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Science Students' Attitudes Towards the Use of Indigenous Language in Understanding Visual Representations

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Abstract

This study aimed to investigate the attitudes of science students toward the utilization of their indigenous language in comprehending visual representations. A mixed-methods approach was employed to delve into students' perspectives, preferences, and beliefs regarding the medium of instruction in science education, with a specific emphasis on the role played by indigenous languages in the interpretation of visual representations. The study utilized a sequential explanatory research design, initially collecting and analyzing quantitative data, followed by qualitative data to augment the comprehension of the quantitative findings. The findings indicated a marked preference among students for employing English as the medium of instruction in science education, driven by its perceived global significance and potential advantages in accessing scientific resources and opportunities. Furthermore, students who had not been exposed to science education in their indigenous language exhibited negative attitudes toward its utilization. They also repudiated the notion that acquiring science knowledge in their indigenous language would enhance their ability to interpret visual representations effectively. These findings bear implications for the indigenization of curricula and underscore the significance of taking into account students' language preferences and attitudes in the context of science education. Future research should delve further into language choices in various educational settings and refine research instruments to enhance measurement precision. Educators and policymakers would be well-advised to consider students' language preferences to create inclusive and culturally responsive learning environments. This approach provides support to students in enhancing their proficiency in the selected language of instruction.

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INTRODUCTION

Background

The purpose of this study was to examine the viewpoints of science students concerning the use of their indigenous languages to understand visual representations used in science education. The study sought to investigate the potential benefits of incorporating students' indigenous languages into science education. It recognizes that language serves not only as a tool for communication but also as a critical factor influencing comprehension and conceptualization. Hence, through an exploration of how indigenous languages might influence students' interpretation of visual representations, the study aimed to enhance science education's effectiveness and inclusivity.

The intricate nature of scientific concepts and phenomena within science education presents a notable challenge for students. Wellington and Ireson (2008) emphasize the significant nature of this challenge, highlighting the multifaceted composition that characterizes the scientific content encountered by students. Expanding on this viewpoint, Millar (2022) contributes to the discussion by underscoring the intricate and dynamic attributes intrinsic to scientific content, frequently conveyed through the framework of laws and theoretical constructs. This inherent complexity, as noted by Millar, gives rise to an elevated sense of difficulty in comprehending and mastering scientific principles. This heightened complexity is rooted in the abstract nature and fluidity inherent in scientific ideas, factors that collectively serve as obstacles to students' effectiveness in engaging with the subject matter (Wellington & Ireson, 2008). Consequently, the outcome is a conceivable impediment to a comprehensive learning experience, a notion further supported by the research of Mnguni et al. (2016). In response to these diverse challenges, the field of science education has experienced a gradual transformation over time. The necessity for students to acquire a comprehensive understanding of the science curriculum has led to the recognition of visual representations as essential tools, a viewpoint advocated by Evergorou et al. (2015). This realization, as elucidated by Parthasarathy (2022), has resulted in the seamless incorporation of visual aids into science education. According to Rundgren et al. (2010), visual representations serve as dynamic instruments, enabling both scientists and students to engage with intricate phenomena that might remain concealed when employing traditional methods of observation. This interconnected integration contributes to an enhanced comprehension of the intricate nuances within science concepts.

Despite the unquestionable significance of visual representations in enhancing effective science education, it is crucial to highlight the enduring importance of language in this context. Adúriz-Bravo et al. (2013) shed light on the pivotal role of language as a conduit for communicating and comprehending scientific concepts. Even with the profound impact of visual aids, the role of language in facilitating effective communication and fostering a comprehensive grasp of scientific principles remains clear (Matthiessen & Halliday, 2009). This interplay between visual representations and language underscores the multifaceted nature of science education, where both elements collaborate to navigate the intricate complexities inherent in scientific concepts and phenomena. Given the inherently intricate nature of scientific subject matter, students are compelled to cultivate not only robust cognitive aptitudes but also proficiency in visual literacy skills. Navigating the convoluted intricacies of scientific content requires the ability to decipher and interpret visual representations, as emphasized by Gangwer (2009). Visual literacy skills empower students to extract substantive information from diagrams, graphs, charts, and other visual aids, thereby bridging the chasm between abstract theories and tangible comprehension (Ametller & Pinto, 2002). Thus, the symbiotic integration of visual literacy skills alongside language proficiency emerges as an imperative facet, facilitating a comprehensive and holistic pedagogical approach within science education. This integration equips students to adeptly traverse the multifaceted challenges inherent in the abstract and dynamic nature of scientific concepts.

