competencies of a multilingual learner.

Scholars such as Hattingh et al. (2022); Makonye (2019); Mostert and Roberts (2022); Chirinda, Kitchen, Castellón and Matute (2023); and Planas, (2021) have shown a connection between children's exposure to science and mathematics-specific terminology and their learning of numeracy and how this is linked to the language of instruction. Bezuidenhout (2022) contends that low socioeconomic class children are less likely to be exposed to terminology that is relevant to mathematics and science and also have a propensity to score poorly in assessments.

In a general mathematics and science classrooms, communication improves academic performance as events take on meaning, sounds become language, body movements become gestures, and symbols become written language (Vygotsky, 1980). Research on the relationship between language and methods of knowing has convincingly set that multilingual learners are frequently pressured to view the world and themselves through a monolingual lens (Hattingh et al., 2022). This is against the monolingual lens. This oneness philosophy of incorporating monolingual approaches, which can be loosely translated as "one language, one nation" or "one classroom, one language," dates back to the colonial era and was embedded in the dogma of monolingual orientation in the school curricula (Makalela, 2022). Research puts

forward that proficiency in the language of instruction should not be undervalued when it comes to mathematics and science achievement because the mastery of mathematical and science literacy is necessary for learners to acquire information and abilities in the learning areas.

Considering that South Africa is a multilingual country and the Language in Education Policy adopted in 1997 permits for the use of any one of the 11 official languages as the primary language of instruction, translanguaging becomes a useful tool to be utilised in mathematics and science classrooms. The majority of South African schools, however, have chosen to use English starting in grade 4 or even earlier, despite the fact that few learners by this point have attained the necessary proficiency in English to fully access the curriculum. This according to Hattingh et.al. (2022) is due to language ideologies that date back to the colonial era and the fact that English is widely spoken. These dominant monolinguals and Anglo normative language ideologies hinder opportunities to learn mathematics and science.

According to Hattingh et. al's (2022) research they claim that the grade 4 transition year from home language which was isiXhosa instruction to English, constrained learners' participation and meaning-making. Secondly, they investigated how learners' languaging practices in small-group work and discovered that group work mobilise their linguistic resources for effective discussion of science concepts. They also claim that translanguaging practices in teacher-led whole-class talk engages learners in meaning-making and scaffolds learning across the mode continuum. Lastly, they highlight how written translation activities enable learners to deepen their conceptual understandings.

In accordance with the claims mentioned above and Reynolds, Altmann and Allen's (2021) research in America, it would seem that learner's performance on intelligence tests is greatly influenced by their command of the English language, especially in the field of science and technical education, which places a strong emphasis on laboratory and workshop practical as a way of developing skills. This indicates how important language is in the teaching and learning and if translanguaging practices can be incorporated to fill the language gaps then South African learners could perform better than they currently are.

Translanguaging as a Pedagogical Strategy in Multilingual Contexts.

The effectiveness of translanguaging pedagogy in increasing the teaching of bilingual and multilingual learners while utilising learners' entire linguistic repertoire has been investigated in a number of research (see for example Charamba, 2023, Mgijima & Makalela, 2021, Charamba 2020, Hattingh et al., 2022). The researchers went over both international and local studies carried out in foundation (grade R-3), intermediate (grade 4-6), and senior phases (7-12) classrooms. Pedagogical translanguaging is an educational strategy in the context of multilingual education that has multilingualism as its foundation (Driouch, 2022). It seeks to facilitate learning through multiple languages involving issues of language production, effective communication, the function of language, and the thought processes behind language use. If put into practice, it is the use of resources that individuals in the classroom use to think (Li, 2018) and communicate their ideas: one that is multilingual, multisemiotic, multisensory, and multimodal.

According to the study conducted in Pakistani, Qureshi and Aljanadbah (2022) argue that translanguaging is an opportunity to allow learners to use what they already have learned in the past from their first language (Arabic) to clarify ideas and concepts of the second language (English). This implies it can offer the tools to connect all linguistic repertoire and help learners comprehend better allowing a more natural process of understanding. Therefore, translanguaging can also be a new way to teach a language where not only a single new language is used, but rather all knowledge is implemented to support learning (Iliescu Gheorghiu, 2022). Educators can also use translanguaging to compare and contrast the

similarities and differences of language to solve the complexity of some words or sounds in a science and mathematics classroom.

