Journal of Research in Education and Pedagogy
ISSN 3047-7131 (online) & 3047-6410 (print)
November 2025, Vol. 2, No. 4, pp. 626–641

Research Article

Cross Fertilization of Ideas between Indigenous Knowledge and Western Science: Navigating the Complexity in Science Lessons

Fredrick Simataa Simasiku[1]

[1]School of Secondary and Postgraduate Education, The International University of Management, Windhoek, Namibia

Abstract
Learners find it difficult during science lessons when they are asked to relate their indigenous knowledge to Western science, not only that they do not know that they might know it in their indigenous language, but it difficult for them to translate it into the language of teaching and learning (LoTL). The complexity of the indigenous language in science lessons hinders the integration of IK in science lessons. The aim of the study was to investigate the complexity of indigenous knowledge in science lessons that are taught in English when the teacher includes learners' lived experiences in science lessons. Social constructivism theory was used as the lens to analyse the data. The study employs the Dialogical Argumentation Instructional Model (DAIM) and Contiguity Argumentation Theory (CAT) as analytical tools to analyze the data obtained from the learners during science lessons. The study involved Grade 9 learners taught the topic on acids and bases in a rural school in the Ohangwena region. The data were generated using lesson observation and focus group interviews with learners. The major findings of this study show that learners are loaded with indigenous knowledge before they enter the science classroom, and teachers need to use this knowledge to enhance the conceptual understanding of learners in science lessons. The study also shows that using argumentation as a teaching model helped learners to reflect back and engage their indigenous knowledge in science lessons. However, some learners were not able to cross-fertilize the indigenous knowledge into scientific knowledge due to a lack of terminology in English. Thus, the study recommends that teachers need to be trained on how to integrate indigenous knowledge into their lessons.

Keywords: Indigenous Knowledge, Indigenous Language, Cross Fertilization of Ideas, Social Constructivism Theory, Dialogical Argumentation Instructional Model, Contiguity Argumentation Theory

Correspondence
Fredrick S. Simasiku
f.simasiku@ium.edu.na

Received
May 3, 2025
Accepted
August 24, 2025
Published
November 3, 2025

Citation: Simasiku, F. S. (2025). Cross fertilization of ideas between indigenous knowledge and Western science: Navigating the complexity in science lessons. *Journal of Research in Education and Pedagogy, 2*(4), 626–641.

DOI: 10.70232/jrep.v2i4.118

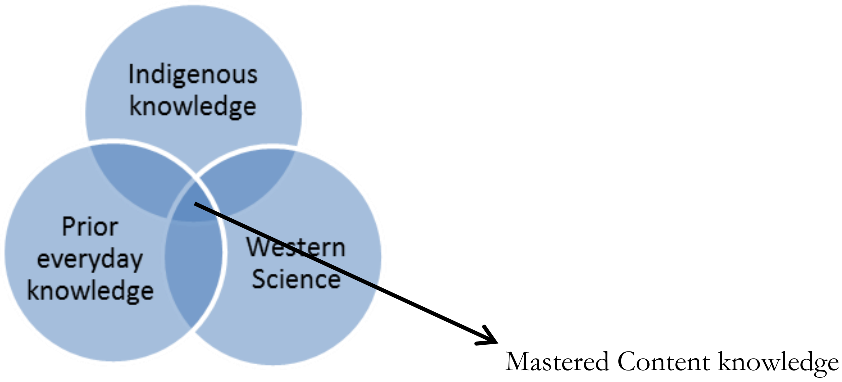
1. INTRODUCTION

The introduction of Learner-Centered Education (LCE) in Namibia and Outcome-Based Education (OBE) in South Africa signals a fundamental shift towards actively involving learners in the learning process. This paper advocates for embracing the core principles of LCE, particularly in the realm of science education. It emphasizes the importance of tailoring learning experiences to leverage learners' prior knowledge and interests, acknowledging their relevance to their lives. Active engagement with learning materials, whether provided by teachers or accessed from home, is integral to this approach. Learners, when given the opportunity, become active architects of their own knowledge. This embodies the essence of learner-centered education, fostering a dynamic classroom environment. Moreover, the rich natural resources surrounding schools and communities present valuable teaching opportunities. For instance, the abundance of fruit trees in learners' homes not only embeds indigenous knowledge (IK) but also provides a tangible context for understanding scientific concepts such as acids and bases. The familiar sensory experiences of sour and bitter tastes associated with various fruits offer a tangible link to classroom lessons. Mukwambo et al. (2014) highlight the wealth of Indigenous Knowledge possessed by learners, underscoring the importance of harnessing and integrating it with Western scientific concepts. Bridging this gap between IK and Western knowledge necessitates a process of cross-fertilization, wherein learners' ideas from both perspectives enrich one another. This paper underscores the significance of such cross-cultural exchange in fostering a more holistic understanding of science education. Research answered the following research questions: *How do Grade 9 learners cross fertilized the IK into scientific knowledge during physical science lessons?* and *What are the Grade 9 physical science learners' cultural practices on the topic of acids and bases?*

2. LITERATURE REVIEW

2.1. Cross Fertilization of Ideas in Science Lessons

Learning can be the result of the interweaving of the indigenous knowledge, prior everyday knowledge, and subject matter knowledge in the science lesson. Cross fertilization of ideas is when the indigenous worldview and scientific worldview of knowledge come together and reach a consensus on one idea that has the some meaning from the two worldviews but approached from different perspectives. Aikenhead and Jegede (1999) called it cultural border crossing. Cultural border crossing can serve science teachers, the pedagogical culture workers who make the culture of science accessible to all their learners (Lee et al., 2020). The knowledge from home (IK) and science subject content cross fertilizes each other, and where it agrees, the learner masters the subject content, and where it disagrees, the content is examined and learned. Dziva, Mpofu & Kusure (2011) posited that the difference between scientific and indigenous knowledge continues to create a barrier to meaningful collaboration, as does the widespread assumption that science is superior to other knowledge systems. Learners always face the challenges to cross fertilize their indigenous knowledge into scientific or Western knowledge. Science teachers need to work with both world views as they complement each other, and they are both superior in their own nature. Comparing indigenous knowledge world views and scientific knowledge world views will expand the gap between them, and learners will not be able to connect the two forms of knowledge. The diagram below attempts to show what happens during the lessons when PEK, IK, and Western science (WS) are included in one science lesson. The section where the three are interwoven is called Mastered content knowledge, where the knowledge has cross fertilized each other, and the results will be learners understand the concepts. Not everything that is taught during the science lessons used to be mastered by the learners for future retrieval during examinations. For the learners to master the content, teachers need to build from what the learners already know and make the connection between WS, PEK, and IK.



Adapted from Mukwambo, Ngcoza, and Chikunda (2014, p. 3)

Mastering the content requires science teachers to use the indigenous knowledge (IK), prior everyday knowledge (PEK), and Western science (WS) to help learners master the content. The three circles represent the different knowledge that learners have in their minds, or different knowledge zones in the minds of the learners. The sections where the circles intersect represent the knowledge that matched and cross fertilized each other, and while the zone outside represents the knowledge that does not have the link to either of the two. The fourth zone, where all three circles intersect, represents the mastered content during the science lessons.