The role of language extends beyond mere communication; it shapes students' understanding of science through its connection to their home language, cultural values, experiences, and epistemologies (Luykx et al., 2007). In multilingual contexts like South Africa, the choice of the language of instruction in science education becomes a pressing issue. Despite being non-native English speakers, a significant number of students in South Africa continue to learn science in English, leading to difficulties in comprehending subject knowledge and hindering academic performance (Desai, 2001). The use of a foreign language, such as English, may diminish the vividness of mental imagery, impacting students' ability to form mental representations (Hayakawa & Keysar, 2018). Nonetheless, English has become the de facto global language of science, granting access to an extensive corpus of scientific literature and facilitating international scientific communication (Drubin & Kellogg, 2012). Nevertheless, the abstract and diverse symbolic language used in science education can pose a barrier to effective learning through visual representation, particularly for non-native English-speaking students (Amano González-Varo & Sutherland, 2016). Addressing these language-related challenges in science education is crucial for promoting effective learning and inclusivity.

Problem statement

The central research problem under scrutiny in this study is to discern the intricate interplay among students' visual literacy skills, language barriers, and their combined impact on their proficiency in interpreting visual representations within the science curriculum. Despite the acknowledged potency of visual representations as pedagogical tools in science education, students frequently encounter challenges when deciphering the intricate symbolic language inherent in these representations, thus impeding their ability to extract meaning (Velázquez-Marcano et al., 2004). This issue prompts a significant gap in the literature, which centers around investigating whether the struggles students face in comprehending visual representations stem from deficiencies in their visual literacy skills (Grisham et al., 2007). This gap underscores the imperative for a comprehensive exploration of the underlying factors contributing to students' difficulties in interpreting visual content within the science curriculum (Schönborn & Anderson, 2004).

Schonbörn and Anderson (2006) highlight the complexities of mastering the abstract and diverse symbolic language embedded within science education, offering insights into students' evident challenges in navigating this nuanced visual discourse. Consequently, this inquiry prompts a critical consideration*: do deficits in visual literacy skills contribute to the hurdles students encounter in effectively engaging with and comprehending visual representations* (Mnguni et al., 2016)? The significance of addressing this gap lies in attaining a holistic understanding of the elements influencing students' interpretation of visual content in science education. This, in turn, potentially paves the way for the development of pedagogical strategies aimed at enhancing visual literacy skills. Furthermore, the lingering question regarding the intricate nexus between students' struggles in decoding visual representations and their visual literacy skills underscores the necessity for a thorough exploration of the contributing factors influencing students' interaction with visual content within the science curriculum (Schönborn & Anderson, 2004).

Moreover, the pervasive challenge posed by language barriers further complicates these issues, as highlighted by Oyoo (2012), who emphasizes the benefits of learning science in one's indigenous language for fostering familiarity with scientific concepts. Conversely, studies such as the work conducted by Amano González-Varo and Sutherland (2016) underscore the hindrance presented by the use of English as the medium of instruction in South African science classrooms, particularly for non-native English speakers, thereby obstructing their access to the curriculum and accurate interpretation of visual representations. Aligned with Mammino's viewpoint (2010), this study asserts that the incorporation of indigenous languages in science education holds promise in addressing these challenges. It has the potential to enhance students' comprehension of intricate scientific concepts, particularly when conveyed visually. Thus, the central research problem of this study seeks to untangle the intricate interplay among visual literacy skills, language barriers, and their collective influence on students' proficiency in interpreting visual representations within the science curriculum.

Through a comprehensive exploration of these multifaceted factors, the study aims to illuminate the potential advantages associated with the integration of indigenous languages into science education, thereby contributing to a deeper comprehension of how language and visual literacy synergistically shape students' understanding of visual scientific information. The insights generated by this endeavor have the potential to inform the development of more effective and inclusive practices in science education.

Rationale

Situated within the context of prevalent linguistic diversity in South African universities, this study delves into the enduring dominance of English, even amidst a rich tapestry of languages. This linguistic milieu poses formidable challenges for students lacking English proficiency, exerting tangible repercussions on their ability to grasp intricate scientific concepts and consequently influencing their academic performance (Desai, 2001). The nucleus of this study revolves around an exhaustive investigation into the attitudes held by first-year science students concerning the integration of indigenous languages within educational contexts. Moreover, it endeavors to ascertain the extent to which the incorporation of these languages shapes students' interpretation of visual representations embedded within the science curriculum. Framed by the central research inquiry, *"To what extent do indigenous languages shape students' interpretation of visual representations in the realm of science learning?",* this inquiry strives to unveil nuanced insights that shed light on the potential advantages and challenges associated with language choices.