Similarly, a study conducted in Norway by Iversen (2019) indicates that English teachers should consider multilingualism as a resource and incorporate all of their students' linguistic abilities into their English instruction. He claims that the inclusion of student resources in several languages as "core elements" enables expertise in the subject. He offers five pedagogical translanguaging characteristics that can help educators achieve the updated English curriculum's requirements in Norway which are raising students' awareness of multilingualism, appreciating linguistic diversity, positioning them as proficient multilinguals, encouraging students to compare English with other languages in their linguistic repertoires, using literature that includes translanguaging as a teaching resource, and implementing tasks that call on students' full linguistic repertoires which are all part of the multilingual education process. These strategies are considered very effective as Norway is regarded as having one of very high proficiency levels in English, ranking third in Europe and fourth in the world according to the 2022 EF English Proficiency Index. Prilutskaya (2021) in his paper concurs with this notion and emphasizes that the use of translanguaging in language instruction has been crucial in fostering the normality of bilingual language usage in Norway and inspiring innovative pedagogical strategies based on the flexible use of languages in classrooms.

Furthermore, a study conducted in Morocco by Driouch (2022) demonstrates that utilizing all of a student's linguistic abilities in a classroom has never been widely accepted. While some researchers continue to adhere to the monolingual worldview, others believe that utilizing students' first languages can be beneficial in many areas of teaching techniques. He states that translanguaging is one of the multilingual teaching strategies that have resulted from this and is an inclusive teaching strategy in early education. He then asserts that translanguaging greatly aids in involving young students in their classroom activities, boosts participation, and makes learning activities more enjoyable. However, Moroccan teachers are reluctant to adopt and use translanguaging in their regular teaching practices for a variety of pedagogical and personal reasons, despite the fact that they can see how it increases pleasure and engagement (Driouch, 2022).

Nhongo and Tshotsho (2019) carried out a study in Zimbabwe where they explored Translanguaging as an instructional method in science and mathematics education in English second language classroom contexts. The study focused on the inadequacies of African languages incorporating reading resources, lingo, and orthographies mainly focusing on how these terminologies can be created and how teaching and learning in African languages can be done. They worked with four secondary schools, two rural and two urban, two in Bulawayo, and the other two in Matabeleland South province in Zimbabwe. Through interviews with eight teachers where it was hoped to learn more about how science and math instructors felt about using translanguaging to teach those subjects, their findings demonstrated that teachers have consistently used translanguaging as an instructional strategy in the teaching of science and mathematics, even though they were unaware that translanguaging may be distinguished from other instructional strategies. The article comes to the conclusion that using translanguaging as a teaching strategy in bilingual classroom settings supports students' cognition, improving concept comprehension more effectively than when solely English is employed for teaching and learning.

Recently in a study carried out in Botswana to provide young children with relevant learning opportunities, culture and lived experiences were factored as essential factors (Kganetso, Qiao & Block, 2023). The researchers argue that particularly in Botswana's public schools, classroom writing experiences diverge significantly from children's real lives. Their study's goal was to analyse two types of procedural and informative texts (genres that support culture) produced by Standard 2 students in Botswana where they collected 22 writing

samples both before and after participation in a course employing culturally relevant books to focus on real-world literacy events. Their results indicated that after taking part in the course, pupils added more aspects particular to each genre. Despite English being the primary language of teaching, many students wrote their texts wholly in Setswana or code-meshed Setswana and English in the post-assessment. This shows how translanguaging can be an effective pedagogy that enables learner's understanding.

