Dirasat: Human and Social Sciences, Volume **5**2, No. 6, 2025, 7058

Deanship of Scientific Research

Examining Language Barriers in Science Education at the National Zoological Garden

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Received: 29/2/2024
Revised: 6/4/2024
Accepted: 24/7/2024
Published online: 1/6/2025

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Citation: Bilankulu, H. J., Mudau, A. V., & Ntuli, T. G. (2025). Examining Language Barriers in Science Education at the National Zoological Garden. *Dirasat: Human and Social Sciences*, *52*(6), 7058.
https://doi.org/10.35516/hum.v52i6.7058

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Abstract

Objectives: The study investigates the language-related challenges that arise during interaction and discourse in the context of science education at the National Zoological Garden in Pretoria, South Africa. The central research question guiding this study was as follows: How does the utilization of language impact interaction and discourse within the teaching and learning of science at the National Zoological Garden?

Methods: In this qualitative interpretive case study two education officers were purposefully selected as participants. Data collection involved both observation and conducting semi-structured interviews. Data was analysed using an ethnographic approach.

Results: The findings revealed that despite the predominant use of English as the primary language of instruction in many South African schools, learners encounter difficulties when attempting to engage in interactions, both with their peers and education officers, when using English at the centre. Meaningful interaction tends to occur when the education officers switch to the native languages spoken by the learners.

Conclusions: As a recommendation presented in this study, it is suggested that education officers consider employing other South African languages that are more comprehensible to the learners at the centre to facilitate better interaction and discourse. Furthermore, it is proposed that the science centre should establish a policy that accommodates native languages in their science engagement activities to enhance the teaching and learning of science.

Keywords: Language Barriers; National Zoological Garden; Interaction; Discourse; Science Education.

دراسة الحواجز اللغوية في تعليم العلوم في الحديقة الوطنية للحيوانات

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ملخّص

الأهداف: تبحث الدراسة في التحديات المتعلقة باللغة التي تنشأ أثناء التفاعل والخطاب في سياق تعليم العلوم في حديقة الوطنية في بريتوريا، جنوب إفريقيا. كان سؤال البحث المركزي الذي وجه هذه الدراسة على النحو التالي: كيف يؤثر استخدام اللغة على التفاعل والخطاب في تدريس وتعلم العلوم في حديقة الوطنية؟

المنهجية: في دراسة الحالة التفسيرية النوعية هذه، تم اختيار اثنين من مسؤولي التعليم عن قصد كمشاركين. وشمل جمع البيانات كلا من الملاحظة وإجراء المقابلات شبه المنظمة . تم تحليل البيانات باستخدام نهج إثنوغرافي.

النتائج: كشفت النتائج أنه على الرغم من الاستخدام السائد للغة الإنجليزية كلغة أساسية للتعليم في العديد من مدارس جنوب إفريقيا، يواجه المتعلمون صعوبات عند محاولة الانخراط في التفاعلات، سواء مع أقرانهم أو مسؤولي التعليم، عند استخدام اللغة الإنجليزية في المركز. يميل التفاعل الهادف إلى الحدوث عندما يتحول مسؤولو التعليم إلى اللغات الأصلية التي يتحدث بها المتعلمون.

الخلاصة: كتوصية مقدمة في هذه الدراسة، يقترح أن ينظر مسؤولو التعليم في استخدام لغات جنوب إفريقيا الأخرى التي تكون أكثر قابلية للفهم للمتعلمين في المركز؛ لتسهيل التفاعل والخطاب بشكل أفضل . وعلاوة على ذلك، يقترح أن يضع المركز العلمي سياسة تستوعب اللغات الأصلية في أنشطتها المتعلقة بالعلوم لتعزيز تدريس العلوم وتعلمها.

الكلمات الدالة : حواجز اللغة، الحديقة الوطنية، التفاعل، الخطاب، تعليم العلوم.

Introduction

The National Zoological Garden, as a prominent centre for wildlife conservation and education, welcomes a diverse array of visitors, including local and international audiences. These visitors, with their distinct linguistic backgrounds, often encounter language barriers that may hinder their ability to engage with the educational programs and exhibits on offer. This study seeks to delve into the intricate web of language-related challenges faced by both educators and visitors in the context of science education. In this introductory exploration, we lay the foundation for a comprehensive investigation into how language impacts the learning experiences at the National Zoological Garden. By examining the multifaceted dimensions of language barriers, we aim to shed light on the complexities surrounding communication and interaction within the context of science education in this unique setting. Through a focus on discourse and interaction, we will explore how language barriers manifest and assess their implications for science learning, as well as identify potential strategies and solutions that can enhance the educational experience for all visitors, regardless of their linguistic backgrounds.