In addition, this study seeks to deepen our understanding of the intricate interplay between language and science, with a specific focus on the domain of visual interpretation. By delving into students' perceptions regarding the utilization of indigenous languages in the realm of science education, this research aims to unearth valuable insights that illuminate the complex interrelationship between language and the comprehension of visually presented scientific concepts. At its core, this study is fundamentally geared towards acquiring a profound understanding of students' viewpoints regarding the pivotal role of language within the context of science education. Therefore, by adroitly addressing the research query, the study aspires to furnish a guiding framework for the formulation of pedagogical strategies and policies that are both inclusive and efficacious. The overarching objective of this endeavor is to advocate for an educational approach that holistically takes into account the diverse linguistic backgrounds, individual requisites, and preferences of students. This comprehensive approach ultimately aims to enrich the overall trajectory of science learning, fostering heightened levels of comprehension and engagement among students hailing from diverse linguistic backgrounds.

In conclusion, this research harbors significant potential to inform culturally sensitive science education methodologies, thus engendering an environment conducive to heightened levels of comprehension and engagement. Therefore, by acknowledging the influence of language on science education and visual interpretation, this study seeks to contribute to a more comprehensive and effective pedagogical landscape, thereby benefiting students from a spectrum of linguistic backgrounds.

Theoretical Framework

The theoretical framework of this study is rooted in the foundational principles of the Linguistic Relativity Theory, which posits that language wields a profound influence over cognitive processes and perception, thereby shaping individuals' patterns of thought and their interpretation of the surrounding world (Spair & Lee, 1956; Masharov & Fisher, 2006). This theory suggests that the structural components and lexicon of language function as cognitive tools that guide how individuals categorize experiences and construct their understanding of reality (Levinson et al., 2002). For example, specific linguistic attributes may direct an individual's attention toward specific facets of their environment, subsequently impacting the prominence and significance they assign to visual representations. Within the realm of science education, the linguistic relativity theory offers insights into how language impacts the cognitive skills essential for the interpretation of visual representations. The intricate interplay between language and cognition can influence how students process and extract meaning from visual data, potentially shaping their capacity to apprehend intricate scientific concepts (Desai, 2001). The structure of an individual's language, encompassing grammatical structures and vocabulary, can steer their focus, memory, and strategies for problem-solving when engaging with visual representations within the scientific curriculum.

The inclusion of students' indigenous language introduces an added layer of intricacy to the cognitive process of interpreting visual representations. Distinct linguistic features inherent to indigenous languages, such as terms related to local flora, fauna, or cultural customs, can influence how students perceive and decode visual content (Noormohamadi, 2008). These linguistic subtleties can impact students' cognitive abilities by shaping their recognition of patterns, categorization of visual elements, and extraction of meaning from visual representations. Attitudes and beliefs, as shaped by the linguistic relativity theory, constitute noteworthy determinants of how students interact with and comprehend scientific visual content. Language can mold and reinforce attitudes toward specific subjects, concepts, or cognitive paradigms, potentially influencing students' motivations and cognitive strategies (Hosseini & Pourmandia, 2013). Attitudes play a role in directing attention, influencing information-processing methods, and acting as mediators in the intricate relationship between language, cognition, and the interpretation of visual representations.

Furthermore, language not only influences attitudes but also serves as a conduit through which attitudes are conveyed and fortified. In the context of science education and the interpretation of visual representations, language can facilitate the formation and dissemination of attitudes towards various facets of scientific content. These attitudes, deeply ingrained within linguistic and cultural contexts, shape students' learning approaches and their interaction with visual representations. The amalgamation of philosophical and theoretical perspectives further enriches the theoretical framework. For instance, constructivist and sociocultural viewpoints can harmonize with the linguistic relativity theory, providing insights into the dynamic interplay between language, culture, and cognition within the realm of science education (Creswell, 2014). The adoption of these perspectives offers a comprehensive lens through which to comprehend the intricate relationship between language, attitudes, and the interpretation of visual representations. The choice of *"attitudes"* as a pivotal variable in this study is substantiated by its central role in mediating the nexus between the linguistic relativity theory, language, and cognitive processes. Attitudes function as a conduit between language and interpretation, influencing students' engagement with visual representations. Therefore, by scrutinizing attitudes as a perspective through which the linguistic relativity theory operates, this study endeavors to reveal how language and cognitive processes synergistically shape students' comprehension of visual scientific information.

