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Life sciences teachers' integration of indigenous knowledge: A vision for making science classrooms culturally responsive

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Abstract

This article presents findings from a qualitative study exploring factors influencing life sciences teachers' integration of indigenous knowledge (IK) across various topics in grades 10-12, as mandated by the curriculum and assessment policy statement in South Africa. Despite this mandate aiming to enhance accessibility and comprehension, many teachers struggle to integrate IK meaningfully. Through in-depth interviews and lesson observations with five teachers in Gauteng Province, the study reveals challenges such as inadequate training, limited support structures, and negative attitudes towards IK. Observations highlight deficiencies in pedagogical content knowledge related to IK integration. The study suggests intensified teacher training and future research focusing on textbook content and leveraging information and communication technologies to digitize IK and make its integration more meaningful and interesting. This will enhance educational experiences for both the teachers and learners in life sciences classrooms.

Keywords: pedagogical content knowledge, indigenous knowledge, life sciences teachers, social constructivism

INTRODUCTION

In post-apartheid South Africa, there have been growing calls for decolonization of the curriculum, to address the historical Eurocentric bias in educational content, especially in life sciences (Sitsha, 2022). This endeavor seeks to ensure the integration of content knowledge that enables learners to comprehend the subject matter meaningfully (Mavuru, 2024). Consequently, the South African government through the curriculum and assessment policy statement (CAPS) mandated that teachers integrate indigenous knowledge (IK) in the teaching of life sciences (Department of Basic Education [DBE], 2011). This study's conceptualization of IK is in line with McKnight's (2015) definition that IK is derived from traditional practices encompassing customs, skills, beliefs, and values and with Selepe et al. (2022) that IK is passed down from one generation to another for preservation. Cultural practices such as songs, poems, folktales, dances, and rituals are used to transmit this knowledge (McKnight, 2015).

Integrating IK in life sciences teaching offers numerous benefits for learners and teachers. IK helps learners connect subject matter to their daily lives and local contexts (Kalolo, 2015), and this fosters a deeper understanding of scientific concepts. Additionally, integrating IK simplifies and demystifies complex scientific concepts, thereby enhancing academic performance by making content more relatable and accessible to learners (Cronje et al., 2015). In addition, a study by Seehawer (2018) reported improved comprehension of abstract concepts when IK is integrated into teaching science concepts. Furthermore, IK integration fosters greater interest and motivation among learners to take up life sciences subject (Ngcobo, 2020), which is crucial for ensuring that South Africa produces more scientists capable of addressing contemporary challenges. Moreover, IK fosters cultural inclusivity for all learners, especially those from cultural groups previously marginalized during the apartheid era (de Beer, 2009).

Problem and Research Questions of the Study

Life sciences content knowledge in South Africa features concepts that are too abstract and difficult for learners to understand (de Beer & Mothwa, 2013). This calls for the integration of knowledge that is less

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Contribution to the literature

- This study fills a gap in the literature by identifying the practical challenges and barriers life sciences teachers encounter when integrating Indigenous Knowledge (IK) into the curriculum as per Curriculum and Assessment Policy Statement (CAPS) guidelines in South Africa.
- This study also adds to the literature by examining life sciences teachers' perceptions of the factors affecting IK integration, providing insight into their experiences and attitudes.
- Furthermore, it contributes to the development of pedagogical frameworks that facilitate the integration of IK, enhancing the cultural relevance and inclusivity of life sciences teaching.

cognitively demanding such as IK. As such, through the CAPS document for life sciences grades 10-12, the South African government calls for teachers to integrate IK into classrooms when teaching different topics, to enhance learning experiences and foster inclusivity (DBE, 2011). However, Cronje et al. (2015), de Beer and Mothwa (2013), Mavuru and Makhunga (2020), and Mothwa (2011) revealed that many life sciences teachers overlook this mandate. Those teachers who do integrate IK in their teaching, unfortunately, lack the appropriate pedagogical skills to integrate IK (Ngcobo, 2020).

Mothwa (2011) and Sitsha (2022) postulated that many life sciences teachers are relying on traditional methods to integrate IK in classrooms. It can be argued that this passive integration of IK is problematic, as it diminishes learner engagement and interest. Furthermore, Cronje et al. (2015) stated that life sciences teachers integrate IK as an add-on, only referring to one or two examples of IK. It is against this backdrop, that this study investigated the factors that influence life sciences teachers' integration of IK in classrooms. This is done to understand the challenges that hinder the meaningful integration of IK into life sciences teaching.