Researchers increasingly recognize that science education should transcend the narrow focus of exam-oriented learning and grade progression within formal education systems. Instead, it should foster a lifelong commitment to learning for economic transformation (Vedder-Weiss & Fortus, 2010). As societies transition from industry-based economies to knowledge-based ones, the role of scientific engagement through interaction and discourse becomes pivotal in shaping a competent society (Falk & Dierking, 2017). The cultivation of learners' attitudes and understanding of science, driven by dialogue and motivation through interaction, is key to advancing a knowledge-based society (Falk & Dierking, 2017). Success in science and technology is a vital metric for evaluating a country's education system's impact on accelerating a knowledge-based economy (Falk & Dierking, 2017).

Consequently, it is crucial to reflect on the interaction and discourse between learners and their education officers. Given that the language used is foreign to both learners and education officers, investigating the dynamics resulting from this language issue is important. Understanding discourse as a social phenomenon hinges on the collaborative construction and negotiation of talk for a specific purpose. Social theories of discourse, as described by Gee (2012), reveal how language and speech are embedded in interpersonal interactions. Learning is seen as a discursive process where actions and encounters influence discourse. A dialogic pedagogy can enhance learners' knowledge construction by encouraging questioning, interrogation, and the respectful negotiation of ideas and opinions (Teo, 2019). Set (2019) asserts that the appropriate use of language in knowledge construction is vital for successful learning. Scientific knowledge is dynamic, and interaction and discourse are essential for achieving a shared understanding of it (Tran, 2016).

Ash and Wells (2006) argue that dialogic inquiry should be at the core of science instruction in both formal and informal settings. They further contend that social interactions can foster cooperative knowledge creation in both contexts. Science centres adapt their teaching through conversation to respond to their learners' reactions, resulting in a series of teacher-learner exchanges that address a variety of learning needs (Set, 2019). This study is motivated by a commitment to enhancing the inclusivity of science education and the conservation mission of the National Zoological Garden. By understanding and addressing language barriers, we hope to promote more effective science communication, enrich the educational experience, and contribute to the broader discourse on fostering environmental awareness and scientific literacy in a multicultural and multilingual society.

Background

There is a substantial concern about the quality of science education in South Africa (Fish, 2017). South African learners continue to perform below expectations in science and mathematics (Reddy, 2021). Schulze and Heerden (2015) argue that given this underperformance, science teaching and learning must be improved. A better understanding of how learners interact and discuss science concepts could positively influence teaching, enhancing scientific literacy and academic achievement among South African learners. The Department of Science and Technology (DST) supports science centres to combat the negative perception of science in South Africa (DST, 2016). According to DST (2014), one of the objectives of science centres is to popularize science and make it more engaging for school learners. Science centres are expected to

stimulate learners' interest in science by providing novel learning experiences and promoting lifelong learning (DST, 2016). Institutions like the National Zoological Garden, where this study was conducted, have a significant role in motivating learners to study science. Their informal settings offer a medium through which learners can acquire scientific knowledge and develop their ideas for the benefit of themselves and their societies (Parker & Ballantyne, 2012).

Watermeyer (2012) points out that the philosophy of science centres and museums encourages social interactions that inspire scientific conversations. Furthermore, the collections in these institutions give learners the opportunity to see, touch, and ask questions about exhibits, facilitating their understanding of science and technology (Reiss, 2018). However, in the South African context, most schools visiting the National Zoological Garden use English as the medium of instruction. Education officers, who oversee educational activities at the centre, are responsible for interacting with learners. This raises the question: "How does the use of language influence interaction and discourse in the teaching and learning of science at the National Zoological Garden?" Unlike schools that prioritize the written word, spoken language plays a crucial role in the social learning context of science centres and museums (Tran & King, 2007). It is essential to examine how the use of English affects the teaching and learning of science at the National Zoological Garden, particularly since most visiting learners speak African languages at home and consider English their second language.