METHODS

Research design and Sampling

The research was situated within the realist research paradigm, a philosophical framework that supports the utilization of mixed methods to generate knowledge and improve the validity and reliability of research findings (Creswell, 2014). Aligned with the realist philosophy, this study employs a mixed-methods approach, blending qualitative and quantitative techniques. This strategic choice aims to comprehensively explore students' perspectives on indigenous language's role in interpreting visual representations in science education. Therefore, by seamlessly integrating these diverse methods, the research seeks a heightened understanding of the subject, capturing both individual experiences' richness and broader patterns emerging from the data (Sobh & Perry, 2006). Furthermore, the study employed a sequential explanatory research design (Boru, 2018), commencing with the collection and analysis of quantitative data, which subsequently informed the development of the qualitative data collection method. This explanatory research design entails an initial utilization of quantitative data to discern patterns and relationships, succeeded by the integration of qualitative data to provide supplementary insights and explanations(Austin & Sutton, 2014). This methodological approach culminates in a comprehensive and heightened understanding of the research subject.

Data collection and analysis

The method for data collection closely parallels that of Al-Mashikhi et al. (2014). The participants for this study were selected using purposive sampling (Showkat & Parveen, 2017), with a specific emphasis on first-year science students enrolled in a South African tertiary institution. The sample consisted of 107 first-year university science students, encompassing a diverse range of science disciplines, such as earth science, life science, and physical science. The selection of the institution was guided by its comprehensive offering of science courses and its capability to accommodate a wide spectrum of students, including both native and non-native English speakers.

The method employed for data collection closely aligns with the approach utilized by Al-Mashikhi et al. (2014), encompassing a systematic sequence of steps designed to ensure rigor, reliability, and validity throughout the research process. The participants for this study were intentionally selected using purposive sampling, following the recommendations of Showkat and Parveen (2017). The primary focus was directed toward first-year science students enrolled in a South African tertiary institution, resulting in a sample size of 107 individuals representing diverse science disciplines such as earth science, life science, and physical science. The choice of institution was informed by its comprehensive array of science courses and its capacity to accommodate a wide spectrum of students, including both native and non-native English speakers. Adhering to the guidelines outlined by Lefever et al. (2006) and Matthiasdottir (2007), the collection of quantitative data occurred through the administration of an online questionnaire in English, mirroring the language of science instruction. Given the constraints imposed by the Covid-19 lockdown in South Africa, this approach was deemed suitable for remote data gathering (Ramulumo, 2020). Comprising 10 items, the questionnaire employed a 5-point Likert scale to gauge participants' degrees of agreement. Constructed based on the validated instrument developed by Al-Mashikhi et al. (2014), the questionnaire was specifically tailored to evaluate students' attitudes concerning the incorporation of indigenous language for interpreting visual representations within science education. The questionnaire items were strategically formulated to address four principal domains of inquiry: (1) The use of English as the medium of instruction, (2) The adoption of indigenous language as the medium of instruction, (3) The comprehension of visual representations through English, and (4) The impact of English proficiency on the interpretation of visual representations. Quantitative data were subjected to analysis using SPSS software, with responses being quantified and descriptively presented through frequencies, means, and standard deviations (Nkosi & Mnguni, 2020).

From the initial pool of 107 participants, a subset of 10 individuals was randomly chosen to partake in in-depth interviews. This smaller group was deliberately selected to ensure a thorough exploration and comprehensive understanding of the participants' attitudes and experiences, aligning with the rationale proposed by Al-Mashikhi et al. (2014). To facilitate an in-depth exploration of attitudes and experiences, a subset of 10 participants was randomly drawn from the initial pool for participation in comprehensive in-depth interviews, in alignment with the rationale put forth by Al-Mashikhi et al. (2014). Simultaneously, qualitative data were collected through semi-structured face-to-face interviews, which were conducted during the student's designated lunch breaks. Adopting an approach akin to that of Mouton (2001), audio recordings were utilized to ensure the accuracy and reliability of the data. Employing a descriptive analysis methodology, the process encompassed transcription, organization, and thematic analysis to unearth patterns in attitudes, perspectives, and experiences (Loeb et al., 2017). The integration of a close-reading approach facilitated an enhanced understanding of the data and facilitated the identification of emerging patterns. By ethical standards and the protection of participant well-being, the study obtained ethical approval from the University of South Africa.

Validity and Reliability

The validation and reliability of the constructed questionnaire were methodically ensured through a comprehensive procedure. Content validity underwent scrutiny from a panel of experts, resulting in an 82% content validity index (Mnguni, 2007). Usability and the absence of technical difficulties were established via pilot testing (Jenn, 2006). Furthermore, the calculation of the Cronbach alpha coefficient from pilot data yielded a value of 0.78, signifying a notable degree of internal consistency (Maree, 2008). The meticulous design and validation process employed in shaping the questionnaire underscores its effectiveness in accurately gauging the intended constructs.