Mukwambo (20012) affirms that although prior everyday knowledge and experiences have been sanctioned as sources of knowledge, little has been done to incorporate them into the actual teaching and learning of science. Furthermore, for learning to happen, learners need to have a base foundation to be able to connect the knowledge learned to their IK and PEK. Indigenous knowledge, prior everyday knowledge, and subject matter knowledge are interwoven and cannot be separated, but the teacher needs only to reconnect the subject matter knowledge to the IK of the learners in the science classroom. Mukwambo et al. (2014) argued that learning becomes effective when participants' cultural resources are harnessed in the teaching and learning of science subjects.

Moreover, when learners come into contact with Western science concepts, it will be linked to the existing knowledge and make meaning from the concepts in the local language before being translated back into the language of learning and teaching (LoLT). This calls for CFI to be brought in to help the learners understand the concepts in the local language and fertilized it before translating it into science and making meaning for understanding. For non-Western learners, interaction between two worldviews (IK and WS) characterizes much of their school experiences, complicating the learning process and potentially resulting in cognitive conflict called cognitive dissonance/perturbation (Le Grange, 2007). The diagram above illustrates when the two worldviews conflict in the mind of a non-Western learner and the result as learned content. It is crucial for the teachers working in these contexts to be aware of this interaction and understand the way it could complicate the learning process. Effective learning will depend on teachers' understanding of this interaction and their ability to manage classroom discourses related to this matter to reduce the conflicts (Le Grange, 2007). Every new word introduced to the learners will bring about conflict. The solution to this conflict was resolved by introducing Jegede's (1999) theory of collateral learning. To solve these problems, learners and science teachers in a science classroom need to work toward cross fertilize the ideas from both world views.

Jegede's (1999) theory of collateral learning identified four types of collateral learning: parallel, simultaneous, dependent, and secured. For the learners not to have dissonance/perturbation, teachers need to incorporate all the four-collateral learning in their teaching and know exactly what has happened to the learners.

Parallel collateral learning occurs when learners acquire and maintain opposing schemata about concepts and ideas in their long-term memory when learning new science concepts.

Simultaneous collateral learning occurs when the concept to be embedded in the long-term memory of the learner, the information needs to be processed over a long period of time.

Dependent collateral learning occurs when schemata from one worldview are presented, which challenge those of other worldviews, enabling the learner to modify existing schemata.

Secured collateral learning occurs when learners acquire knowledge or an intellectual skill is a gradual and incremental process rather than a single event. Learners have to resolve what he/she might experience as cognitive conflict or mental dissonance in the knowledge base embedded in his/her long-term memory (Le Grange, 2007).

This collateral learning helps the teachers to integrate IK and WS into the science lessons. These points refer to the uses of learners' indigenous knowledge as underpinned by socio-cultural theory. Even though research has been done on teaching science with IK, it still poses some benefits and challenges to both learners and teachers.

2.2. Complexity of IK in Science Lessons

Although we may acknowledge and respect our learners' Indigenous Knowledge (IK), this does not mean that we should not expose factual errors. We should always scrutinize the IK that learners might have and correct any mistakes (Kibirige & Van Rooyen, 2006). Recent studies emphasize the importance of critical engagement with IK, ensuring that misconceptions are addressed while maintaining respect for indigenous perspectives (Seehawer, 2018). Most local concepts are not yet developed in the Language of Learning and Teaching (LoLT). According to Mukwambo et al. (2014), science concepts are not always explicit in most indigenous practices, but the Africanisation of the school science curriculum calls upon teachers and learners to attach scientific explanations to indigenous knowledge. Curriculum reforms in various African countries have begun to explore ways to integrate IK meaningfully into science education, ensuring that learners can connect their cultural knowledge with scientific principles (Silva et al., 2024).

Shizha (2007) argues that biases were detected when teachers in Zimbabwe were asked how they integrate indigenous knowledge, culture, traditional beliefs, and customs into their science lessons. This bias was influenced by the national curriculum that does not integrate IK into the science syllabus, and also the use of English as LoLT (ibid). English was only linked to Western knowledge, not to indigenous knowledge. Indigenous knowledge and language are not totally acceptable in the teaching and learning of science. Indigenous science and language are judged as irrelevant to the understanding of 'modern' scientific values and skills that are practiced internationally (Shizha, 2007). Recent research highlights the need for bilingual education models that incorporate indigenous languages alongside English to facilitate better comprehension and integration of IK in science lessons (Amuthenu, 2023).

The other challenge is textbooks, which hinder the successful integration of IK into science lessons because they document only scientific knowledge, which is perceived as proven facts and absolute truth. Science teachers rely on documented information and accept it as legitimate knowledge (Shizha, 2007). This is the problem in Namibia, since IK is not documented; it is difficult for science teachers to integrate it into their lessons because they are not knowledgeable about IK. Within South Africa, this has been further exacerbated by the lack of attention given by the national schooling curriculum to IK. The Curriculum 2005 (C2005), launched by the African National Congress (ANC), is primarily focused on Western-based scientific knowledge and gives very little acknowledgment to the fact that this knowledge is given in a cultural framework that is primarily based on indigenous epistemology (Cocks, Alexander & Dold, 2012). Recent studies advocate for the development of indigenous knowledge textbooks that provide structured content for teachers to use in science lessons (Zidny et al., 2021).

Cronje, de Beer, and Ankiewicz (2015) illustrate the following challenges:

- Science teachers struggle to incorporate indigenous knowledge into their lessons.
- Teachers were not exposed to training on how to include IK since they were trained in so-called "Western science".
- IK has a lack of instructional methods and pedagogical content knowledge.
- Science teachers fear that they will be teaching pseudoscience when integrating IK into Western science.
- Indigenous knowledge has not been scientifically proven and is not based on scientific methods; and
- Lack of literature or textbooks that include IK to be universal in all schools in the country.

These might be some of the challenges that science teachers face when attempting to include local knowledge in their science lessons. Simasiku (2016) asserts that teachers fear that IK could not be examined during examinations; therefore, it might be a waste of time to include it in science lessons. This resonates with Nyika (2017), who states that teachers indicate that they teach what is examinable, and indigenous knowledge is rarely examined in external final examinations. Recent policy discussions suggest that examination frameworks should be revised to include IK-based assessments, ensuring that indigenous perspectives are valued in formal education (Silva et al., 2024).

2.3. Integrating CFI in teaching Science

The cross-fertilization of ideas (CFI) between Indigenous knowledge and Western science presents a transformative approach to science education, fostering inclusivity and deeper engagement among learners. Science teachers teaching in a multicultural classroom need to be knowledgeable about what other cultures are doing. The use of indigenous knowledge helps learners to be engaged in the classroom discourse. Recent research highlights the importance of integrating Indigenous perspectives into science curricula to create a more holistic understanding of scientific concepts (Kim, 2022). Teachers can implement cross-fertilization strategies by integrating Indigenous storytelling, traditional ecological knowledge, and culturally relevant examples into lessons, ensuring that learners see their identities reflected in the learning process (Mazzocchi, 2018). This approach not only enhances learners' engagement but also promotes equity by validating diverse ways of knowing and challenging the dominance of Western scientific paradigms (Bala & Joseph, 2007). Working with an indigenous knowledge custodian to explain the indigenous knowledge to the learners promotes the culturally responsive pedagogy. Culturally responsive pedagogy is an educational approach that integrates learners' cultural backgrounds into teaching practices to foster inclusivity and equity in learning. It emphasizes recognizing diverse perspectives to ensure learners feel valued and represented in the curriculum (Caingcoy, 2023). By adapting teaching methods to align with learners' lived experiences, teachers can promote engagement and deeper understanding (Boison & Burke, 2025).