The educational system is increasingly instrumental in fostering a skilled workforce in the fields of science and technology. Globally, the primary goal of the education system is to enhance learners' comprehension of science and technology in the learning process, as emphasized by Talib (2020). Cultivating learners' attitudes and understanding of science through dialogue and motivational interactions is pivotal for the advancement of a knowledge-based society, as advocated by Falk and Dierking (2017). Assessing the effectiveness of an education system in a country's transition to a knowledge-based economy often hinges on its achievements in the realm of science and technology, as underscored by Falk and Dierking (2017). However, South Africa faces a significant challenge regarding the quality of science education. South African learners continue to underperform in the fields of science and mathematics, as noted by Reddy (2012). This concern is highlighted by South Africa's ranking as the lowest among 38 participating countries in the Trends in International Mathematics and Science Study (TIMSS) in 2005 (Reddy, 2006). Furthermore, in the 2011 TIMSS study, South Africa scored lower than Botswana in mathematics and had the lowest science scores among all countries (Schulze & Heerden, 2015). Although there was marginal improvement in the 2015 TIMSS study, South Africa remained one of the five lowest-performing countries in science and mathematics (Reddy et al., 2016).

In light of the persistent poor performance by South African learners in science and mathematics, Schulze and Heerden (2015) argue that science teaching and learning must be enhanced. A more profound understanding of how learners interact and discuss science concepts has the potential to influence teaching and elevate scientific literacy and academic achievement among South African learners. Science centres and museums play a crucial role in motivating learners to study science. Their relaxed settings provide an environment where learners can acquire scientific knowledge and generate ideas for themselves and their communities (Parker & Ballantyne, 2012). These institutions have effectively positioned themselves within society as hubs for promoting public understanding of science. They complement formal education by promoting the development of scientific literacy (Bencze & Lemelin, 2001). Consequently, it is essential for learners to visit these centres to gain motivation and a deeper understanding of science.

Science centres and museums that emphasize interactive activities and exhibits, providing hands-on and experiential learning, are celebrated for their ability to engage learners in scientific concepts and principles (Watermeyer, 2012). Interactive lessons and exhibits are deemed more pedagogically effective than traditional methods of knowledge transfer due to their hands-on nature (Watermeyer, 2012). Experiential learning, with its focus on direct interaction with phenomena rather than mere contemplation, is a cornerstone of the educational paradigm provided by science centres and museums (Barry, 1998). This style of experiential learning offers a unique platform for engaging with science (Addison, 2002). The operational philosophy of science centres and museums encourages social interactions that stimulate scientific conversations, as emphasized by Watermeyer (2012).

Scholars like Eshach (2016) and Watermeyer (2012) contend that educational settings within science centres and

museums can lead to improvements in learners' attitudes and understanding of scientific concepts. However, there is limited knowledge about educational settings in science centres and museums within the South African context. Mosabala (2014) observed that most schools visit science centres and museums as part of their school tradition within the South African context. In light of this context, the study delved into the impact of language usage on the dynamics of interaction and discourse during the process of teaching and learning science at the National Zoological Garden.

Theoretical Framework

This study was grounded in constructivism theory as it recognizes that learners and teachers visiting the National Zoological Garden engage in knowledge construction. Furthermore, the study involved crafting and executing a strategic framework to enhance science teaching and learning at the National Zoological Garden. The constructivism theory posits that individuals build knowledge and derive meaning from their experiences (Hof, 2021). A visit to the National Zoological Garden offers a unique experiential learning opportunity for both learners and teachers. Constructivism is an educational theory that elucidates how learners and teachers when visiting the National Zoological Garden in Pretoria, acquire knowledge within an environment distinct from their usual classroom settings. According to Clark (2018), learners actively construct fresh knowledge and meaning based on their personal experiences and existing knowledge. The National Zoological Garden in Pretoria welcomes learners from diverse regions, each with its unique approach to learning science. Learners and teachers come to the National Zoological Garden with pre-existing knowledge of science. The National Zoological Garden exposes them to novel and diverse exhibits that aid in the construction of scientific knowledge.

According to scientific research and observations, constructivism is a theory concerning the process of individual learning (Clark, 2018). It posits that people develop their understanding of the world by engaging in activities and reflecting upon those experiences (Bereiter, 2002). The National Zoological Garden is replete with exhibits and materials that both teachers and learners can observe. As per Brau (2020), when we encounter something new, we must reconcile it with our existing ideas and experiences, which may entail altering our beliefs or dismissing the new information as irrelevant. It is imperative that teachers and learners visiting the National Zoological Garden can establish links between the science learned in the classroom and the scientific knowledge presented at the garden. Constructivism places strong emphasis on integrated curricula and encourages teachers to employ materials in ways that actively engage learners. This perspective has far-reaching implications for teaching methods and curriculum development (Phillips, 1995).