It should also be noted that the lack of IK integration in life sciences teaching hinders learners from enjoying a lot of benefits that can be afforded by IK. Including improved comprehension of abstract concepts (Seehawer, 2018). Moreover, it fosters cultural inclusivity for all learners, especially those who belong to cultural groups that were previously marginalized during the apartheid era (de Beer, 2009; Ngcobo, 2020). Therefore, the absence of IK perpetuates cognitive injustice and disengagement among learners (Leibowitz, 2017). This means that learners from non-European groups do not get to learn life sciences through forms of knowledge originating from their respective cultural groups. This makes it difficult for learners to comprehend most concepts in life sciences. Therefore, integrating IK may help overcome this challenge by making concepts more understandable for learners and enhancing their academic performance (Selepe et al., 2022). Failure to integrate IK not only impacts learners' academic performance but also threatens South Africa's development prospects in STEM (science, technology, engineering, and mathematics) fields (de Beer, 2009). Integrating IK will play a huge role in demystifying life sciences concepts and make learners more interested in taking up the subject, and subsequently, pursue STEM-related careers.

Consequently, the main question guiding this study is what are the factors affecting life sciences teachers' integration of IK in their classrooms? and the study also explores the following sub-research questions:

1. What are life sciences teachers' perceptions regarding factors affecting the integration of IK in life sciences classrooms?
2. How do life sciences teachers integrate IK in life sciences classrooms?

Significance of the Study

This study contributes to the literature by addressing the gap in understanding the practical challenges and barriers life sciences teachers face when integrating IK into the curriculum as mandated by the CAPS in South Africa. Additionally, the study also significantly contributes to the integration of IK into life sciences classrooms, addressing obstacles hindering teachers from aligning with CAPS guidelines. It sheds light on the gap between curriculum plans and implementation, urging clearer guidance and practical strategies for IK integration. It emphasizes the need for curriculum developers to specify relevant IK and assist teachers in effective integration, echoing concerns about the lack of guidance in the current CAPS document (Mavuru & Makhunga, 2020; Mothwa, 2011; Ngcobo, 2020; Sitsha, 2022).

For pre-service teachers, it underscores the importance of incorporating IK-related skills in teacher training programs and addressing potential barriers to integration. In-service teachers will benefit from insights into the challenges they face, prompting the DBE to develop workshops and training opportunities to enhance their integration skills, particularly relevant for teachers trained during apartheid. The research encourages teachers to expand their knowledge of IK and utilize appropriate teaching methods, aligning with indigenous practices. Additionally, it informs learning material developers to integrate practical examples and strategies for effective IK integration into life sciences textbooks.

LITERATURE REVIEW

Policy Stipulation on the Integration of Indigenous Knowledge in South African Life Sciences Teaching

CAPS for life sciences grades 10-12 explicitly encourages life sciences teachers to appreciate and incorporate IK into their classrooms when teaching various topics within the subject (DBE, 2011). The CAPS document emphasizes the importance of recognizing and valuing IK systems, acknowledging their significant role in nurturing the values embedded in the constitution (DBE, 2011). This endeavor aligns with the principles of ubuntu and inclusivity, striving to make the curriculum culturally responsive to all learners and preventing cognitive injustice, where knowledge from their communities and culture is excluded (Leibowitz, 2017).

Affordances of Integrating Indigenous Knowledge in Life Sciences Teaching

The integration of IK into life sciences education offers significant affordances for both teachers and learners. Currently, however, this integration falls short of what is needed. Historically, the life sciences curriculum during South Africa's apartheid era was exclusively European, neglecting African learners' IK and leaving them without a foundation to grasp new scientific concepts (Mothwa, 2011; Ngcobo, 2020; Seehawer, 2018). This exclusion perpetuated what Ndlovu (2014) terms "epistemic apartheid," which hinders the integration of different forms of knowledge into teaching, especially the indigenous forms of knowledge (Hoppers, 2015). According to de Beer (2009), this act hinders inclusive education as most learners are not cognitively accommodated through the knowledge originating from their cultural groups. Additionally, Msila (2009) contended that inclusive education should be understood beyond the accommodation of physical disabilities, but also be extended to forms of knowledge. Arguably, this can be understood as meaning that there is also a need to ensure cognitive and epistemic inclusion in classrooms through integrating IK.

Moreover, Selepe et al. (2022) postulated that the exclusion of IK in teaching exacerbates cognitive overload, which makes grasping content difficult for learners. Moreover, IK helps learners connect subject matter to their daily lives and local contexts (Kalolo, 2015), fostering a deeper understanding of scientific concepts. Additionally, integrating IK simplifies complex scientific concepts, enhancing academic performance by making content more relatable and accessible to learners (de Beer, 2009; Cronje et al., 2015, Ngcobo, 2020; Sitsha, 2022). This fosters greater interest and motivation among learners to take up life sciences, and this is crucial for producing more scientists in future who will be capable of addressing contemporary challenges (Ngcobo, 2020).