Credibility and trustworthiness

To augment credibility and enhance trustworthiness, this study employed two pivotal methodological procedures: member checking, as outlined by Birt et al. (2016), and data saturation, as articulated by Fugard and Potts (2015). Member checking entails participants' involvement in reviewing and validating interpretations, contributing to the assurance of accuracy (Candela, 2019). Concurrently, data saturation involves a comprehensive exploration of themes until no new insights emerge, thereby affirming thoroughness (Saunders et al., 2018). The integration of these methodological practices serves to reinforce the reliability and validity of the study's findings.

RESULTS

Table 1 presents an overview of students' attitudes toward using English as the medium of science instruction. The majority of participants expressed a positive attitude regarding the importance of studying science in English, with 85% preferring English as the language of instruction. Specifically, 43.9% agreed and 41.1% strongly agreed with this statement, resulting in a mean value of 2.0 (on a scale where 1 represents strongly agree and 5 represents strongly disagree) and a standard deviation (SD) of 1.24. Similarly, approximately 80% of participants viewed English as the universal language of science, with a mean value of 2.0 and an SD of 1.28. These results indicate a strong inclination among students towards using English for science instruction and highlight the perception of English as a widely recognized language in the scientific domain.

Table 1. Students' attitudes towards English as the medium of instruction

Attitude statement (%)	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	*M*	*SD*
1. I believe that it is important that I study science in English	5.6	4.7	4.7	43.9	41.1	2	1.24
2. I believe that English is the universal language of science	5.6	5.6	9.3	47.7	31.8	2	1.28

In contrast, table 2 reveals a negative attitude among students towards using their indigenous language as the medium of instruction for science education. A majority of participants, 63.5%, expressed a preference against using their indigenous language, indicating a lack of preference for it as the medium of instruction (M=4, SD=1.20). Similarly, over 60% of participants disagreed with the notion that their indigenous language is/would be more effective than English for understanding scientific concepts (M=4, SD=1.19). These results suggest a prevailing preference among students for English as the medium of instruction in science, indicating a lower level of support for using their indigenous language in this context.

Table 2. Indigenous language as the medium of instruction

Attitude statement (%)	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	*M*	*SD*
3. If given a choice, I prefer/ would prefer my indigenous language as the medium of instruction and not English to learn science	27.1	36.4	6.5	18.8	11.2	4	1.20
4. Indigenous language is/would be more effective than English for understanding scientific concepts	29	31.8	4.7	24.2	10.3	4	1.19

Table 3 illustrates students' attitudes toward the understanding of visual representations through English as the medium of instruction in science. The majority of participants, over 81%, reported no difficulty in conceptualizing the visual representations used in science when presented in English (M=4, SD=2.09). Additionally, approximately 60% of participants expressed that they would not spend more time conceptualizing visual representations if science were taught in English (M=4, SD=1.26). Furthermore, around 66% of participants disagreed with the statement that they would have difficulty conceptualizing visual representations when learning science in their indigenous language (M=4, SD=1.51). These results suggest that students generally perceive English as an effective medium for understanding visual representations in science, with a smaller proportion expressing a preference for their indigenous language in this context.

Table 3. Understanding of visual representations through English as the medium of instruction

Attitude statement (%)	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	*M*	*SD*
5. English makes/would make it difficult for me to conceptualize the visual representations used in science	28	53	7.5	9.3	1.9	4	2.09
6. I believe I/would spend more time conceptualizing visual representations used if science is taught in English	28.1	31.8	8.4	25.2	3.7	4	1.26
7. I will/cannot easily conceptualize visual representations used when learning science in my indigenous language	26.2	39.3	5.6	25.2	3.7	4	1.51

Table 4 presents students' negative attitudes toward the effect of English proficiency on their ability to effectively interpret visual representations. A majority of participants, over 61%, disagreed with the statement that having low English proficiency affects their ability to master the interpretation of visual representations in the science curriculum (M=2, SD=2.09). Regarding the fairness of using English as a medium of instruction, 43% of participants disagreed with the statement that it is unfair, while 39.3% agreed (M=2, SD=0.82). Moreover, around 72% of participants agreed with the statement that it is necessary to study science in English, even with low English proficiency, as it helps them better interpret visual representations used to explain abstract concepts (M=2, SD=1.91). These findings suggest that despite some concerns about English proficiency, a significant proportion of students perceive the importance of studying science in English for better interpretation of visual representations.