Constructivism is fundamentally concerned with learning as a process of construction, rather than passive acquisition (Clark, 2018). Learners construct new knowledge by building upon their previous understanding and by recognizing connections between different concepts and domains of knowledge (Brau, 2020). Each time new information is encountered, it is integrated with prior knowledge, as perceived by learners. The National Zoological Garden provides scientific knowledge through its exhibits, and it is vital for both teachers and learners to establish links between this new knowledge and their existing classroom-based scientific knowledge. As Clark (2018) argues, each time a particular topic or concept is employed in a different setting or from a new perspective, an individual's understanding of that topic or concept evolves. Furthermore, when a particular topic or idea is employed in a novel context or from an alternative angle, it acquires new connotations. Aseeri (2020) posits that learners bring their past experiences and knowledge to any situation, and the mental models they have developed through these experiences significantly influence their new learning. Therefore, learning is an ongoing process of adjusting one's mental models to account for new experiences.

Methodology

The research methodology applied in this paper adopts a qualitative case study approach. In this approach, language is employed as the primary source of data to comprehend and interpret localized meanings. This process involves collecting data within a specific context to generate a broader, more comprehensive understanding (Yin, 2016). Braun and Clarke (2013) assert that qualitative research is inherently exploratory and open-ended, yielding in-depth, rich, and detailed data that supports the formulation of assertions. The researcher selected this methodology because it aligned effectively with the

study's purpose and research question. As argued by Richards and Morse (2013), the researcher establishes a deliberate connection between the research purpose and the chosen methodology. A multiple case study design was employed to investigate how language is used to facilitate interaction and discourse at the National Zoological Garden.

The selection of participants in this study followed a purposeful sampling approach. Purposeful sampling involves choosing participants based on specific characteristics, particularly those who are willing to reflect on the phenomena of interest and participate in the study (Richards & Morse, 2013). According to Richards and Morse (2013), sampling plays a pivotal role in ensuring the quality of qualitative inquiry, helping to address issues related to qualitative validity. Two education officers were purposefully selected for this study based on their qualifications in Natural Sciences, training in facilitating teaching and learning at the centre, and their willingness to participate. Participants were informed of the objective of the study and their right to withdraw from the study when they did not wish to continue or feel uncomfortable participating in the study. The researchers used the observer as a participant as he remained uninvolved and did not influence the dynamics of the settings. To avoid subjectivity from the research, data collection instruments were approved by the University of South Africa ethics committee.

Qualitative data was collected from the two participants, with each case treated and analysed independently since this was not a comparative case study. To enhance the depth and breadth of understanding, a triangulation method was applied, utilizing multiple data sources. This approach corroborated findings and offered a more holistic view of the phenomenon (Billups, 2014). Participants were interviewed both before and after their lesson presentations, and they were also observed during the presentations. This comprehensive approach was adopted to gain a profound understanding of how language is employed to foster interaction and discourse at the National Zoological Garden.

Following data collection, the researcher adopted an ethnographic approach for data analysis. Data from each case was analysed independently and word by word to avoid subjectivity from the researchers. According to Richards and Morse (2013), in ethnography, data segments are viewed as pieces of a puzzle that fit together to provide a complete, holistic, and detailed description. Each case was independently analysed to elucidate how language is utilized to promote interaction and discourse at the centre.

Results

The results are divided into two distinct cases.

Case 1:

In the initial case, an education officer referred to as Marry (a pseudonym) underwent interviews and observations while engaging with learners at the science centre. Marry's interactions involved instructing learners on the subject of biodiversity and making use of biofacts and animals housed in their enclosures as educational tools. Marry initiated her lesson in the following manner:

Marry: Good morning learners!

Learners: Good morning mam!

Marry: can you identify some of the things I have on my table?

Learners:……(no response).

Marry: Name any of the animals on my table

Learner: …….(no response)

Marry: Ok. Lebowa Setswana (Do you speak Setwana)

Learners: E Mam

Marry: Ke eng e ? (what is this?)

Learners: Ke Lerubisi (Is an Owl)

During the interaction between Marry and the learners, it was noticeable that the learners did not respond when questions were posed in English. However, they promptly engaged when questions were presented in Setswana. Marry used Setswana for communication, fostering interactive dialogue, where both Marry and the learners actively participated in the lesson

(Mudau, 2023). Initially, the learners showed limited interaction when Marry posed questions in English. Ntuli (2022) contends that learners are more likely to engage and interact when taught in a language they fully comprehend.