Integrating IK into education aligns with sustainable development goal 4, which calls for the promotion of sustainability education (Magni, 2017). It encourages learners to address community issues using sustainable practices, contributing to solutions for challenges such as food insecurity and climate change (Kothari, 2002). Ndlovu (2014) argues for a shift towards sustainable knowledge production, emphasizing IK's potential to address pressing issues effectively. Integrating traditional ecological knowledge or IK within life sciences teaching equips learners with sustainable insights to tackle sustainability issues such as biodiversity loss, food insecurity, and climate change (Kothari, 2002).

IK also facilitates learning by connecting new knowledge with learners' existing understanding, bridging scientific concepts with cultural backgrounds (Gravett, 2022). As schools serve as conduits for transmitting cultural heritage (Pretorius, 2000), integrating IK aids learners in comprehending new content and interpreting the natural world. Challenges such as the COVID-19 pandemic and the shift to online learning formats posed obstacles to effective teaching and learning (Gravett, 2022). Therefore, integrating IK, which is less cognitively demanding, can mitigate these challenges, especially amid mental health concerns triggered by lockdowns (de Beer, 2009; Selepe et al., 2022). In addition, it can be argued that the integration of IK, lessens the cognitive overload among the learners.

Pedagogical Methods and Approaches for Integrating Indigenous Knowledge in Life Sciences Classrooms

Even though various pedagogical strategies may be employed when teaching life sciences. It should be noted that not all of them are suitable for integrating IK meaningfully. Therefore, there is a need for teachers to carefully select methods that promote active learner engagement (Seehawer, 2018). Kaya and Seleti (2013) suggest involving IK holders through verbal communication or modelling, aligning with Vygotsky's (1978) social constructivism theory. In addition, this leads to an authentic integration of IK as owners and more knowledgeable people are involved in the process. Dialogic and argumentative teaching strategies are also recommended to avoid traditional banking education methods as coined by Freire (1970). Banking education would hinder learners' engagement and make the integration of IK to be less interesting to learners.

Maluleka and Khazamula (2019) advocate for aligning teaching strategies with the African indigenous philosophy of ubuntu which promotes dialogue, care, active learner involvement, and fostering a classroom with no walls. This approach to teaching is referred to as Ubuntugogy (Omodan, 2022). Ubuntugogy

encompasses project-based, problem-based, and inquiry-based approaches, aligning with emancipatory pedagogy (Freire, 1970). This approach stresses the importance of a classroom with no walls, where learners are encouraged to look for answers using knowledge that is beyond the walls of the classroom. Integrating IK using indigenous communication methods such as songs, games, poems, and folktales has been endorsed by (Seehawer, 2018). This is because these methods enhance learning engagement and demystify life sciences content. Infusing fun and playful pedagogy is crucial for emotional well-being and content comprehension (Gravett, 2022). An inference from the literature can be made that teachers should expand their pedagogical content knowledge (PCK) to develop suitable teaching approaches for integrating IK effectively (Nkopodi & Mosimege, 2009).

Potential Factors Influencing Life Sciences Teachers' Integration of Indigenous Knowledge in Classrooms

The literature highlights various factors that impact the integration of IK into the teaching of life sciences. Mavuru and Makhunga (2020) asserted that a significant obstacle is teachers' lack of understanding of what IK entails or the nature of IK. This deficiency in understanding hampers the effective integration of IK since teachers who are unfamiliar with IK concepts remain unaware of its relevance to various life sciences topics. Additionally, de Beer (2009), Mavuru and Makhunga (2020), Mothwa (2011), Ngcobo (2020), Seehawer (2018), and Shihza (2007) noted that the absence of explicit guidance within the CAPS document concerning the integration of IK poses a challenge. Furthermore, the CAPS document and prescribed life sciences textbooks in South African schools currently offer limited IK content, primarily consisting of only illustrative examples (Cronje et al., 2015; Mothwa, 2011). Seehawer (2018) corroborates these findings by emphasizing that teachers encounter difficulties due to inadequate resources and materials to support IK integration. Presently, life sciences textbooks for different Grades do not provide detailed examples and instructions on how teachers can practically integrate IK into each topic.

As early as 2007, Shizha (2007) identified a reluctance among many science teachers to integrate IK, primarily due to a lack of support from school management teams. This reluctance is attributed to the pressure exerted by school management to adhere to a teach-to-test approach, focusing on achieving high pass rates in standardized assessments. Consequently, teachers are discouraged from integrating IK, as it is perceived as time-consuming and not assessed in summative assessments, such as final examinations (Selepe, 2021). Integrating IK demands considerable time and effort, involving the exploration of additional IK and the development of teaching strategies that facilitate its effective integration. Teachers who adhere to the Christian faith may feel that IK conflicts with their religious values, particularly in areas such as ancestral beliefs and the use of traditional medicine, associated with indigenous healers (Cronje et al., 2015; Shihza, 2007). Consequently, these teachers may allow personal biases to influence the knowledge they impart in their classrooms, effectively acting as gatekeepers by obstructing the integration of IK due to their religious convictions and beliefs.