Table 4. The effect of English proficiency on students' ability to effectively interpret visual representations

Attitude statement (%)	Strongly disagree	Disagree	Neutral	Agree	Strongly agree	*M*	*SD*
8. Having low English proficiency affects my ability to master the interpretation of visual representations used in the science curriculum	24.4	37.4	14	16.8	7.5	4	2.09
9. It is unfair to use English as a medium of instruction, because students with higher English proficiency may be able to master interpreting visual representations used in the science curriculum	14.9	28	17.8	29	10.3	2	0.82
10. It is necessary that I study science in English, even though my English proficiency is low, as studying science in English will help me to better interpret the visual representations used to explain abstract concepts	6.5	11.2	10.3	53.3	18.7	2	1.91

The analysis of the interview data yielded four prominent themes: the importance of English for scientific communication and collaboration, the preference for indigenous languages in science education, participants' attitudes toward the challenges in understanding visual representations, and the influence of English proficiency on students' perception of visual interpretation in the science curriculum. Due to the consistency of responses among participants, only select excerpts will be presented to provide a representative sample of the findings.

Theme 1: The significance of English for scientific communication and collaboration

Participants expressed a preference for studying science in English due to the perceived benefits of global exposure, alignment with international standards, and access to a broader range of resources and opportunities. They emphasized the importance of English as a language widely used in international scientific literature, conferences, and collaborations. Participants believed that learning science in English allows them to tap into a wealth of resources, research papers, and global scientific advancements. This exposure not only enriches their knowledge but also prepares them for potential collaborations and opportunities beyond their local context. Using English as a medium of communication in the scientific field was metaphorically described as *"opening a window to the world of science,"* suggesting the connectivity it provides to a global network of scientists and scientific information.

Theme 2: The preference for indigenous languages in science education

Participants who strongly preferred their indigenous language as the medium of instruction in learning science cited several reasons. Nobahle responded by saying: *"I strongly prefer using my indigenous language as the medium of instruction in learning science. One of the main reasons is that it helps me better understand complex scientific concepts. When scientific terms and explanations are presented in my indigenous language, it resonates with my cultural background and makes the content more relatable. I find it easier to grasp scientific ideas when they are conveyed in a language that I have grown up with and feel connected to. Additionally, using my indigenous language fosters a sense of pride in my heritage and promotes the preservation of our cultural identity. It allows me to learn science while also honoring and promoting the richness of our indigenous language and traditions."*

While Wavhudi indicated that his preference for using my indigenous language as the medium of instruction in learning science stems from the importance of cultural context. *"Scientific concepts are often complex and can be challenging to comprehend fully. When science is taught in my indigenous language, it not only helps me understand the subject matter but also ensures that I grasp the cultural and contextual nuances associated with it. Our indigenous language carries deep cultural knowledge and wisdom that cannot always be accurately translated into English. By using our language, we can preserve and transmit traditional knowledge related to science, such as traditional healing practices or ecological wisdom specific to our region. It allows us to maintain our unique cultural perspective while engaging with scientific education, contributing to a more inclusive and diverse scientific community."*

The results reveal a strong inclination among participants to utilize their indigenous language as the medium of instruction for learning science, driven by discernible advantages. Firstly, this approach enhances the comprehension of intricate scientific concepts through the utilization of scientific terms and explanations in their indigenous language, establishing relatability and ease of understanding. Secondly, the use of their indigenous language in scientific education maintains a deep connection to their cultural heritage, fostering pride in their ancestral roots and actively contributing to cultural identity preservation. Thirdly, acquiring scientific knowledge in their indigenous language provides a deeper grasp of the subject matter by encompassing cultural and contextual nuances that might be lost in translation to alternative languages. Lastly, integrating their indigenous language in scientific education safeguards traditional knowledge embedded within their culture, protecting invaluable cultural wisdom inadequately translated into other languages. Consequently, the incorporation of indigenous languages in scientific education promotes a comprehensive understanding, cultural preservation, and diversity within the scientific community.

Theme 3: Participants' attitudes toward the difficulty in understanding visual representations.