Marry inquired if the learners spoke Setswana, and all learners responded loudly with a "Yes," indicating their proficiency in Setswana (Reiss, 2018). Reiss emphasizes that activities and exhibits at science centres must be designed to actively engage learners. Marry recognized the language barrier as a significant challenge affecting science education at the National Zoological Garden. She effectively switched to the learners' language to enhance engagement in her teaching. When asked by the researcher during the interview about how language assisted her in conveying scientific concepts while teaching at the National Zoological Garden, Marry commented:

"Sometimes explaining these concepts in English is not easy for these learners to understand. They kept quiet and looked at you, they were not responding to my questions but you can tell that they do not understand. Is better to ask them to explain in their home language. This English is foreign to all of us, is not easy and these kids do not understand English very well. I know the policy says we must teach the intermediate phase in English, but these learners don't understand". (Marry)

In contrast to a school environment, where written communication takes precedence, the social learning context within a science centre emphasizes spoken communication (Tran & King, 2007). Education officers at the National Zoological Garden heavily rely on verbal interaction to connect with learners. According to Tran (2016), involving learners in scientific discourse encourages them to critically examine their own perspectives, and language plays a pivotal role in the construction of knowledge. Ntuli (2022) argues that while English serves as the medium of instruction in most schools, it creates a language barrier in some rural schools where learners may lack proficiency in English. Set (2019) contends that when language is comprehensible to all learners, it facilitates the construction of knowledge. The use of the English language posed a challenge in Mary's lesson for knowledge construction.

The language barrier in science teaching and learning continues to present a challenge for both learners and educators. When Marry was asked about the difficulties associated with science teaching and learning at the National Zoological Garden, she expressed:

"Sometimes you find that there is a group that speaks Setswana, they don't understand English that well and then you are Venda and you don't understand Setswana that much, so it kind of gives you that low confidence that they may not be understanding what you telling them because of their language, but I find that the solution is usually if you don't understand the language you find someone who understands the language to come and conduct the lesson. Like swap with someone who understands that language if you see that you are not confident to speak that language, if it's hard." (Marry)

Marry made it evident that language significantly influences the teaching and learning of science at the National Zoological Garden. When learners have difficulty understanding English, education officers should consider switching to indigenous languages to promote interaction, as recommended by Maluleke (2019). Language acts as a mediator for communication between learners and education officers at the National Zoological Garden. In cases where learners have limited English proficiency, it can lead to a breakdown in communication. The incorporation of various indigenous languages can be a catalyst for enhanced interaction. Competent education officers should be adaptable in their instructional methods and language use, tailoring them to the learners' responses through dialogue, thus facilitating a productive exchange between teacher and learner, in line with Set's (2019) perspective.

Case 2

The second education officer, going by the pseudonym Lethabo, underwent observation and interview sessions while instructing learners on the utilization of microscopes in the field of Natural Sciences. During this observation, Lethabo was engaged in teaching learners about microscopes at his designated station. He had an array of microscopes and accompanying equipment, including pipettes, dissecting kits, test tubes, slides, and cover slips, all commonly used in conjunction with microscopes within a science laboratory. Learners enthusiastically interacted with the microscopes, readily examining and discussing their observations amongst themselves.

Learner 1: wa tseba gore ke eng e. (Do you know what it is?)

Learner 2: Kea e tseba, e gona ko sekolong (I know it, is there at school)

Lethabo interjected their discussion and asked:

Lethabo: Do you know these instruments?

Learners 2: Is a Microscope. … (whispering to the other learners)

Lethabo: I cannot hear, say it louder

Learners: …….. (did not respond)

Lethabo: ok, kare la itsi selo se? (ok, do you know this thing?)

Learners: E! ra itsi (yes we know it)

Learner 2: E! ke Microscope, eteng ko sikolong. (yes is a microscope, we have it at school)

In Lethabo's station, it was evident that learners felt at ease interacting with each other in their native language. However, when Lethabo posed questions in English, they exhibited a lack of responsiveness. In contrast, when Lethabo employed Setswana for his inquiries, learners readily engaged, demonstrating their comfort in interacting in Setswana. English-language queries garnered a notably weaker response from the learners, with some speaking in hushed tones, indicating a lack of confidence in answering questions in English. The use of the English language failed to foster substantial interaction at the station.