While there have not been any noteworthy studies in the FP in South Africa, a number of studies have been conducted in the IP though not focusing on both Mathematics and Science. In the South African context, the South African Language in Education Policy (1997) recognised that the majority of our learners are bilingual given that South Africa is a rainbow nation with eleven official languages. Interestingly, in Spencer-Smith and Hardman (2022) study, which was carried out in one successful secondary school in a low-income area of South Africa's Western Cape province, the authors investigate if mathematicsteacher "talk" varies between face-to-face and computer-based sessions. The results showed that the examined teachers considerably changed their "talk" in both circumstances, with a medium impact size. Additionally, a substantial relationship between any two of the three variables—lesson location, "talk" kind, and scale of interaction—at a medium effect level was discovered. Particularly in the computer lessons, teachers utilised considerably less mathematical jargon. This raises the question of what mathematical concepts are learned in a computer-based class because language is the main medium for conceptual learning (Vygotsky, 1978).

Moreover, due to different factors learners have been dismally performing in international and even national assessments indicated in TIMSS and the recent PIRLS 2021 mentioned above. In a recent study carried out by Charamba (2023) on a South African township school in Jabulani it is clear that the importance of enhancing pupils' academic performance in science education has grown over the past few years. Due to migration between states, it has also grown more difficult in light of the increasing cultural and linguistic diversity of today's classrooms. His study explored the role language plays in the academic performance of multilingual students at a primary school and the findings support the idea that translanguaging pedagogy is essential for successful instruction in multilingual classrooms. The author's findings support findings from earlier studies showing that multilingual students perform better academically when given the opportunity and encouragement to use multiple languages in science classes. This practice involves generating and developing scientific explanations in one's own voice.

The effectiveness of translanguaging in diverse circumstances has been the subject of a plethora of studies (see for example Garca & Li Wei 2014; Childs 2016; Mgijima, 2021; Omidire & Ayob 2022, Sefotho, 2022; McKinney, 2020; Charamba, 2021). These studies support the idea that translanguaging has a variety of instructional uses and advantages. However, there are certain translanguaging pedagogical concerns as teachers frequently view it as 'illegitimate' in traditional education and Conteh (2018) examines translanguaging asserting that research has focused more on understanding interaction mechanisms than on the subject's pedagogical potential and this approach's educational tools are not precisely defined.

While these findings reveal that a translanguaging pedagogy results in successful outcomes for multilingual learners in multilingual contexts, there remains a gap in the research at national level pertaining to translanguaging in the IP mathematics classroom especially in Grade 4 and 5. Very little is known about the efficacy of a translanguaging pedagogy in mathematics and science classrooms in the IP in South Africa. This is a notion that is quite neglected and demands attention. The low literacy levels in South Africa indicate a poor literacy foundation which necessitates a translanguaging pedagogy to develop literacy skills in the IP. To initiate this, a systematic review of how to adopt a translanguaging

pedagogy in the IP to enhance multiliteracy development in a mathematics and science classroom is necessitated.

The purpose of this study was to; (1) review translanguaging studies focusing on literacy development and mathematics and science classrooms conducted internationally and nationally between the years 2019-2023; (2) synthesise the main findings of these reviewed studies and make recommendations of how a translanguaging pedagogy can be applied in the Intermediate phase mathematics and science classroom. Taking into consideration the above purpose, the present study seeks to contribute to the field of mathematics and science in Intermediate Phase in South Africa from a review perspective. This study comes at a crucial time when there is need for educators, curriculum developers and policy implementers to rethink pedagogy especially in the Intermediate phase so as to address issues of the drop in academic performance as indicated by the most recent TIMSS and PIRLS assessments where South Africa dropped from 22% to 19%, multilingualism, diversity in the classroom, respond to the digital age which requires rapid adaptation in order for learning to continue and align their pedagogical approaches with the demands of the 4IR.

RESEARCH METHOD

A conceptual research approach was used allowing the researchers to use already published material. This method was chosen because there is a lot of existing work on the topic, and the researchers sought to examine and explore these concepts in a deeper and more comprehensive way so as to synthesise the ideas to develop a more refined understanding of the topic. In order to fully engage with the idea of a TL pedagogy, several forms of data were gathered from a wide range of studies in diverse multilingual educational environments internationally and nationally to establish legitimacy. Researchers were able to establish a thorough picture of the kinds of TL practices that take place in multilingual classrooms by gathering a variety of data types from various and numerous studies.