During the inquiry, the participants were presented with the question: "What are the reasons or factors influencing your attitudes towards the perceived difficulty in conceptualizing visual representations when learning science in English, compared to your indigenous language?" In response to this query, Warona provided insightful perspectives concerning the determinants of his attitudes toward the perceived challenges in conceptualizing visual representations during the process of learning science in English. Warona ascribed this difficulty to the presence of a language barrier, underscoring the fact that English is not his primary language of proficiency. He explicitly articulated encountering "struggles in fully comprehending scientific terminology and concepts presented in English," consequently impeding his capacity to promptly and accurately interpret visual representations. Furthermore, Warona communicated a heightened sense of self-assurance and comfort when engaging with visual representations in his indigenous language, thereby implying that his familiarity with the linguistic aspects contributes significantly to the facilitation of comprehension within the realm of scientific discourse.

Khotso on the other hand, identified lack of familiarity as a factor influencing the difficulty in conceptualizing visual representations when learning science in English. "Visual representations, such as graphs, charts, and diagrams, are often accompanied by labels, annotations, and descriptions. When these supporting textual elements are in English, it can be challenging for me to fully understand the context and meaning. In my indigenous language, I am more accustomed to the terminology and linguistic conventions used in scientific visual representations, making it easier for me to grasp their intended message."

The results of this study offer insights into the influence of participants' attitudes toward the perceived challenges in conceptualizing visual representations during the process of learning science in English, in comparison to their indigenous language. Language barriers and lack of familiarity emerge as significant factors shaping these attitudes. One participant underscored the pivotal role of the language barrier, describing struggles in comprehending scientific terminology and concepts presented in English. Consequently, a heightened level of comfort and comprehension of visual representations was articulated about their indigenous language. Another participant accentuated the impact of insufficient familiarity with English, leading to a hindered understanding of visual representations. Their preference for comprehending visual representations in their indigenous language stemmed from their adeptness with the terminology and conventions specific to their cultural context. These results underscore the importance of linguistic proficiency and familiarity with one's indigenous language in facilitating the comprehension of visual representations within the realm of science education.

Theme 4: The impact of English proficiency on students' perception of visual interpretation in science curriculum.

To gain insight into the influence of English proficiency on students' perception of its impact on their ability to master the interpretation of visual representations in the science curriculum, participants were asked: *"How does your level of English proficiency influence your perception of the impact it has on your ability to master the interpretation of visual representations used in the science curriculum?"* Ntakadzeni's response provides a nuanced perspective from a participant with low English proficiency. *"Despite my low English proficiency, I believe it is necessary to study science in English because it offers opportunities to enhance my ability to interpret visual representations used to explain abstract concepts. Although my understanding may be limited due to language constraints, studying science in English exposes me to a broader range of scientific concepts and vocabulary. Over time, I can develop a better understanding of visual representations and improve my interpretation skills. While I acknowledge that students with higher English proficiency may have an advantage in mastering visual interpretation, I believe that with proper support and resources, students with lower English proficiency can also make progress and bridge the language gap."*

The results of this study shed light on the dynamics of English proficiency among participants and their perceptions of its impact on their ability to interpret visual representations in the context of science education. Despite encountering challenges due to limited English proficiency, participants recognize the indispensability of studying science in English, attributing it to the augmentation of their capacity for interpreting visual representations. While they acknowledge the constraints imposed by language proficiency, they perceive exposure to English in science education as instrumental in broadening their grasp of scientific concepts. Notably, the participants exhibit an optimistic outlook regarding the prospective advancement of their interpretation skills over time.

Furthermore, results suggest an advantage for proficient English students in visual interpretation. Participants acknowledge the need for tailored support and resources to bridge the language gap, essential for equitable learning. Learning science in English enhances interpretation skills, even for those with limited proficiency, requiring effective support for inclusive education. Consequently, the results highlight the potential growth of interpretation skills through targeted assistance, enhancing science education outcomes and inclusivity. Educational institutions should prioritize comprehensive support for equitable English-based science education.

Discussion

The congruence between the findings arising from this study and the investigations conducted by Al-Mashikhi et al. (2014) serves to underscore the coherence of outcomes across a diverse spectrum of contexts. Analogous to the scrutiny applied to undergraduate science students by Al-Mashikhi et al. (2014), the participants encompassed in this study, despite their limited English language proficiency, overtly manifested a predilection for acquiring scientific knowledge through the medium of English. This predilection emanates from a shared perspective between both cohorts, postulating that the precision and depth intrinsic to specific scientific concepts may undergo compromise during translation into their respective indigenous languages. This alignment harmoniously corresponds with the proposition put forth by Van Nes et al. (2010), positing that the intricate nuances inherent in scientific terminology may undergo a diminution in fidelity during the translation process. Concurring with the sentiments espoused by Al-Mashikhi et al. (2014), participants in this study similarly articulated a viewpoint where English assumes an indispensable role as a conduit toward the attainment of global citizenship. This acknowledgment accentuates the prominence of English as a linguistic medium, providing access to a wide array of scientific resources and avenues. Despite facing deficiencies in English language proficiency, the participants in this study, akin to their counterparts examined by Al-Mashikhi et al. (2014), evinced a pronounced inclination toward English as the preferred medium for instructional dissemination.