Recent research highlights that culturally responsive pedagogy enhances learners' achievement by creating meaningful connections between classroom content and learners' lived experiences. Teachers can implement this approach by integrating multicultural materials, facilitating discussions on diverse perspectives, and using instructional strategies that reflect learners' cultural contexts (Caingcoy, 2023). Additionally, fostering strong relationships between teachers and learners helps create a supportive learning environment where all learners feel empowered. Policymakers play a crucial role in supporting this integration by developing frameworks that encourage collaboration between Indigenous communities and educational institutions, ensuring that curricula are designed with cultural sensitivity and respect (Kim, 20221). By embracing CFI, science education can evolve into a more inclusive and dynamic field, empowering learners to navigate complex scientific concepts while honouring multiple knowledge systems.

2.4. Theoretical Framework

The paper used social constructivism theory as the theoretical framework and DAIM and CAT as analytical tools to analyses the data obtained from the lesson observation and group interviews with learners.

2.4.1 Social Constructivism Theory

Social constructivism emphasizes the importance of culture and context in understanding what occurs in society and constructing knowledge based on this understanding (Kim, 2001). Adding to this, Kundi and Nawaz (2010) clarify that social constructivism emphasizes collective learning, where the role of the teacher, parents, peers, and other community members in helping learners becomes prominent. This theory allows teachers to use the knowledge they gained from home to be part of the classroom context. The classroom is viewed as the social unit where teachers, parents, and the community work together to educate the learner. Social constructivism is based on specific assumptions about reality, knowledge, and learning (Kim, 2001). To apply and understand those models of instruction that are rooted in the perspective of social constructivism, it is of utmost importance to consider the premises that underlie them (Mkhwebane, 2024).

2.4.2. Reality

Social constructivism believes that reality is constructed through human activity; reality cannot be discovered, it does not exist prior to its social invention (Kim, 2001). Through professional development of teachers on the inclusion of IK in science lessons, human activities were used to enhance the understanding of teachers regarding indigenous knowledge practices that are useful in science classrooms (Nsindiso, 2024). The use of Oshikundu and Omutoko in teaching science concepts became a reality for some teachers and learners when they were part of the research process (Mhakure & Otulaja, 2017).

2.4.3. Knowledge

According to social constructivism, knowledge is also a human product and is socially and culturally constructed (Kim, 2001). As individuals, it creates meaning through interaction with each other and with the environment in which we live. The interaction between community members and teachers allows for new knowledge to be created from indigenous knowledge into Western science. This knowledge was transferred into science classrooms (Mkhwebane, 2024). IK is located in the environment where people live and is linked to past practices based on the environment (Nsindiso, 2022).

2.4.4. Learning

Social constructivism views learning as a social process. It does not take place only within an individual, nor is it a passive development of behaviors shaped by external forces. Meaningful learning occurs when individuals are engaged in social activities (Kim, 2001). The use of IK in science classrooms allowed learners to engage in meaningful learning and reconnect IK to Western science (Mhakure & Otulaja, 2017). Social constructivism is crucial for both the context in which learning occurs and the social contexts that learners bring to their learning environment (Mkhwebane, 2024).

3. METHODS

Mixed methods research, as defined by Johnson, Onwuegbuzie, and Turner (2007), integrates both quantitative (QUANT) and qualitative (qual) approaches across various research components, including questions, methods, data collection, and analysis. This approach allows researchers to combine elements of both paradigms to enhance breadth, depth, and corroboration in their findings. Recent studies continue to emphasize the value of mixed methods research in addressing complex educational and social issues (Creswell & Plano Clark, 2017).

This research collected data by using both qualitative and quantitative approaches. Mixed methods research is also an attempt to legitimate the use of multiple approaches in answering research questions, rather than restricting or constraining researchers' choice (Johnson & Onwuegbuzie, 2004). This allowed us to have questions that require QUANT and the ones that need qual to analyse them. In support of this, mixed methods research has advantages over other forms of research as indicated by Johnson et al. (2007). Firstly, combinations are used to confirm or corroborate each other to provide triangulation (Creswell & Creswell, 2017). Secondly, combinations are used to enable or develop analysis in order to provide richer data (Guetterman et al., 2023). Thirdly, combinations are used to initiate new modes of thinking by attending to paradoxes that emerge from the data sources (Plano Clark & Ivankova, 2015).

3.1. Participants

The study involved grade 9 learners at the rural school in the Ohangwena region, Namibia. 12 grade 9 learners were involved, aged between 15-21 years old, and one Physical Science teacher. The participants were purposively sampled due to the location of the school as a rural school and the knowledge of the teachers on teaching Physical Science using indigenous knowledge.

3.2. Research Instruments

3.2.1 Lesson Observation

Lessons observation was used in this study to be able to collect data from learners during the lessons with the help of the science teachers. Learners' ages were in the range between 15 years to 21 years old in Grade 9. I observed three different lessons on the topics of acids and bases, as it has a lot of IK in the surrounding area. Observation means that the researchers go to the site of the study, which may be a school, a classroom, a staff room, or a community meeting space, and observe what is actually taking place there (Bertram & Christiansen, 2015). Observation is a highly flexible form of data collection that can enable researchers to have access to interactions in a social context and to yield systematic records (Cohen, Manion & Morrison, 2018).

Kraus (2023) emphasized the importance of lesson observation in science education, particularly in understanding how teachers facilitate inquiry-based learning. Observation allows researchers to capture real-time interactions between teachers and learners, providing insights into pedagogical strategies that support IK integration (Silva et al., 2024). In this case, I observed the teacher teaching in the science classroom to have first-hand information on how DAIM and CAT help learners learn. The data were generated from the response of the learners either by answering the questions by writing and orally. The lessons were video-recorded and transcribed, ensuring a detailed analysis of classroom discourse and instructional methods (Kraus, 2023).

3.2.2. Focus Group Interviews

According to Gay, Mills, and Airasian (2011), when conducting a focus group interview, it is important to ensure that all participants have their say and nurture a group agreement to take turns. Participants should understand that the focus group interview is a group-sharing activity and not something to be dominated by one or two individuals. Sachdeva et al. (2024) emphasise the importance of structured facilitation to ensure balanced participation and avoid dominance by more vocal individuals.

As a researcher, I conducted focus group interviews by providing opportunities for participants to share their thoughts on each question. Using a structured and semi-structured interview schedule, a researcher can pose questions to the group and encourage all participants to respond (Gay et al., 2011). Vaughn et al. (2013) suggest that open-ended questions and probing techniques help elicit deeper responses and ensure inclusivity in discussions.

One of my duties during the interview was to direct the proceedings of the focus group interview by ensuring that only the active/talkative learners did not dominate the session. Time allocation was equally divided among participants to ensure that everyone had an opportunity to contribute and no one felt left out. Best practices for focus group facilitation recommend using rotational speaking methods and moderation techniques to maintain engagement and fairness (Sachdeva et al., 2024). A total of 12 selected learners participated in this interview.

3.3. Procedures

Data were collected using the lesson observation schedule first. Three consecutive lessons were observed that yielded data for this research. Furthermore, to supplement the lesson observation, focus group interviews were conducted with all 12 learners who were involved in the study.