Research Design

The current qualitative study followed a semi-systematic review design which relies on qualitative data collection methods. Semi-systematic reviews help synthesise research on a topic or how a topic has been studied in different fields (Snyder 2019). It is a good study design because it enabled us to examine the development of research on the area under study. Semi-systematic review proved flexible enabling us to construct and inquire within the focus area and to pursue unconventional ideas while conducting the research in order to gather rich data (Snyder, 2019). A semi-systematic review is intended for subjects that have been conceptualised differently and investigated by numerous research groups across a range of disciplines, impeding the completion of a full systematic review procedure (Wong, Greenhalgh, Westhorp, Buckingham & Pawson, 2013).

As mentioned earlier the aim of the study was to review translanguaging studies conducted nationally between the years 2019-2023 to explore the efficacy of translanguaging in selected mathematics and science classrooms. The review process included a content analysis where the authors identified, analysing, and reported patterns in the form of themes within a text (Braun and Clarke, 2006). This type of analysis enabled the researchers to detect themes, theoretical perspectives and common issues within this specific research discipline and the selected studies were peer reviewed from scholarly journals. This means that the studies selected to be reviewed and analysed were high quality research articles. Therefore, this study drew on consistent and reliable sources. To ensure credibility, different types of data were collected from a wide range of studies in various multilingual educational contexts internationally and nationally in order to fully engage with the notion of a TL pedagogy.

Instruments

Data was collected from various electronic databases including Google Scholar, and texts together information and investigate the efficiency/ effectiveness/ efficacy of translanguaging in the teaching and learning of Mathematics and Science in South African Intermediate phase classrooms (Grade 4-6). The data was collected from the years 2019-2023 because it is relevant, have undergone academic examination and current making them relevant and reliable to use in the study. The key research words were translanguaging, multilingualism, Maths and science education.

Data Analysis

The data that was collected from the eight studies was thoroughly reviewed and coded. Thereafter, through a thematic analysis process, the data was analysed systematically. According to Braun and Clarke (2006), a thematic analysis involves identifying, analysing and exploring recurring themes within the data. The researchers identified common strategies that were employed across translanguaging studies that lead to successful outcomes as well as unsuccessful outcomes. Data was then examined closely and emerging patterns and correlations were identified across the studies to inform application in the South African multilingual Mathematics and Science classroom (Javadi & Zarea, 2016). The data analysis process was ongoing and interactive. Thematic analysis was the preferred analysis approach as it was effective and useful in organising data to identify emerging themes across the studies, interpret the data, prepare a detailed presentation of the findings and lastly to achieve the study objectives. In sum, the analysis process was informed by Braun and Clarke's (2006) six-step process to gain further insight into analyzing the data and identifying themes. These six phases of the thematic analysis process include (i) Familiarization with data (ii) coding (iii) Identifying themes (iv) Reviewing themes (v) Defining and naming the themes (vi) Producing the thematic analysis report. The themes and the sub-themes that emerged will be discussed in the next section.

RESEARCH FINDINGS AND DISCUSSION

Research Findings

Translanguaging as Tools for Epistemic Access

The studies suggest translanguaging as a pedagogy can be utilised in the intermediate phase mathematics and science classroom as a tool to epistemological access. A study by Charamba (2020) on perceptions primary preservice teachers in Soweto have on linguistic potential and language competence in relation to translanguaging strategies in a science classroom. Language plays a pivotal role in science, incorporating student's linguistic repertoire and allowing science students and teachers to shift seamlessly between their languages enables them to understand and explain abstract scientific concepts more fully. As one of the teachers in the study stated that translanguaging helps clarify and review concepts which makes it a cognitive tool for meaning making in the science classroom.