Jumba and Mwita (2022) raise a point that multicultural classrooms suffer the most regarding the integration of IK as teachers would be faced with the dilemma of which culture's IK to use and which may discriminate against other cultures. Mothwa (2011) states that in some instances the teacher will only be aware of the IK from one culture and not the other cultures represented in the classroom which may render the teacher biased in favor of one culture. de Beer (2009) and Mothwa (2011) asserted that most life sciences teachers, especially those who were trained during the period of apartheid lack professional development and knowledge that would enable them to integrate IK effectively and meaningfully in their classrooms. Loughran (2010) adds that most learners and teachers come to class with IK that is in their home language, and it is difficult to translate it into the English language.

Theoretical Framework

This study is underpinned by social constructivism as a theoretical framework, as conceptualized by Vygotsky (1978). This study is strongly against the use of traditional methods when integrating IK in life sciences teaching. It is rather advocating for the use of methods and approaches aligned to the theory of social constructivism. Vygotsky (1978) argued that learners do not come into the classroom as *tabula rasa* or empty vessels who need the teacher to fill them with knowledge passively. Freire (1970) terms this kind of teaching as a banking education, whereby a teacher deposits content knowledge to learners only to withdraw that knowledge later in the form of assessments. This kind of teaching should be strongly discouraged as it excludes learners in the process of the construction of knowledge and hampers the development of important skills such as 6Cs. According to Fullan et al. (2017), these skills include citizenship, character, communication, collaboration, critical thinking, and creativity. In addition, such learners will not be able to apply content knowledge in a real-world context (Ngcobo, 2020).

Ngcobo (2020) concurred with Vygotsky (1978) in that learning starts or flows from a social environment to an individual learner through a social interaction between him/her with the teacher and peers. This underscores the nature of collaborative learning, where learners' social environment serves as a foundation

through which they use to make sense of new knowledge. According to Gravett (2022) for effective learning to take place, teachers must acknowledge the principle derived from the science of learning which posits that learners learn new ideas by relating them to what they already know. This will help learners to have an opportunity to connect what is learnt in the classroom to their social and cultural environment. This will also ensure that learners take part in the construction of knowledge by using IK from their culture as a foundation to build their understanding of scientific concepts in life sciences.

An effective strategy to facilitate this integration is the concept of scaffolding, as originally proposed by Vygotsky (1978). Scaffolding involves a teacher, often referred to as a more knowledgeable other (MKO), guiding and assisting learners in connecting their existing knowledge with new information (Ngcobo, 2020). Scaffolding is most effective when teachers employ learner-centered and facilitative teaching methods that actively engage students in the learning process. Vygotsky (1978) highlighted that scaffolding serves to transition learners from the zone of potential development, where they require guidance from the MKO to comprehend concepts and complete tasks, to the zone of actual development, where learners can independently complete tasks. In essence, scaffolding facilitates learners' progression through the zone of proximal development (Gravett et al., 2015). The researcher believes that IK holds the potential to facilitate this transition, helping learners move from potential development zones to actual development zones. This theoretical framework underpins the research study by advocating for the integration of local traditional, cultural, and IK from the learners' communities.

METHODOLOGY

Research Approach

This study employed a qualitative research approach to delve into life sciences teachers' experiences and perceptions regarding integrating IK into their teaching practices. Creswell and Creswell (2018) asserted that qualitative research prioritizes the depth and quality of experiences over quantitative measures. Furthermore, this approach allows participants to articulate their views using language, thus capturing the nuances of their experiences (Creswell & Poth, 2016). As early as 2002, Merriam (2002) argued that qualitative studies aim to understand individuals' interpretations and constructions of their experiences. Through in-depth interviews and lesson observations, the researcher explored factors influencing the integration of IK in classroom instruction, providing meaningful insights into the experiences of life sciences teachers.

Selection of Participants

Purposive sampling was employed to select five life sciences teachers from four schools in the Gauteng Province. This technique, chosen for its ability to provide detailed insights into the research topic, allows deliberate selection based on participants' qualities. For instance, teachers participating in the study should have a minimum of two years of teaching experience. This requirement ensures they are familiar with CAPS implementations and recent curriculum changes in South Africa. Additionally, the teachers demonstrated their willingness to participate by signing consent forms after the researcher thoroughly explained the study's purpose and the implications of their participation

The selected teachers represented diverse cultural and racial backgrounds, with varied levels of teaching experience. School names were withheld to adhere to confidentiality guidelines outlined in the protection of personal information act no. 4 of 2013 (Adams et al., 2021; Cohen et al., 2021). The selection of schools was both purposive and convenient, facilitating data collection and ensuring researcher convenience. Additionally, the sample size is relatively small, owing to scope and time constraints. The findings of this study provide valuable insights regarding the factors influencing life sciences integration of IK in their classrooms. Therefore, further research with a larger sample size is recommended to expand upon the findings of this study.