3.4. Data Analysis

Data generated from the observation and group interviews were analyzed by using DAIM and CAT. DAIM allowed us to have a dialogic between the learners and the teacher when IK was used as the teaching aid during the lessons, and on how learners responded to the questions from the teacher. Learners supported their answers with reasons and explanations during the lessons. I used Ogunniyi and Hewson's (2008) Contiguity Argumentation Theory (CAT) five cognitive categories to analyze the data. The dominant conceptions allowed us to observe how the learners used their dominant IK they gained at home in learning science concepts. Suppressed conceptions and dominant conceptions can become suppressed by, or assimilated into, another more adaptable mental state. Assimilated conceptions allowed learners to assimilate their IK with Western science, which could suppress the dominant conception. Emergent conceptions allow learners without prior everyday knowledge to link Western science to the indigenous knowledge that the learners did not have at the beginning of the science lessons. Equipollent conceptions allow learners with two worldviews to try and understand each worldviews. This is the point where I call it cross-fertilization of ideas. Two ideas from two worldviews need to be examined each other and allow learners to learn. Ogunniyi (2007) outlines more on the five cognitive categories. This was used as an analytical tool to analyze the data (Langenhoven, 2014; da Silva et al., 2024). Data from lesson observation and focus group interview were coded as L1LO (learner 1 lesson observation) and L1FGI (learner 1 focus group interview).

3.5. Statement of the Problem

Cross-fertilization of ideas (CFI) between Indigenous Knowledge (IK) and Western Science (WS) in the context of navigating complexity in science lessons entails addressing the challenge of integrating diverse epistemological frameworks into science education. Despite growing recognition of the value of indigenous knowledge systems alongside Western scientific paradigms, there remains a lack of systematic approaches to effectively blend these perspectives within science curricula (Kim, 2022). The complexity arises from differing ontologies, methodologies, and worldviews inherent to each knowledge system, posing significant pedagogical and logistical hurdles for science teachers (Seehawer, 2018).

This necessitates a comprehensive examination of how to integrate indigenous knowledge while ensuring alignment with curriculum standards and educational objectives, thereby fostering inclusive and culturally responsive science education practices. Scholars have explored various strategies for integrating IK and WS, emphasizing the need for decolonizing science curricula and developing pedagogical models that bridge these knowledge systems (Zidny et al., 2021). Research highlights that successful integration requires collaboration between teachers and indigenous custodians, ensuring that IK is not merely an add-on but a fundamental component of science education (Kim, 2022). Seehawer (2018) suggests that participatory action research can empower teachers to develop practical methods for integrating IK into their science lessons.

By addressing these aspects, science education can evolve into a more holistic and inclusive framework, recognizing the legitimacy of multiple ways of knowing and fostering deeper engagement among learners.

3.6. Significance of the study

The research helped science teachers to be able to accommodate IK of learners in their science classrooms whenever they need be. Learners, if allowed to take part in science lessons using their IK from home, will be encouraged to be critical thinkers and research further into the IK of the community that is applicable in science lessons. This allows them to be community science researchers who would like to prove any indigenous knowledge practices that are done in the communities or at home.

4. RESULTS AND DISCUSSION

The qualitative data presented here were obtained from the learners on the activities that they were given by the teachers. In these activities, teachers were incorporating IK in their Physical Science lessons. During the first lesson one it was vividly clear that the teacher wanted the learners to write the substances that taste sour at home, and most learners could not think of the local substances that they have at their home, and when they eat them, they taste sour. The result obtained from these activities was analysed and presented to see which substances were commonly known by the learners.

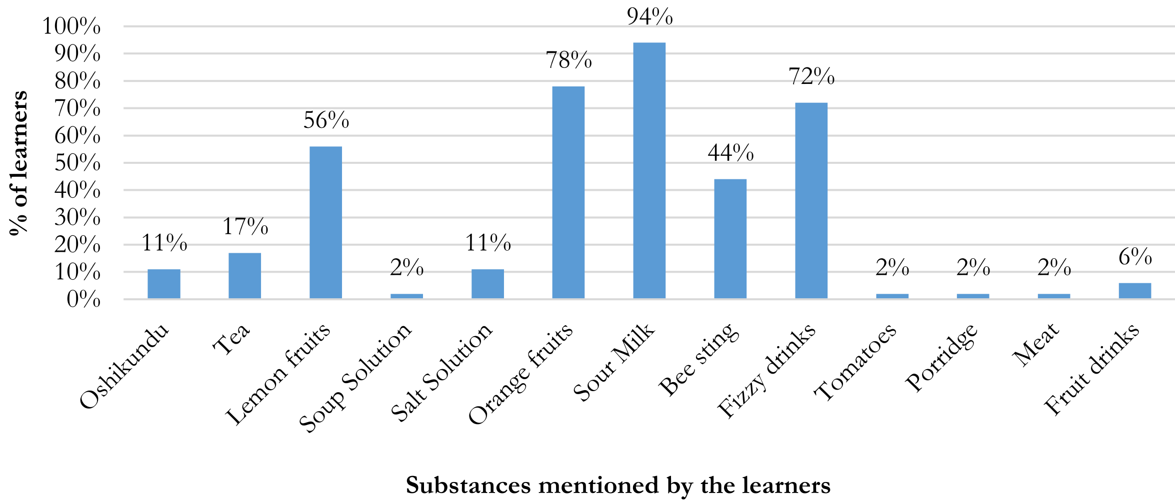


Figure 1. Statistics for the Learners Naming the Substances that Taste Sour at Home

This indicates that 94% of learners mentioned sour milk, which is commonly used at home as an acid. L3LO asserts that, "*When you eat milk after three or four days, it will be very sour, so it is an acid,*" while another learner indicated that, "*When you eat it fresh, it is not sour, so it changes to acid after three or four days*" (L5LO). This shows the dominant conception that learners have about the milk. However, 56% of the learners mentioned lemon fruit, which is common in their homes, while 78% mentioned orange fruit, as these are commonly grown in the backyard at their homes. Learners shared that they eat fruit every day on their way to school, and it is very sour. The learners knew that these fruits taste sour, and they did not mention lemon juice or orange juice, but rather the fruits that are available in their homes.

Only 11% of learners named [1]*Oshikundu* as a substance that tastes sour at home, 17% named tea, and 11% mentioned salt solution. *Oshikundu* has a sour taste when you drink it, which shows that it is an acid (assimilated conception). However, 2% of learners mentioned meat as an acid, possibly due to the sour taste of meat when it is about to rot. Learners argued that meat must be acidic because it has a sour taste when it is left outside without refrigeration. One learner explained when asked why they named meat as an acid: "*It has that taste like sour milk when left outside without refrigerating, and we used to eat this during weddings*" (L10LO) (equipollent conception). The learners argued that milk also should not be acidic because fresh milk does not have a sour taste, but when left for two to three days, it will change the taste to be sour, which also the meat does *(emergent conception)*. They also argued that *Oshikundu* also used to become more sour the longer it stays. *"Why Oshikundu, that is one day old, is different from the one that is two to three days old, meat also must be an acid"* (L7LO argued). Meaning that the longer *Oshikundu* stays, the sourer it becomes. These misconceptions might hinder the integration of IK into Western Science (WS) if not proven worthwhile before inclusion in science lessons. Ogunniyi (2011) explains that Conceptual Argumentation Theory (CAT) deals with both logical or scientifically valid arguments as well as non-logical metaphysical discourse embraced by IK. These discussions were embraced during the lesson, even though some of the learners' arguments were not followed up to prove correctness or incorrectness. The difficulty learners face in distinguishing between scientific concepts and indigenous beliefs is discussed by Dziva et al. (2011), who emphasize that learners' understanding of science is affected by language barriers, mathematical skills, and academic orientation.