Another study by Mgijima & Makalela (2021) in Eastern Cape, on the effect of translanguaging on grade 4s ability to reorganize text shows that translanguaging is an effective pedagogy that enhanced learners' ability to reorganise information when reading and this in turn improved their reading comprehension. Their results show that translanguaging was effective in inducing the text reorganization abilities by equipping learners with the requisite knowledge that enables them to respond to the questions accordingly hence linking their world to the English word that they had to understand. Translanguaging is then a tool that enables learners to automatize certain reading processes so as to free up resources for more demanding processes needed in the mathematics and science classroom

Furthermore, Hattingh et al., (2022) conducted a study in different provinces namely Western Cape, Gauteng and Eastern Cape where they challenged the dominant monolingual and anglonormative language ideologies and in so doing they explored some alternative translanguaging practices and how these support teaching and learning in a science classroom. Their finding gives a strong diverse affirmation from different environments of effectiveness of translanguaging where the recognition of linguistic repertoires not only permits access to learning but deepen conceptual understanding in science and learners get to connect and construct knowledge in their own understanding.

These studies reveal that translanguaging is a beneficial tool for enabling epistemic access. Charamba (2022) also asserts that translanguaging pedagogies enable learners to articulate their reasoning which often times is not possible in a typical monolingual classroom. Therefore, recognizing learners' linguistic repertoire is crucial in the understanding of scientific concepts in a multilingual classroom thus by adopting strategies discussed in these reviewed studies, teachers can help and support learners in conceptual learning which is crucial in the overall development of the mathematics and science classroom.

Translanguaging as a Vehicle for Academic Excellence and Enhancing Participation

The eight studies reviewed revealed that the underachievement of learners in Mathematics and science is largely contributed by the low proficiency in the language of instruction. It was discovered that using the learners' home language helped students understand concepts better and led to successful outcomes. Studies by Charamba (2023), Mgijima and Makalela (2021), Charamba (2020), Hattingh et al., (2022) show evidence regarding this. For example, a study by Charamba (2022) investigated the role played by language in the academic performance of Grade 6 natural science learners in Free State and reported that language plays a pivotal role in both the comprehension and subsequent academic performance which affirms that translanguaging result in positive academic effects.

Overall, the use of translanguaging pedagogies does not only enhance academic performance in science classroom but in mathematics and other fields of study in a multilingual context. Learners who are not bound by the monolingual pedagogies and are allowed to use their linguistic repertoire show a great improvement in their studies and understanding as evidenced by the findings from the studies by Mgijima (2021), Omidire & Ayob (2022), Sefotho (2022), McKinney (2020). Therefore, using resources and strategies that integrates learners' home language scaffolds learners and improves their overall academic performance.

An inclusive translanguaging pedagogy makes use of all of the learners' semiotic resources in order to encourage learning and involvement. Due to the improved comprehension of teacher talk, learners in studies that used a translanguaging pedagogy reported being more capable of participating in class (see for example Charamba, 2023; Charamba, 2020; Hattingh et al., 2022; Mgijima, 2021; Mgijima & Makalela, 2021; Omidire & Ayob, 2022; Sefotho, 2022; McKinney (2020). Hattingh et al., (2022) conducted a study with various learners from several locations in South Africa. The study's aim was to examine different translanguaging strategies used by teachers and students in multilingual classrooms and how they enhance possibilities to learn science in order to challenge monolingual and Anglo normative language ideologies. In all the different vignettes findings of the study show that translanguaging encouraged creativity and enabled learners to draw on their personal bilingual experiences and background. There was increased engagement and interaction amongst learners.

Another recent relevant study was conducted by Charamba (2023) with Grade five Intermediate phase science class in Jabulani Township, South Africa. The study's goal was to

investigate how language affects multilingual pupils' academic achievement. Seemingly, the study's findings showed that there was enhanced communication amongst learners and teachers and increased participation and inclusion which resulted in enhanced learners' self-confidence and wellbeing, thus increasing academic performance. According to García and Li (2014) in multilingual language schools, translanguaging- the simultaneous use of many languages in one lesson- should be practiced to improve learning.

Translanguaging as a Valuable Tool for Social Inclusion

The reviewed studies show that encouraging learners to engage in translanguaging promotes the development of inclusion. Translanguaging encourages a unified system that is negotiated for contextual conversational goals and rather than restricting learners to write and converse in English in a classroom, McKinney (2020) argue that they should be encouraged to shift seamlessly between their home language and the language of instruction. According to the case study by McKinney (2020) social inclusion includes allowing learners to tap into their personal life and share a bit about their families in a group. This gives them a sense of belonging as they get to explain themselves and who they are in a language they fully understand while being linked to for example in this current case study the bigger idea was heritage which was brought to their understanding through translanguaging strategies.