To ensure ethical standards were upheld throughout this study, ethical clearance (certificate no: SEM-2023-007) was obtained from the University of Johannesburg Faculty of Education Research Ethics Committee before data collection commenced. Permission was also obtained from the Gauteng department of education and participating schools. Before obtaining consent, participants received written information about the study to ensure voluntary participation without coercion. To protect confidentiality, pseudonyms were used for all participating teachers. Teachers consented to video recordings during teaching sessions, and these recordings have been securely stored to maintain privacy and prevent public access.

Data Collection

Five life sciences teachers were each interviewed individually using an in-depth interview schedule. Each interview lasted for about 35 to 45 minutes. They aimed to explore life sciences teachers' views on factors impacting the integration of IK in their classrooms. Additionally, they were conducted in private offices to minimize distractions, interviews provided insights into teachers' perceptions and interpretations. After the interviews, each of the five life sciences teachers was observed twice teaching. A total of 10 lesson observations were made. Additionally, lesson

Table 1. Life sciences teachers' profiles

Participants' pseudonyms	Nozipho	Nasreen	Thabiso	Zenathi	Lorraine
Experience in teaching life sciences	23 years	7 years	5 years	2 years	12 years
Highest qualification	B. Ed honors	B. Ed	B. Ed	B. Ed	M. Ed
Race/ethnicity	African (Zulu)	Indian	African (Venda)	African (Xhosa)	White
Age	47	36	29	25	37
Gender	Female	Female	Male	Male	Female
School location and quantile	Edenvale (Q2)	Edenvale (Q5)	Soweto (Q3)	Auckland Park(Q4)	Germiston (Q4)

observations were conducted during regular school hours with permission, aimed at understanding how teachers integrate IK. The researcher used the reformed teaching observation protocol (RTOP) instrument, adapted from Sawada et al. (2002), to assess integration and challenges. Observations were categorized according to research objectives, ensuring alignment with the study's focus on life sciences teachers' integration of IK.

Data Analysis

Data analysis began with transcribing semi-structured interview recordings using MS Word, ensuring accuracy and authenticity. Cross-referencing with original recordings validated transcriptions. The analysis employed a dual approach: deductive analysis using established codes from lesson observations and inductive analysis to identify new codes. Video recordings of lessons were deductively coded using RTOP instrument codes aligned with research aims and objectives. RTOP categories included lesson design, content knowledge, classroom culture, and engagement. This approach, recommended by Soiferman (2010) and Stemler (2000), ensured a comprehensive analysis of interview and observation data.

To validate the interviews, the researcher shared the interview findings with participants to verify accuracy. Additionally, the coding of the data was repeated at different stages to ensure consistency in the collected data. Moreover, triangulation and cross-checking of findings were ensured by comparing data collected from both interviews and lesson observations. In this study, life sciences teachers' interview responses were compared with how they integrated IK in the lessons.

FINDINGS

This section reports on the research results, to answer the question: what are the factors affecting life sciences teachers' integration of IK in life sciences teaching? presented in three sections, the teachers' biographical information; teachers' perceptions about factors affecting IK integration and how teachers integrated IK in life sciences classrooms.

Teachers' Profiles

To contextualize the results of the study, life sciences teachers' profiles, are presented in **Table 1**.

Table 1 shows that teachers who were participants in the study are diverse in terms of culture and race. In addition, the teachers also varied in terms of years of teaching. This means that findings are drawn or informed by multiple perspectives.

Teachers' Perceptions Regarding Factors Affecting Indigenous Knowledge Integration in Life Sciences Classrooms

This section is further divided into five sub-sections, which reveal the perceptions of teachers about factors affecting IK integration in their classrooms. The sub-sections are teachers' understanding of IK, teachers' awareness of IK available for integration in life sciences, teachers' views on challenges hampering meaningful IK integration, teachers' views on affordances of integrating IK, and the impact of religion on IK integration.

Teachers' understandings of the meaning of indigenous knowledge

The analysis of interview data revealed that all the teachers understood what IK is and what it entails. This is shown in the excerpt that follows.

> Nosipho: I would say it is the traditional knowledge that is used by the people who live in that country or by the local communities in the place/area.

Teachers emphasized that IK is traditionally transmitted orally and practically from elders to the young ones. Thabiso highlighted that IK includes knowledge, practices, values, customs, and diverse systems. Thabiso's assertion reflects teachers' acknowledgement of the value of combining indigenous and Western knowledge to enrich students' understanding of life sciences content. Teachers grasp the significance of IK and the nature of indigenous knowledge, signals a positive inclination towards integrating it into their teaching practices.