Oshifima (Porridge) was also mentioned as an acid. Most learners' favourite porridge is *Mahangu* porridge. *Mahangu* flour is made from *Mahangu* that has been soaked in water for two to three days and then dried before it is crushed. When *Mahangu* is left in water for two to three days, it undergoes fermentation, which imparts a sour taste. The germinated seeds are dried and crushed using a mortar and pestle, and then sieved or processed using a machine. The porridge from this *Mahangu* flour has a sour taste, similar to other fermented substances studied in African indigenous food research (Baquete et al., 2024). This highlights the complexity of IK when integrated into science lessons, requiring testing for validity to avoid confusion in the science classroom. According to Ogunniyi (1987), CAT assumes that when different ideas come from different learners, they tend to find commonality. These ideas are cross-fertilized into Western knowledge and engaged to form new knowledge. However, Dziva et al. (2011) emphasize that juxtaposing these two distinctive worldviews should occur within a structured dialogical space to prevent misunderstandings. Cross-fertilization of indigenous knowledge and modern science is essential for fostering productive dialogue in education (González-Piñero et al., 2021).

Dialectical Argumentation Instructional Model (DAIM) allowed the teacher to encourage learners to support their answers with explanations or reasons (Ogunniyi, 2007). The argumentation in the lesson helped learners conclude that not all substances that taste sour are acids unless proven scientifically. The conversation between the teacher and learners below highlights that:

T: *Let's look at Oshikundu, is it an acid or a base*

L6LO: *Ms Oshikundu is acid*

T: Why are you saying that is acid

L6Lo: *aa because Oshikundu can taste…..*

L11LO: *Sour*

L6LO: *yes sour*

T: *Where does the sour come from, if you make Oshikundu today and drink it after, will it taste sour*

L12LO: *No, Ms, it will not taste sour because inashipya (not fermented)*

[1]Oshikundu is a non-alcoholic traditional beverage which is made from fermenting three flours, namely, Ongudo, Uushutu, and Mahangu. It is a staple drink for many Oshiwambo speakers in Namibia and it is a rich source of carbohydrates, proteins, vitamins, as well as minerals. It also provides the body with water essential to preventing dehydration (Shinana, 2019).

L5LO: *Oshikundu is not fermented and the taste will be like water, but after 3 to 4 hours, it will be fermented, and the taste will change to sour.*

T: *soo you mean fermentation changes Oshikundu from neutral to acidic*

L6LO: Pamwe (maybe)

L10LO: Ngenge Oshikundu shapya (If Oshikundu is fermented), it changes the taste to a sour taste, and the longer it stays, the more sour it becomes

These extracts highlight the importance of teaching learners by building on learners' lived experiences. Ogunniyi (2007) highlights argumentation instruction as a method of teaching and learning that enables teachers to create opportunities for learners to discuss and debate freely, facilitating the cross-fertilization of ideas between indigenous and scientific worldviews. Strategies for supporting learners in engaging in scientific argumentation have been explored in recent studies (Mikeska et al., 2024), which highlight the importance of interactive teaching methods.

In this science lesson, learners were encouraged to apply their indigenous knowledge to answer questions and defend their explanations. The teacher prioritized local substances found at home rather than those available only in school or laboratory settings. This demonstrated the teacher's ability to integrate local knowledge when teaching acids. The findings suggest that the teacher effectively infused IK into science lessons, enabling learners to identify sour-tasting substances in their homes. The learners linked classroom knowledge to their everyday experiences, using their background knowledge of acids from home before formal science instruction. CAT provided a framework for learners to engage in peer learning through argumentation. This was observed when learners tried to convince one another about substances that taste sour at home. Some learners also recalled substances learned in previous grades as their prior knowledge, which were not necessarily local, such as fruit drinks, bee stings, and fizzy drinks.

To further solidify their understanding, the teacher facilitated an experiment in which learners tested seven substances brought by the teacher using litmus paper (both red and blue) to determine acidity. Learners recorded their observations, and the results were analysed to confirm which substances were acidic. The teacher aimed for learners to discover scientific principles through hands-on experimentation, aligning with best practices in science education (Simasiku & Ngcoza, 2024). This emphasises the practical value of indigenous knowledge in science education. Many aspects of IK prove useful when validated through experimental activities. The figure below presents the learners' results after conducting the experiment.

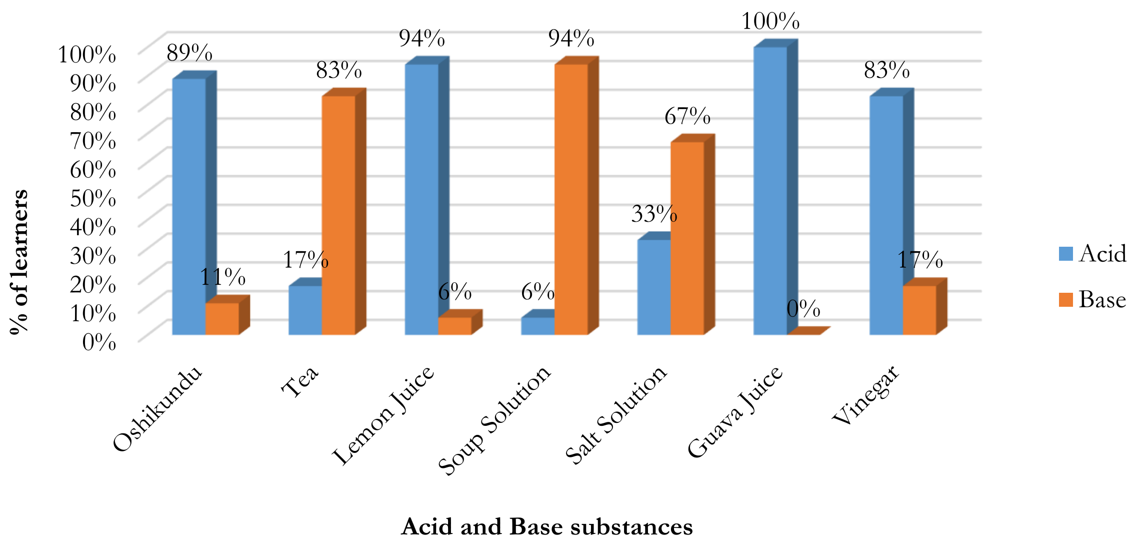


Figure 2. Shows the Results Obtained After the Learners Tested the Substances

This indicates that 89% of learners identified *Oshikundu* as an acid after testing it, while only 11% suggested it was not an acid. Similarly, 83% of learners indicated that tea was not an acid, but the teacher explained that tea is acidic if the litmus paper is left in it for a longer period. Due to time constraints, learners were unable to observe this change. Out of the seven substances tested, learners found that four were acids *Oshikundu, lemon juice, guava juice, and vinegar,* while three were not acids, such as *tea, soap solution, and salt solution* (dominant conception). However, the teacher clarified that tea was indeed an acid, but could not prove to the learners why it was found to be alkaline when tested. Integrating IK into school science teaching is one way of maximizing the socio-cultural relevance of science education to enhance learners' performance (Zinyeka et al., 2016). Indigenous knowledge provides learners with a familiar context, making scientific concepts more accessible and relatable (Handayani et al., 2018). Studies have shown that integrating IK into chemistry lessons enhances learners' understanding of acids and bases, particularly when using local substances (Simasiku & Ngcoza, 2024).