As Teo (2019) suggests, a dialogic pedagogy can more effectively facilitate the process of knowledge construction among learners through questioning, probing, and the exchange of ideas and opinions in an intellectual and respectful manner, particularly when all participants are proficient in the language of instruction. Set (2019) contends that the appropriate utilization of language in knowledge construction is pivotal for successful learning. When questioned about interactions with learners during the lesson presentation, Lethabo expressed:

"ok, in my observation there are kids who are familiar with English, they interact more. To some, scientific concepts are foreign to them, so if you try to explain to them in English, they are not going to understand you and they won't participate, so, if you are using the language that they can understand or their native language it makes easier for them to comprehend even they concentrate more and participate because you are talking about something they can understand."

In line with Tran (2016), the concept of discourse is understood as a social phenomenon where dialogue is collectively constructed and negotiated with specific intentions. The significance of language in rendering this dialogue meaningful cannot be overstated. In Lethabo's case, the use of English for discourse posed a challenge. Lethabo pointed out that when he conducted his lesson in English, which serves as the primary medium of communication in most South African schools, he encountered difficulties with communication. Some learners did not engage actively, and they struggled to grasp certain scientific concepts presented during the lesson. Lethabo indicated that when he employed the learners' native language, they became more active participants, comprehending the material and focusing on the lesson. Lethabo expanded on this by stating:

"ok, with most public schools, I think is better to deliver the lessons to them in their native language, because if I ask them which language they understand better they mention their native language, not English. If I continue teaching them in English they don't participate. When I use their native language they start talking and ask questions showing that they understand the lesson. So English is a bit of a problem."

According to Gee (2012), social theories of discourse describe how language and speech are embedded in interactions between people. Lethabo described that for discourse to take place at her station, she had to switch from English to a native language such as Sepedi or Setswana, which is the language understood by the learners at his station. A dialogic pedagogy as Alluded by Teo (2019) can better facilitate the learners' process of constructing knowledge through questioning, interrogation and negotiation of ideas and opinions intellectually and respectfully. When Lethabo switched to their native language, learners started asking questions and showed an understanding of some scientific concepts.

The teachers accompanying learners to the National Zoological Garden confirmed that the use of English as the primary language of instruction presents a significant challenge, particularly for primary school learners who are still in the process

of developing their English language proficiency. Relying exclusively on English throughout the lesson can impede the effectiveness of the instruction for those learners who have limited comprehension of the language. Lethabo further emphasized that learners engage more actively and participate when they are taught in a language they fully understand. As Set (2019) argues, the appropriate utilization of language in knowledge construction is a critical factor for successful learning. Language barriers continue to have a substantial impact on the teaching and learning of science. When discussing this challenge, Lethabo stated:

"Language barrier is very challenging. So like I said you need to know the level of their understanding of the English language. So if you know that you will be dealing with learners who do not know much, I mean to express themselves in English you need to lower your language, you need to use examples that they can relate to daily, you don't need to use complicated scientific concepts, sometimes you have to divert away from English into their own language or mother tongue. And that will help them to learn more. When you ask them questions in English they don't respond, if you ask them in their mother tongue they respond. Interaction is sometimes difficult in English".

Gee (2012) elucidates how language and speech are intricately woven into interpersonal interactions. Learning is perceived as a discursive process where actions transpire, and these encounters are recognized as influential in shaping discourse. Involving learners in scientific discourse aids in scrutinizing their own viewpoints, evaluating concepts, and identifying conflicts that may prompt a revision of their beliefs, as highlighted by Tran (2016). Set (2019) contends that the judicious use of language in constructing knowledge is pivotal for effective learning. Scientific knowledge is dynamic, and interactions and discourse are instrumental in reaching a shared comprehension of scientific principles, as underscored by Tran (2016). Lethabo also suggested that leveraging code-switching and translanguaging can be advantageous in cultivating learner interactions and discourse.

Discussion

The National Zoological Garden serves as a remarkable testament to the potential of learner interaction and discourse in shaping a profound educational experience. As one contemplates this dynamic environment, it becomes evident that the garden is not merely a collection of exhibits but a vibrant arena where learners actively engage, explore, and connect with the natural world on various levels. Learner interaction at the National Zoological Garden is akin to a symphony of curiosity and discovery. The study uncovered that the language barrier posed a challenge to learners' interaction and discourse in the context of science education at the National Zoological Garden. It was observed that learners tend not to engage in a lesson when the language of instruction is unfamiliar to them. Consequently, there is a pressing need for education officers to be proficient in various South African languages to facilitate meaningful interactions with the learners. Proficiency in these languages would enable education officers to employ techniques such as code-switching and translanguaging to scaffold effective science teaching and learning at the National Zoological Garden.