Teachers' awareness of indigenous knowledge available for integration in life sciences

Teachers demonstrated a limited awareness of IK available for integration into various topics in life sciences, focusing mainly on two specific areas. This suggests a lack of awareness regarding IK applicable to most topics across grades 10-12 in the life sciences

curriculum. The topics mentioned, include cellular respiration, animal tissues, dicotyledonous plant anatomy, the biosphere, biodiversity, and human nutrition. In addition, these topics represent only a fraction of the curriculum. Below are some of the teachers' responses when asked about IK applicable to life sciences.

> Nasreen: The use of medicinal plants. So, we have the African potato. So, originally was used from. people from KZN to treat fever and pain. And then we have the Devil's claw was used by indigenous people to treat fever and pain. As well. We have many more others that are used to treat arthritis and asthma. So, the use of medicinal plants is one example which is biodiversity.
>
> Thabiso: I know of the making of traditional beer using dried maize and sorghum to make a traditional beer under fermentation. I also know of medicinal plants such as African potatoes used to treat certain diseases. That's all I can think of.
>
> Lorraine: As I have mentioned earlier, I have limited knowledge or awareness of IK. I only know about medicinal plants such as African potato and how we can teach fermentation using an example of traditional beer.

Teachers' views on challenges that may hamper meaningfully integration of indigenous knowledge

Despite recognizing the importance of integrating IK into life sciences teaching, teachers opined that they face numerous demotivating challenges hindering their efforts. A significant issue highlighted is the lack of essential resources such as textbooks and materials guiding the incorporation of IK into various topics. This shortage extends to the absence of artefacts aiding effective integration, even in resource-rich schools. Additionally, existing textbooks often offer limited coverage of IK, focusing on a narrow range of topics. When asked about the availability of resources for IK integration, teachers provided the following responses.

> Nasreen: I can say lack of resources and artefacts to demonstrate IKS since it is transmitted orally.
>
> Thabiso: Not a lot of material and resources are available. Even the school that we are at is not well-resourced.
>
> Nosipho: There is little information in the textbook. The textbooks currently lack information on IK.
>
> Lorraine: No not at all, there is no IK in the textbooks that I am using.

When asked if the SMT and DBE provide support for the integration of IK, Thabiso stated that there are no dedicated mechanisms in place. Both entities prioritize adherence to the annual teaching plan and emphasize exam success, leaving teachers feeling discouraged from integrating IK due to perceived time constraints and demanding planning requirements. Lorraine also voiced out this concern by saying the following:

> "No, Sir, no, not much support structure. From the department, we were just told that you should include IKS".

The situation highlights that the department's commitment to integrating IK remains largely theoretical, lacking substantial practical implementation. Teacher Zenathi emphasized that, in her twelve years of teaching, IK has never been mentioned in any school meetings with the SMT. Another obstacle faced by teachers in integrating IK into life sciences is learners' negative attitude towards it. Teachers have observed that learners often do not take IK seriously, failing to recognize it as a legitimate form of science. When teachers attempt to integrate IK into their lessons, learners express confusion, boredom, and a perception of irrelevance. These sentiments were echoed by teachers in their responses:

> Nosipho: The challenge is that sometimes it's not that easy to make the learners take this information seriously and be interested in it because some learners are not exposed to it as mostly all of us in the township are now living the European way and they've never heard anything.
>
> Lorraine: My learners most of them get confused why are we learning about this most of them are not Africans, and this does not sound like a real science, and they do not see the relevance of such knowledge in science.

Teachers like Lorraine are discouraged from integrating IK into their life sciences instruction due to perceived confusion and potential misinformation for learners. Additionally, they may feel that integrating IK is not worthwhile since it is not typically assessed in formal evaluations, making it seem less valuable in terms of instructional time. Thabiso echoed this concern.

> "But the problem is that I have never seen IK being assessed formally. No question paper from grade 10-12 assesses IKS".

Unfortunately, teachers have highlighted a lack of adequate training on effectively integrating IK into their classrooms. DBE has not provided any professional development opportunities on this topic, indicating a lack of ongoing support for teacher development in IK integration. Additionally, institutions of higher

education responsible for training teachers have failed to adequately prepare life sciences teachers for integrating IK into their teaching practices. Nozipho expressed her dissatisfaction with the training received in college, highlighting this issue.

> "I was not prepared at the college. I was prepared by chance because I was involved in a project, a Landcare project by wildlife in KZN".

Nozipho, with a 23-year teaching career, has never attended any workshop focused on integrating IK into her life sciences classrooms. Teachers who received IK training during university studies expressed dissatisfaction. Thabiso had fewer than three lectures on IK integration in his four-year B.Ed degree. Nasreen never encountered IK integration in her training. This collective lack of training suggests teachers are not adequately equipped to meet CAPS requirements for IK integration. Teachers express frustration with CAPS' lack of comprehensive guidance on IK integration, despite brief mentions of specific aims. Some teachers overlook IK mentions in the content section, highlighting a need for better understanding and guidance in CAPS. Overall, teachers agree CAPS falls short in effectively integrating IK into teaching.