Moreover, the findings of the present study contrast with those of Behrman (2018). Behrman's study showcased enhanced learning outcomes through instruction in students' indigenous languages, indicative of heightened proficiency in grasping intricate scientific concepts. However, even in the presence of conspicuous advantages stemming from the use of students' indigenous languages for instruction, the findings resoundingly echo a preference for English as the medium for learning science, largely attributed to its adeptness in conveying visual representations. Lastly, aligned with the findings of the current study, a study conducted by Kiraz et al. (2010) substantiates and validates a favorable inclination among students toward science and technology courses instructed in the English language. The significance of this inclination is underscored by its notable contribution to augmenting students' interpretive capacities in the domain of visual representation in both scientific and technological contexts, thereby enriching their comprehensive learning experiences. This sentiment mirrors the observations posited by Al-Mashikhi et al. (2014) and is further reinforced by the conclusions drawn by Kiraz et al. (2010), collectively affirming students' recognition of the advantageous aspects associated with acquiring scientific knowledge in English.

In this particular context, the impactful findings of this study propose strategies aimed at harmonizing linguistic diversity and enriching science communication. By recognizing students' preference for English as the medium of instruction in science education, as well as their attitudes toward indigenous languages, educators can seamlessly integrate language preferences with the inherent visual capacity of English. This integration serves to cultivate immersive cross-cultural understanding and augment visual literacy (Smilan, 2017). Nevertheless, as posited by Lubogo et al. (2023), advocating for the integration of indigenous languages presents challenges that necessitate meticulous curriculum design, comprehensive teacher training, and continuous evaluation to achieve a harmonious equilibrium with scientific precision (Handayani et al., 2018). The study adeptly addresses language barriers and their implications for interpreting visual representations in science education. Consequently, by aligning language preferences, student attitudes, and visual comprehension, the study significantly contributes to comprehending the intricate relationship between language, visual literacy, and scientific proficiency.

Consequently, the significance of this study lies in its role in shaping science education practices and informing pedagogical strategies across diverse contexts (Darling-Hammond et al., 2019). The congruence between the findings and the research problem underscores the intricate interplay between visual literacy, language barriers, and science literacy. The students' preference for English and their attitudes toward indigenous languages highlight nuanced considerations, even in the face of the potential benefits of indigenous language integration, which competes with the effectiveness of English in conveying scientific concepts and facilitating engagement (Kago & Cisse, 2022). Therefore, through comprehensive exploration, the study illuminates the potential advantages of integrating indigenous languages into science education, enhancing the comprehension of scientific knowledge, guiding inclusive science education practices, and addressing language, visual literacy, and curriculum challenges.

Limitations of the Study

This study provides valuable insights into the impact of indigenous languages in science education. However, it is important to acknowledge the limitations inherent in the study design. One notable limitation is the reliance on data collected from a single learning institution that predominantly uses English as the medium of instruction for science education. This sampling approach may have limited the representation of diverse attitudes and perspectives that students from different educational contexts may hold if they were taught science in their indigenous language. To address this limitation, future research should aim to broaden the sample by including participants from multiple learning institutions and regions with varying language preferences in science education. Therefore, by incorporating a more diverse range of participants, researchers can capture a broader spectrum of attitudes and perspectives toward language choices in science education.

CONCLUSION

Consequently, this study underscores students' inclination toward acquiring scientific knowledge in the English language and its proficient utilization in interpreting visual representations. This alignment with established research findings extends its implications to curriculum design, accentuating the significance of accommodating language preferences and attitudes. Subsequent research endeavors should delve into diverse contextual settings to explore language preferences further and refine measurement methodologies to enhance precision. It is incumbent upon educators and policymakers to cultivate inclusive learning environments that cater to students' language mastery and predilections, thereby facilitating the advancement of science education practices. Moreover, students lacking exposure to science in their indigenous language demonstrated negative attitudes and disavowed the notion of its efficacy in interpreting visual representations. These findings reverberate through curriculum development, highlighting the need to recognize the role of language preferences and attitudes in science education. Future investigations should delve into varied educational landscapes to delve into language preferences and enhance measurement accuracy. Educators and policymakers alike bear the responsibility of establishing comprehensive and culturally responsive learning milieus, thereby bolstering students' language proficiency and preferences to enrich their science education experience.

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