Learner interaction at the exhibits encourages a sense of agency and ownership over the learning process. The hands-on nature of interacting with displays empowers individuals to manipulate objects, make observations, and draw independent conclusions. This experiential learning can lead to a deeper comprehension of scientific principles and concepts. The findings also emphasize the importance of using language that is comprehensible to both learners and education officers for effective interaction and discourse. Utilizing a language understood by learners triggers a spectrum of questions, ranging from basic to complex, fostering an ongoing dialogue between the learner and the environment (Set, 2019). Whether it involves marvelling at animal behaviours, deciphering adaptations, or contemplating the intricate web of ecosystems, each encounter serves as a stepping stone toward a deeper grasp of science.

Furthermore, the study's findings underscore that the National Zoological Garden provides a fertile ground for discourse to thrive. However, the insistence on using English as the primary medium of instruction for all schools visiting the garden hampers interaction and discourse. Through language, learners can share their observations, insights, and questions with peers and educators, enhancing their learning experience. Language serves as the conduit for learners to gain fresh insights and expand their thinking through discussions (Teo, 2019). This shared exploration nurtures a sense of community, where

diverse viewpoints merge to create a more comprehensive understanding of the natural world and its intricacies.

Interpretation of key findings in terms of the underlying theoretical framework

Social constructivism posits that knowledge is constructed through social interactions. In this study, the language barrier emerged as a critical factor affecting learner interaction and discourse. When learners and education officers were unable to effectively communicate due to language differences, it impeded the construction of knowledge. Social constructivism emphasizes that language plays a pivotal role in mediating communication, meaning-making, and knowledge construction. Social constructivism underscores the importance of collaborative discourse in learning. The study findings reveal that learners are more engaged and participatory when they can communicate in their native language or a language they understand well. This aligns with social constructivist principles, where collaborative discourse helps learners examine their own perspectives, evaluate concepts, and resolve conflicts. It emphasizes that meaningful interactions and discussions contribute to the construction of knowledge.

The study suggests that education officers should be proficient in various South African languages to facilitate meaningful science teaching and learning. This concept resonates with social constructivist ideas of scaffolding, where more knowledgeable individuals (in this case, the education officers) adapt their language and support to meet the learners' needs. Using techniques like code-switching and translanguaging, as suggested in the study, is a form of scaffolding that assists learners in comprehending scientific concepts. Social constructivism emphasizes the creation of a learning community where diverse viewpoints merge to enrich understanding. The study indicates that using a language that learners understand fosters shared exploration, creating a sense of community. This mirrors social constructivist principles, where a sense of community encourages peer interaction, shared experiences, and the collective construction of knowledge.

Interpreting the study's findings through the lens of social constructivism underscores the importance of language as a mediator of knowledge construction, the value of collaborative discourse, the role of scaffolding and adaptation of language, and the creation of a community of learners in science education at the National Zoological Garden. It highlights the need for educational practices that promote effective communication and interaction to facilitate the construction of scientific knowledge in a diverse and multilingual educational setting.

Implications for science education

The study underscores the need for educational policies that acknowledge and address language barriers in science education. It suggests that science education should be more inclusive of South African languages, especially for learners who are still developing their English proficiency. Education officers at the National Zoological Garden and other informal science educators may benefit from training and professional development programs that enhance their proficiency in indigenous South African languages. This training can better equip them to facilitate effective science teaching and learning. The study highlights the importance of scaffolding techniques, such as code-switching and translanguaging, to support learners in comprehending scientific concepts. Educators should be encouraged to adapt their language and teaching methods to meet the needs of diverse learners.

Implications for curriculum designers and science educators include the incorporation of more language-accessible materials and resources that cater to learners with varying language backgrounds. This can help bridge the language gap and promote better interaction and understanding. Addressing language barriers can enhance scientific literacy among diverse groups of learners. By fostering effective communication and understanding, learners are likelier to develop a deeper appreciation for science and the natural world. The study suggests that future research in informal science education should consider the role of language in learner interaction and discourse. It encourages a deeper exploration of how language influences the learning process in similar settings.

The study emphasizes the importance of cultural and linguistic sensitivity in science education. It implies that educators should respect and incorporate the cultural and linguistic backgrounds of learners to create a more inclusive and effective learning environment. The study advocates for the promotion of multilingualism in science education. Embracing the diversity of languages spoken by learners can enrich the learning experience and foster a sense of belonging and participation. The study has broader implications for informal science education settings beyond the National Zoological

Garden. It underscores the importance of language accessibility in museums, science centres, and other similar environments.