> Nosipho**:** Not explicit. It doesn't have very much information provided there, it's just. Just tell you that you should incorporate.
>
> Nasreen: I cannot say it does provide a detailed guideline. It just highlights that there must be Teachers, especially in multi-racial schools, face a dilemma regarding the integration of IK. There's a misconception that IK is primarily associated with African cultures, leading to hesitation in integrating it into teaching for non-African students. However, all cultural groups, including those outside Africa, possess their forms of IK that can be integrated for inclusivity. Lorraine expressed this misconception.

Teachers also worry about the cultural inclusivity of integrating IK in multi-racial classes. They fear non-African learners may struggle to comprehend IK conveyed through songs and poems in indigenous languages. This dilemma extends to African racial groups, where cultural diversity prevails, raising questions about including IK from some cultures while potentially excluding others. Zenathi articulated this complex dilemma:"Language barrier was the factor as I have learners from other countries who don't understand indigenous languages of South Africa but as much as it was nice to integrate it and learners were relating to it and they were more engaged to it, I found that I was having a class that was very racially diversity. Some learners were colored, some were white, and others were from Asian countries, and it was difficult for them to understand and take part and this was because of language issues. I think all learners should be exposed to one another languages. This creates a dilemma also on which culture to include and which one to leave out and remembering inclusivity in the culturally diverse South Africa."

Teachers' views on the affordances of integrating indigenous knowledge in life sciences

Teachers argue that IK integration helps decolonize the curriculum, making it more relevant and representative of South Africa's diverse cultures and perspectives. This inclusion fosters a sense of national unity and showcases the country's cultural richness. Additionally, integrating IK makes the subject more engaging and enjoyable for learners, sparking increased interest and comprehension. Moreover, IK enables learners to relate the content to their everyday lives and local contexts, enhancing its practical application and significance. This approach, often conveyed through songs and poems, not only makes learning enjoyable but also aids in demystifying complex science concepts. Thabiso emphasized the value of IK in life sciences when he said the following:

> "Most learners find it interesting and helpful as they develop a better understanding compared to when they came into us with their general knowledge, that they can relate with. Unfortunately, this knowledge is not assessed hence we don't integrate it sometime."

Impact of religion on teachers' integration of indigenous knowledge

Teachers in the study affirmed that religion does not impede the integration of IK in their classrooms. Even those of Christian and Muslim faiths expressed the belief that nature was created by God for their benefit, aligning with the incorporation of IK. Nozipho, a traditional healer embracing African spirituality, found IK integration consistent with her beliefs. Thus, there was a harmonious coexistence between teachers' religious beliefs and IK integration in teaching practices.

> Nosipho: It does not because I believe in African Spirituality and I'm a naturalist. I believe that we should not interfere with nature. We should lose things as they are from the nature provided by what? Because God created everything that we have so that we can. You can benefit from it.
>
> Nasreen: I am Muslim, and my religion is not against the use of nature to our benefit at all.
>
> Lorraine: No, the views I have about IKS integration are not based on my religion but on logic and rationale.

How Teachers Integrated Indigenous Knowledge in Life Sciences Classrooms

The lesson observations aimed to investigate how life sciences teachers integrate IK in their classrooms. The findings indicate that teachers faced challenges in meaningfully integrating IK into their lessons. For example, Teacher Nozipho mentioned African medicinal plants like the African potato and Devil's claw while teaching the sub-topic of animal tissues. This is how the teacher mentioned the two medicinal plants in her lessons:

> "Khoisan people used Devil's claw medicinal plants to treat back pain and headache. They also used African potato to strengthen their immune systems, especially the elders."

Similarly, teacher Nasreen discussed the role of indigenous communities in vaccine development using a traditional chalk-and-talk strategy. In this regard, the teacher read from the notes on the chalkboard. The notes highlighted the role of indigenous communities, as follows:

> "African traditional healers through the use of different medicinal plants have played a key role in the prevention of infections such as pneumonia."

This showed that IK is treated as an add-on rather than integrated deeply into teaching. In addition, although classrooms were inclusive and students showed respect, teachers often did not actively engage learners in the teaching and learning process. In addition, most teachers encountered greater difficulties in integrating IK, often resorting to traditional lecture-style teaching that minimized student involvement. This passive approach limited opportunities for students to contribute their own IK from diverse cultural backgrounds. Additionally, the observations revealed a lack of resources such as artifacts to demonstrate and explain different aspects of IK. These challenges can be attributed to factors such as learner resistance to unfamiliar topics like IK integration and limited availability of teaching resources, including textbooks.