During lesson two, learners were asked to name substances that could be used for cleaning dishes, clothes, and their bodies instead of soap. The graph below illustrates the substances mentioned by learners.

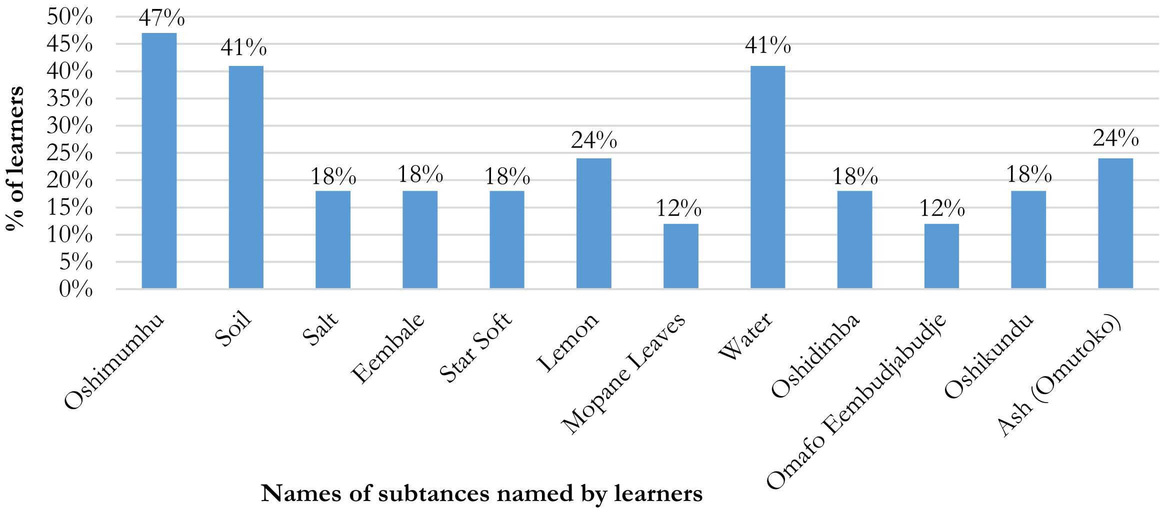


Figure 3. Substances Used for Cleaning at Home

During the lesson, 47% of learners mentioned *Oshimumhu* (Diospyros lycioides, the shrub used to clean teeth) as one of the substances used for cleaning. Traditionally, [2]*Oshimumhu* is used when a person does not have a toothbrush or toothpaste. The shrub is also known for its pleasant smell after use. *Oshimumhu*, when tested for alkalinity, was actually found to be an acid. However, learners indicated during group interviews that they believed *Oshimumhu* to be a base due to its bitter taste when cleaning teeth (dominant conception). L2FGI indicated that "O*shimumhu has a bitter taste that indicates that is alkaline*". This contradicts the finding that was discovered during the testing of the substances used for cleaning. L7FGI alluded that "*the testing was wrongly done, Oshimumhu by taste it has it is a base, not acidic*". The argument of the learners was based on the cultural beliefs and the taste they feel when using *Oshimumhu*. Which prompts further research to clarify these misconceptions?. This misconception highlights the importance of testing indigenous knowledge (IK) scientifically before integrating it into formal science education.

The use of *Oshimumhu* for cleaning teeth has been passed down through generations without scientific validation, leading to the belief that its bitter taste signifies it is a base (teacher). The cultural clash between IK and Western Science (WS) can create barriers for learners in understanding scientific concepts (Aikenhead & Jegede, 1999). According to Aikenhead & Jegede (1999), transitions between IK and WS are smooth when the family culture aligns with science, manageable when somewhat different, hazardous when diverse, and nearly impossible when highly discordant.

Other substances mentioned by learners included ash *(Omutoko)* by 24%, *Oshindimba* (bitter bush) by 18%, soil by 41%, and Mopane leaves by 12%. This illustrates that learners possess IK that can be useful in Physical Science lessons. Ash and soil are commonly used to clean dishes and pots, with ash being particularly effective in removing fats. L11GFI stated, "*After eating fatty meat, we use ash to clean the fat, and it is always used to clean dishes. I don't know why it removes the fats*" (equipollent conception). Kibirige and Van Rooyen

[2]Oshimumhu is Diospyros lycioides use to brush the teeth by indigenous people

(2006) argue that incorporating IK into science lessons encourages learners to participate actively, as education is about changing the meaning of experience through shared understanding.

Learners were able to mention *Omutoko* but could not explain the chemical process behind fat removal. The teacher also did not allow learners to engage further and discover the reaction involved. Soil was also mentioned as a cleaning agent, particularly for washing dishes and removing fats from pots (emergent conception). In interviews, female learners recalled using soil, especially sand, to clean plates and pots at home. L5FGI stated, "*I recall back home that when something is stuck on the pots, I just use sand to remove it.*" Another learner related, "*I think soil behaves like the spongy (steel scourer) used in modern times to clean pots*" (L9FGI) (emergent conception). Zinyeka et al. (2016) highlight that certain elements of IK and WS intersect, allowing knowledge acquisition through both systems.

Ramorogo and Ogunniyi (2010) emphasise that teachers should be equipped with alternative ways of viewing knowledge so that learners can consider different perspectives and interpretations. Some substances mentioned by learners were not traditionally used for cleaning, including modern products like *Star Soft*. Learners demonstrated an understanding of both IK and WS, though the question required them to focus on locally used cleaning substances. Social constructivist theory helped learners construct knowledge by engaging with modern science. Water was mentioned as the most common solvent. Surprisingly, learners also mentioned salt, lemon, and *Oshikundu* as cleaning substances, though they could not elaborate on how these substances function as cleaning detergents (emergent conception). Handayani et al. (2018) argue that elaborating IK in science curricula fosters cultural sustainability and meaningful learning.

5. LIMITATION OF THE STUDY

One of the primary methodological limitations of this study was the sample size, which may restrict the generalizability of the findings. The study was done at one school, which might not give enough evidence on the integration of IK in science lessons. Given the study's focus on a specific group of teachers and learners, the results may not fully represent the broader educational landscape. Future research could expand the sample size and include diverse educational settings to enhance the robustness of these conclusions (Seehawer, 2018).

The study is situated within a specific cultural and educational context, which influences its findings. The challenges and opportunities identified in integrating IK into science education may differ across regions, depending on factors such as national curricula, teacher training programs, and local community engagement (Silva et al., 2024). Amuthenu (2023) indicated that policy differences regarding IK inclusion in science education across various countries may limit the applicability of the findings beyond the study's specific educational setting. The researcher's positionality may influence the interpretation of findings. The perspectives, experiences, and epistemological stance of the researcher could shape the analysis and discussions surrounding IK and Western Science (WS) integration (Seehawer, 2018).