Additionally, Sefotho (2022) explored how teachers incorporated and understood the Language in Education Policy in promoting multilingualism. The findings from this study revealed though teachers use translanguaging to enhance understanding they have a lot of misunderstanding on how to effectively use it and Sefotho (2022) suggests Ubuntu translanguaging pedagogy which is a systematic approach based on the African Ubuntu value system (Makalela, 2016) which strongly promotes social inclusion. This implies that the notion of languages being interwoven in a South African multilingual school context should be used as a tool to promote inclusion in the classroom given that this is also closely aligned to the Language in Education Policy and is enshrined in a humanizing pedagogy.

Omidire and Ayob (2022) draws attention to employing translanguaging as a method to comprehend the benefits and drawbacks of using many languages in primary school classrooms for learning. Their findings revealed that translanguaging encourages a friendly environment that supports students and helps them feel included. These findings are in line with Li's (2011) observation that is focused on the inclusion of meaning-making in the learning and teaching processes. This was accentuated by learners in the study who verbalised their feelings of inclusion and it was more noticeable in their participation.

Translanguaging as a Transformative and Decolonizing Pedagogy in Intermediate Phase

Diversity of culture and language is widespread in South African classrooms. However, monolingual pedagogies still dominate and this according to Maseko (2014) can be traced back to the colonial era as discussed above. Ngũgĩ wa Thiong'o (1972) considers the English-only monolingual strategy used in education as an instrument of oppression to prevail social order in societies and to support colonialism or imperialism, and it calls for a break from this practice. A study by Sefotho (2022) questions the relevance of the separatist perspective towards language education and literacy development in the twenty-first century by demonstrating how confluent, fluid, and porous languages have become. This explains why the notion of translanguaging fits in to account for complex multilingual encounters, and decolonise the prevalent imbalances contributing to the dismal performance by Intermediate phase learners in mathematics and science.

Drawing from McKinney's (2020) study, the perpetual use of a monolingual pedagogical strategies decades after democracy poses a threat to the rights of learners who are by the Language in Education Policy to use their entire linguistic repertoire. Looking back at

the history of South African Education, decolonisation of education has been a heated debate since 1994 and was further fueled by the student protests #RhodesMustFall and #Fees Must Fall of 2015, which saw tertiary students calling for, among other things, a change in the sector's curriculum from one that was colonised to one that was Africanised and acknowledged the importance of their languages and cultures in all institutions of higher learning (Le Grange, 2016). This indicates that the issue of decolonisation of the country's education curricula including pedagogies as indicated by the reviewed studies is long overdue by other studies (see for example Charamba, 2023; McKinney 2020; Mgijima & Makalela, 2021; Hattingh et al., 2022).

Through translanguaging, languages that have historically been segregated on the basis of ethnic, cultural, and linguistic inequality can conglomerate through fluid educational interactions and enhance the comprehension of knowledge in many situations among multilingual students because they are not perceived as fixed or stable entities (Charamba, 2021). Teachers in the Intermediate Phase mathematics and science classrooms can adopt this inclusive pedagogy as the Intermediate Phase is the most crucial phase of learning. During this phase, learners transition to a new language of instruction, concepts and familiarizing themselves with mentally demanding content, translanguaging is a very crucial inclusive pedagogy that should be taken into consideration.

Discussion

There is evidence that translanguaging strategies and techniques can be incorporated in mathematics and science classrooms to enhance learners' epistemic and academic performance as shown in the reviewed studies. It was discovered that using a translanguaging pedagogy in multilingual contexts had several benefits for learners' social and cognitive development. For example, teachers can elicit learners' background knowledge by drawing on their home language and using their prior knowledge from home to deepen the understanding of scientific explanations. Drawing on learner's background knowledge creates a link between social inclusion and participation which in turn promotes epistemological access as learners get to relate with each other and the content at a deeper level. Additionally, translanguaging necessitates transformation and decolonisation in the academic spaces providing opportunities for identity formation, and creates positive learning experiences as learners' languages are given a chance to be expressed freely. This notion challenges monoglossic ideologies that are pervasive in South African classrooms thus, a translanguaging approach accepts linguistic diversity and opposes linguistic hierarchies and inequities due to its flexibility and dynamic nature which in turn gives access to abstract concepts embedded in subject like mathematics and science.