The implications of this study extend to educational policy, teacher training, curriculum design, cultural sensitivity, and the broader field of informal science education. Addressing language barriers can contribute to more inclusive and effective science education experiences, promoting scientific literacy and a deeper understanding of the natural world.

Recommendations

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

Language Proficiency Training for Education Officers*:* Provide education officers at the National Zoological Garden with language proficiency training in indigenous South African languages commonly spoken by learners. This will enable them to interact effectively with a broader range of learners.

Promote Multilingual Science Education*:* Encourage the use of multiple languages, including indigenous languages, as mediums of instruction in science education programs. This promotes inclusivity and ensures that learners can engage in meaningful scientific discourse.

Incorporate Language-Accessible Materials: Develop and utilize science education materials and resources that are accessible to learners with varying language backgrounds. These materials should be designed to facilitate comprehension and engagement among all learners.

Scaffolded Instruction: Emphasize the importance of scaffolding techniques, such as code-switching and translanguaging, for education officers. They should be trained in how to adapt their language and teaching methods to support learners in understanding complex scientific concepts.

Cultural Sensitivity*:* Promote cultural sensitivity and respect for the linguistic diversity of learners. Create an inclusive educational environment that values the cultural and linguistic backgrounds of all participants.

Curriculum Adaptation: Adapt the science education curriculum to accommodate the needs of learners with varying language proficiencies. This may involve the development of language-inclusive curricular materials.

Professional Development Programs: Establish ongoing professional development programs for education officers, focusing on effective pedagogical strategies for multilingual science education in informal settings.

Community Engagement*:* Foster collaboration between the National Zoological Garden and the surrounding communities. Engage with local educators, families, and learners to better understand their language needs and preferences.

Promotion of Multilingualism*:* Advocate for the promotion of multilingualism in science education, not only at the National Zoological Garden but in informal science education settings more broadly.

Policy Advocacy*:* Collaborate with relevant educational authorities and policymakers to advocate for policies that recognize and address language barriers in science education. These policies should support multilingual and culturally sensitive practices.

These recommendations aim to enhance the quality of science education at the National Zoological Garden and similar informal science education settings by addressing language barriers and promoting inclusivity. They also contribute to the broader goal of fostering scientific literacy and a deeper understanding of the natural world among diverse learner populations.

Conclusion

The study sheds light on a crucial aspect of science education in informal settings, highlighting the role of language in learner interaction and discourse. The findings of this study illuminate the complex interplay between language, education officers, and learners within the unique context of the National Zoological Garden. At its core, this study underscores the profound influence of language on the teaching and learning of science. Language serves as both a bridge and a barrier, capable of facilitating meaningful interaction when comprehensible and hindering engagement when incomprehensible. The language barrier, as revealed in this research, remains a significant challenge for learners and education officers alike, particularly in a multilingual and multicultural South African educational landscape.

The study has provided compelling evidence that learners' ability to interact, engage with scientific concepts, and

participate in meaningful discourse is intrinsically tied to their language proficiency and comfort. The research has shown that when learners are taught in a language they understand well, they are more likely to participate, ask questions, and construct knowledge collaboratively. This has profound implications for promoting scientific literacy and a deeper understanding of science in a society transitioning into a knowledge-based economy. It is evident that the National Zoological Garden, as an informal science education setting, has the potential to offer a unique and enriching educational experience for learners. However, the realization of this potential is contingent upon the proactive recognition and mitigation of language barriers. This study serves as a call to action, urging stakeholders in science education to embrace linguistic diversity and harness the power of language to foster learner interaction, discourse, and the construction of scientific knowledge.

The National Zoological Garden stands as a testament to the transformative possibilities of science education. It is not merely a collection of exhibits but a vibrant arena where learners engage, explore, and connect with the natural world. By addressing language barriers, we can further unlock the potential of this dynamic environment, ensuring that every learner can participate, ask questions, and contribute to the ongoing dialogue that defines the world of science. In an era of rapid change and technological advancement, nurturing the scientific curiosity and competence of the next generation is more critical than ever. The findings of this study offer a pathway toward a more inclusive and effective science education, where language is not a barrier but a bridge to understanding, discovery, and a deeper appreciation of the wonders of the natural world.

Acknowledgement: The researchers wish to thank the Management of the National Zoological Garden for the permission to conduct the study and also the school teachers and learners for participation in the study. More information on this study can be accessed at https://uir.unisa.ac.za/handle/10500/30985

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