6. CONCLUSION AND RECOMMENDATIONS

The findings of this study highlight the need to critically examine why Indigenous Knowledge (IK) is not afforded the same recognition as Western Science (WS) in science classrooms. Learners already possess extensive IK through social interactions within their communities, including knowledge about substances with sour and bitter tastes commonly found in their local environments. This study demonstrates that IK and WS can be taught simultaneously, ensuring that IK is not marginalized. Both teachers and learners involved in this research emphasised IK's practical relevance in science, urging curriculum designers to re-evaluate how science curricula can integrate IK effectively.

This research offers fresh insights into the epistemological tensions between Indigenous and Western paradigms. It challenges the traditional dichotomy between these knowledge systems, advocating for a pedagogical approach that views IK and WS as complementary rather than oppositional. By presenting IK as a legitimate and valuable component of science education, this study pushes the boundaries of current pedagogical frameworks and calls for a redefinition of science teaching that is inclusive of diverse epistemologies.

For IK to be fully integrated into science lessons, additional teacher training is essential. Teachers need clear guidance on which aspects of IK, such as myths, cultural beliefs, indigenous practices, and knowledge systems, should be integrated into their instruction. Furthermore, Namibian universities must decolonize their science curricula, ensuring that future teachers are well-equipped before entering the education system to integrate indigenous knowledge in the science classroom. As agents of change, teachers must actively participate in curriculum design, shaping science education to meaningfully integrate IK.

Fostering collaboration between teachers and community members is also vital for enriching science lessons with IK. Without the engagement of local communities, teachers may struggle to integrate IK effectively. Future research should explore practical strategies for bridging IK and WS, including the development of teaching tools, curriculum frameworks, and methodologies that facilitate their co-existence. By addressing these aspects, science education can become more inclusive, innovative, and responsive to the cultural and epistemological diversity of learners, ultimately enhancing their engagement and understanding of science.

Acknowledgment. I acknowledge the participation of Grade 9 learners and the Physical Science teachers for willingly participating in this research. Without their involvement, this study could not have taken place. Thank you very much for the support. Teacher Shekupe, thank you very much for the knowledge you shared with learners on indigenous substances that are used in everyday life.

Research Ethics. Permission to conduct the research within the chosen group was acquired from the Ministry of Education, Arts, and Culture (MoEAC) in Namibia. Every participant signed consent forms, guaranteeing their involvement in the study with assurances of confidentiality, anonymity, and the trustworthiness of their responses and diagnosis scores. Consequently, discussions and certifications addressed potential internal threats to validity and reliability.

Data Availability Statement. Data supporting the findings and conclusions are available upon request from the author.

Conflicts of Interest. No conflict of interest is declared by the author.

Funding. No funding source is reported for this study.

REFERENCES

Aikenhead, G. S., & Jegede, O. J. (1999). Cross-cultural science education: A cognitive explanation of a cultural phenomenon. *Journal of Research in Science Teaching, 36*(3), 269-287. https://doi.org/10.1002/(SICI)1098-2736(199903)36:3<269::AID-TEA3>3.0.CO;2-T

Amuthenu, S. (2023). Strategies to incorporate and support indigenous knowledge into teacher training education: Lessons and insights for higher education institutions in Namibia. *International Journal for Multidisciplinary Research, 5*(4), 1-11.

Baquete, A. M., Grayson, D., & Mutimucuio, I. V. (2016). An exploration of indigenous knowledge related to physics concepts held by senior citizens in Chókwé, Mozambique. *International Journal of Science Education, 38*(1), 1-16. https://doi.org/10.1080/09500693.2015.1115137

Baquete, A.M., Grayson, D., & Mutimucuio, I.V. (2016). An exploration of indigenous knowledge related to Physics concepts held by senior citizens in Chokwe, Mozambique. *International Journal of Science Education, 38*, 1-16. http://dx.doi.org/10.1080/09500693.2015.1115137

Bertram, C., & Christiansen, I. (2015). *Understanding research: An introduction to reading research.* Van Schaik Publishers.

Clark, V. L. P., & Ivankova, N. V. (2015). *Mixed methods research: A guide to the field* (Vol. 3). Sage publications.

Cohen, L., Manion, L., & Morrison, K. (2011). *Research methods in education* (7th ed.). New York: Routledge.

Cooks, M. L., Alexander, J., &Dold, T. (2012). InkcubekoNendalo: A Bio-cultural Diversity Schools Education Project in South Africa and its implication for inclusive indigenous knowledge systems (IKS) sustainability. *Journal of Education for Sustainable Development, 6*, 241-252. http://dx.doi.org/10.1177/0973408212475232

Creswell, J. W., & Clark, V. L. P. (2017). *Designing and conducting mixed methods research.* Sage Publications.

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches.* Sage Publications.

Cronje, A., de Beer, J., &Ankiewicz, P. (2015). The development and use of an instrument to investigate science teachers' views on indigenous knowledge. *African Journal of Research in Mathematics, Science and Technology Education, 19*, 319-332. http://dx.doi.org/10.1080/10288457.2015.1108567

da Silva, C., Pereira, F., & Amorim, J. P. (2023). The integration of indigenous knowledge in school: a systematic review. *Compare: A Journal of Comparative and International Education, 54*(7), 1210–1228. https://doi.org/10.1080/03057925.2023.2184200

Dziva, D., Mpofu, V., & Kusure, L. (2011). Teachers' conception of indigenous knowledge in science curriculum in the context of Mberengwa District, Zimbabwe. *African Journal of Education and Technology, 1*(3) (2011), 88-102.

Gay, L. R., Mills, G. E., & Airasian, P. W. (2011). *Educational research: Competencies for analysis and application* (10th ed.). Pearson Education International.

González-Piñero, M., Páez-Avilés, C., Juanola-Feliu, E., & Samitier, J. (2021). Cross-fertilization of knowledge and technologies in collaborative research projects. *Journal of Knowledge Management, 25*(11), 34-59. http://dx.doi.org/10.1108/JKM-04-2020-0270

Guetterman, T. C., Motohara, S., & Molina-Azorin, J. F. (2023). In this issue: Tribute to Michael Fetters, queer approaches to mixed methods, mixed methods community-engaged evaluation, instrument fidelity and natural language processing, teaching mixed methods, and geographic information system. *Journal of Mixed Methods Research, 17*(4), 335-339. http://dx.doi.org/10.1177/15586898231202075

Haimene, J. S. (2018). *Exploring how the integration of indigenous knowledge in the topic of acids and bases influences Grade 10 Physical Science learners' conceptions, dispositions, and sense-making.* Rhodes University, Grahamstown.

Handayani, R. A. D., Wilujeng, I., & Prasetyo, Z. K. (2018). Elaborating indigenous knowledge in the science curriculum for the cultural sustainability. *Journal of Teacher Education for Sustainability, 20*(2), 74-88. http://dx.doi.org/10.2478/jtes-2018-0016

Jegede, O. J. (1995). Collateral learning and eco-cultural paradigm in Science and Mathematics Education in Africa. *Studies in Science Education, 25*, 95-137.

Johnson, B. R., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Research, 33*, 14-26. http://dx.doi.org/10.3102/0013189X033007014

Johnson, B. R., & Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a definition of mixed methods research. *Journal of Mixed Methods Research, 1*, 112-133. http://dx.doi.org/10.1177/1558689806298224

Kibirige, I., & Van Rooyen, H. (2006). Indigenous Knowledge and Science Education: Encouraging Learner Participation. *South African Journal of Science Education, 12*(1), 45-58.