Drawing on the theoretical framework of this study, the present study established that monolingual pedagogies in today's multilingual mathematics and science classrooms can be academically restrictive and prevent students from expressing themselves fully creatively, innovating, and academically. Therefore, translanguaging comes as an inclusive pedagogy that not only explains but permits allows teachers to use language as a source of background knowledge to elicit students' prior knowledge while using multilingual and multicultural ways to convey scientific topics. Teachers can draw on learners' multimodal semiotic repertoire by incorporating gestures, images, body language and even facial expressions to develop meaning of the English vocabulary and even scientific and mathematical concepts. According to the study's findings, translanguaging proved to be very common and demonstrated endless dependencies between the many linguistic resources used in classroom discourses.

Multilingual learners are at a disadvantage since they must simultaneously study a new language (English) and other topics in a language they are not fluent in. This follows studies that showed how language matters negatively for learners' academic performance when the

native language and the language of instruction are different. By purposively removing illogical and dogmatic distinctions between native speakers and immigrants, the majority and the minority, as well as target languages versus home languages, translanguaging would inspire both the learner, the parent, and the teacher. It is indisputably true that a learner's academic performance would decline in any academic scenario when their competency in the language of instruction is poor.

Finally, teachers can encourage learners to utilise all of their semiotic resources when acting out the solving mathematics problems and even analysing scientific problems order to improve comprehension. Learners can become familiar with the language structure of the English language through the use of multilingual resources and by drawing on their home language. The use of multilingualism and a multilingual print environment can enable learners to compare the different terms across the languages and allows learners to use their familiar terms to express themselves while making the links. Further, through drawing on their home language, they can develop knowledge of the English language structure. Drawing on their home language and eliciting their background knowledge can enable learners to make inferences and enhance learners' verbal reasoning skills consequently developing critical thinking needed in science classrooms

RECOMMENDATIONS

The current study recommends multilingual pedagogy as a vehicle to enhance equity of access and progress in a South African mathematics and science multilingual classroom. This would involve using the full linguistic repertoire in a mathematics and science classroom and allowing learners to express themselves in a language they understand better. This practice is so closely aligned to the language principles and it supports what other teachers have already started doing as revealed by the studies reviewed. The study further recommends exploring translanguaging pedagogy in intermediate mathematics and science classrooms as there is a dearth of studies in this field in South Africa.

CONCLUSION

Basing on the data from the reviewed studies, the efficacy of translanguaging pedagogy in the South African mathematics and science classrooms was accentuated. It was revealed that translanguaging can be the effective vehicle for academic excellence and enhance learners' literacy development and overall breaks the boundaries imposed by the colonial era. The reviewed studies revealed that translanguaging pedagogy supports higher levels of meaning, encourages creativity, boosts self-confidence, offers opportunity for identity construction, and produces pleasant learning experiences which is what learners in South African science and mathematics classrooms need as a bridge between the transition from foundation phase to intermediate. In educational settings, translanguaging pedagogy opposes the monoglossic assumptions that are common in South African schools. Thus, its adaptable and dynamic nature respects language diversity and challenges linguistic hierarchies and inequities. Emergent bilingual students are accommodated and given an equal opportunity to learn mathematics and science in a linguistically varied classroom and a socially equitable educational system.

The current study therefore, suggests that learners' home language should be valued as a resource in the development of their literacy abilities, their epistemological access and their overall academic excellence in the mathematics and science classroom. The teachers should also make use of multicultural materials that draw on the backgrounds and experiences of the students as well as multilingual resources. This study contributes to the field of research by offering insight into how a translanguaging pedagogy can be strategically utilised in mathematics and science intermediate phase multilingual classroom in order to enhance understanding and improve competence.

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