Kim, B. (2001). Social constructivism. In M. Orey (ed.), *Emerging perspectives on learning, and technology.* http://www.coe.uga.edu/epltt/socialcontructivism.htm

Kraus, S.F. (2023). The Method of Observation in Science Education: Characteristic Dimensions from an Educational Perspective. *Science and Education, 33*, 1033–1068. https://doi.org/10.1007/s11191-023-00422-x

Kundi, G, M., & Nawaz, A. (2010). From objectivism to social constructivism: the impacts of information and communication technologies (ICTs) on higher education. *Journal of Science and Technology Education Research, 1*, 30-36.

Langenhoven, K. R. (2014). *The Effectiveness of an Argumentation Instructional Model in Enhancing Pre-Service Science Teachers' Efficacy to Implement a Science-Relevant Indigenous Knowledge Curriculum*. Unpublished Doctor of Philosophy, University of the Western Cape, Republic of South Africa.

Le Grange, L. (2007). Integrating western and indigenous knowledge systems: The basis for effective science education in South Africa? *International Review of Education, 53*, 577-591. http://dx.doi.org/10.1007/s11159-007-9056-x

Lee, H., Lee, H., & Zeidler, D. L. (2020). Examining tensions in the socioscientific issues classroom: Students' border crossings into a new culture of science. *Journal of Research in Science Teaching, 57*(5), 672-694. https://doi.org/10.1002/tea.21600

Mhakure, D., Otulaja, F.S. (2017). Culturally-Responsive Pedagogy in Science Education. In Otulaja, F.S., Ogunniyi, M.B. (eds), *The World of Science Education. Cultural and Historical Perpectives on Science Education*: *Handbooks.* Sense Publishers, Rotterdam. https://doi.org/10.1007/978-94-6351-089-9_6

Mikeska, J. N., Klebanov, B. B., Marigo, A., Tierney, J., Maxwell, T., Nazaretsky, T. (2024). Exploring the Potential of Automated and Personalized Feedback to Support Science Teacher Learning. In Olney, A. M., Chounta, I. A., Liu, Z., Santos, O.C., Bittencourt, I.I. (eds), *Artificial Intelligence in Education. AIED 2024. Lecture Notes in Computer Science*. Springer, Cham. https://doi.org/10.1007/978-3-031-64299-9_19

Mkhwebane, L. N. (2024). Life sciences teachers' integration of indigenous knowledge: A vision for making science classrooms culturally responsive. *EURASIA Journal of Mathematics, Science and Technology Education, 20*(8), em2483. https://doi.org/10.29333/ejmste/14859

Mukwambo, M. (2012). *Understanding trainee teachers' engagement with prior everyday knowledge and experiences in teaching physical science concepts: A case study.* Unpublished Masters' of Science education research. Rhodes University. Grahmstown.

Mukwambo, M., Ngcoza, K., & Chikunda, C. (July 2014). Africanisation, Ubuntu and IKS: A learner-centered approach. In C.I.O. Okeke, M.M. van Wyk, & N.T. Phasha (Eds.), *Schooling, society and inclusive education: An African perspective.* Oxford University Press.

Nikodemus, K.S. (2017). *Exploring how Grade 11physical science learners make sense of the concepts of rate of reaction through the inclusion of the indigenous practice of making Oshikundu: A Namibia case study.* Unpublished master's thesis. Education Department, Rhodes University. Grahamstown.

Nsindiso, M. (2022). Blending a Constructivist Theory of Teaching and Learning with Indigenous Knowledge Systems in the Official Natural Science Curriculum in Phongola Schools, Kwazulu Natal. *Indiana Journal of Arts and Literature, 3*(1), 6-12.

Nyika, R. (2017). Views and experiences of Gweru Rural Primary schools teachers on integrating indigenous knowledge system in the teaching and learning of Environment Science in Zibambwe. *Scholars Journal of Arts, Humanities and Social Sciences, 5*, 280-286. http://doi.org/10.36347/sjahss.2017.v05i04.003

Ogunniyi, M. B. (1987). Conceptions of traditional cosmological ideas among literate and non-literate Nigerians. *Journal of Research in Science Teaching, 24*, 107-118. https://doi.org/10.1002/tea.3660240203

Ogunniyi, M. B. (2011). Exploring science educators' cosmological worldviews through the binoculars of an argumentation framework. *South Africa Journal of Higher Education, 25*, 542-552. https://journals.co.za/doi/pdf/10.10520/EJC37692

Ogunniyi, M. B., & Hewson, M. G. (2008). Effect of an argumentation-based course on teachers' disposition towards a science-indigenous knowledge curriculum. *International Journal of Environmental and Science Education, 3*, 159-177.

Ramorogo, G., & Ogunniyi, M. (2010). Exploring teachers' conceptions of the rainbow using an argumentation-based intervention. *African Journal of Research in Mathematics, Science and Technology Education, 14*, 24-35. https://doi.org/10.1080/10288457.2010.10740670

Ramorogo, P., & Ogunniyi, M. B. (2010). Alternative Ways of Viewing Knowledge in Science Education. *International Journal of Science Education, 32*(5), 789-804.

Sachdeva, S., Tamrakar, K. A., Perwez, E., Kapoor, P., & Gupta, D. (2024). Focus Group Discussion: An Emerging Qualitative Tool for Educational Research. *International Journal of Research and Review, 11*(9), 302-308. https://doi.org/10.52403/ijrr.20240932

Seehawer, Maren. (2018). South African science teachers' strategies for integrating indigenous and Western knowledges in their classes: Practical lessons in decolonisation. *Educational Research for Social Change, 7*, 91-110. https://doi.org/10.17159/2221-4070/2018/v7i0a7

Shizha, E. (2007). Critical analysis of problems encountered in incorporating indigenous knowledge in science teaching by primary school teachers in Zimbabwe. *The Alberta Journal of Educational Research, 53*, 302- 319. http://dx.doi.org/10.55016/ojs/ajer.v53i3.55295

Simasiku, F. S. (2016). *Exploring Grade 9 Physical Science teachers' views and experiences on the inclusion of traditional or local knowledge (indigenous knowledge) in their lesson.* Unpublished master's thesis. Education Department, Rhodes University. Grahamstown.

Simasiku, F. S., & Ngcoza, K. M. (2024). Incorporating Indigenous Knowledge into Chemistry Lessons on Acids and Bases: Exploring Potential and Challenges. *International Journal of Research in STEM Education, 6*(2), 73-84. https://doi.org/10.33830/ijrse.v6i2.1714

Vaughn, S., Schumm, J. S., & Sinagub, J. M. (2013). *Focus Group Interviews in Education and Psychology.* SAGE Publications. https://doi.org/10.4135/9781452243641

Zidny, R., Sjöström, J., Eilks, I. (2023). Indigenous Knowledge and Science and Technology Education. In: Akpan, B., Cavas, B., Kennedy, T. (eds) *Contemporary Issues in Science and Technology Education. Contemporary Trends and Issues in Science Education*, vol 56. Springer, Cham. https://doi.org/10.1007/978-3-031-24259-5_12

Zinyeka, G., Onwu, G. O. M., & Braun, M. (2016). A truth-based epistemological framework for supporting teachers in integrating indigenous knowledge into science teaching. *African Journal in Mathematics, Science and Technology Education, 20*(3), 256-266. http://dx.doi.org/10.1080/18117295.2016.1239963