DISCUSSION

This study has found that life sciences teachers encounter significant challenges when integrating IK as mandated by the CAPS document. These challenges hinder the meaningful and effective integration of IK. Similarly to Mavuru and Makhunga (2020), Mothwa (2011), and Ngcobo (2020), this study has found that there is an absence of clear guidelines from CAPS on how teachers can integrate IK in different topics. The findings also highlight the scarcity of resources such as artefacts, literature and textbooks hindering South African teachers' IK integration efforts, which concurs with Mothwa (2011) and Seehawer (2018). In concurrence with Mothwa (2011), the current textbooks prescribed for teaching life sciences inadequately support IK integration, which limits teachers' IK knowledge breadth.

Teachers also face discouragement due to insufficient support from the SMT and DBE, as they are compelled to prioritize teaching to test. This affects IK integration as teachers are now forced to only focus on what is tested, and at the current moment, IK is hardly formally assessed in South African life sciences examinations as also noted by Ngcobo (2020). This can be referred to as a top-down approach to management, as observed by Selepe (2021) and Shihza (2007). DBE's failure to provide IK integration workshops reflects inadequate teacher support, aligning with Mavuru and Makhunga (2020). This neglect exacerbates the gap in teacher preparedness, as highlighted by de Beer and Mothwa (2022) and Mothwa (2011). Another challenge faced by the teachers as noted by Mothwa (2011) is older teachers being the most unprepared to integrate IK, especially those who received training before the fall of apartheid in South Africa. In this study, Nozipho (47), Nasreen (36), and Lorraine (37) faced the unique challenge of using teacher-centered approaches to integrate IK.

Contrary to Shihza (2007), this study has found that teachers' religious beliefs don't impede IK integration, as indicated by participants. This is because teachers were observed teaching life sciences subjects such as cellular respiration, photosynthesis, and plant and animal tissues, which typically do not conflict with any beliefs. Unlike the topic of human evolution, which is often reported to contradict Christianity, as noted by de Beer and Hennings (2013). However, teachers in multicultural classrooms, as noted by Jumba and Mwita (2022), face dilemmas regarding which cultural IK to include potentially excluding others. In addition, some teachers perceive IK as inferior to science knowledge, echoing the finding by Keane and Moyo (2010). It is noteworthy that teachers do believe that IK integration in life sciences teaching has a lot of affordances as echoed by De Beer (2019); and Ngcobo (2020). They see it as decolonizing education and enhancing learners' understanding, among others. This view aligns with de Beer's (2009), Hayes (2010), and Mawere (2015).

CONCLUSION

This qualitative study has shed light on the significant challenges life sciences teachers face in integrating IK within their classrooms when teaching different topics as mandated by the CAPS curriculum in South Africa. Despite the policy's aim to make education more inclusive and relatable, the current study's findings indicate that inadequate training, limited support structures, and negative attitudes towards IK impede meaningful integration. Moreover, the insights

gathered from the in-depth interviews and detailed lesson observations have revealed a significant gap in PCK among teachers. This lack of PCK not only obstructs the smooth integration of IK but also prevents teachers from enriching their teaching with the depth and relevance that IK can offer. Therefore, addressing these challenges and enhancing teachers' ability to integrate IK meaningfully and effectively is crucial for advancing culturally responsive pedagogy and fostering a more inclusive educational environment.

Implications of the Study

Based on the findings of this study, there is an urgent need for comprehensive teacher training and professional development to enable meaningful integration of IK in life sciences classrooms. Collaboration between higher education institutions and the department of education is essential to develop training models and workshops addressing IK integration. Additionally, revisions to the life sciences CAPS document are necessary to include detailed guidance on IK integration, such as appropriate teaching methods and IK for each topic. Higher education institutions should enhance training modules to extensively cover IK integration, including available resources and PCK.

Furthermore, the department of education should review and enhance prescribed textbooks to support IK integration better. SMTs require training to provide effective leadership and support structures for teachers integrating IK. Teachers should collaborate within their communities and with elder IK holders and traditional healers to share knowledge and mitigate integration challenges. Future studies should explore learners' experiences with IK integration and analyze IK integration in current textbooks. Additionally, research on digitalizing IK through information and communication technology and 4IR technologies can enhance IK integration and preservation.

Lastly, life sciences teachers are encouraged to utilize active learning pedagogies such as problem-based learning, project-based learning, and inquiry-based learning to meaningfully integrate IK into their lessons. For instance, when teaching the topic of human impact on the environment, which encompasses sustainability issues such as biodiversity loss, food insecurity, climate change, and solid waste disposal. Learners could be organized into groups to tackle one sustainability issue. In addressing these challenges, learners can be instructed to consult IK-Holders within their local communities on relevant IK that can be used to solve these issues. Collaborating with IK-Holders, learners can identify and incorporate relevant IK practices and perspectives that contribute to sustainable environmental management and conservation efforts.

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REFERENCES

Adams, R., Veldsman, S., Ramsay, M., & Soodyall, H. (2021). Drafting a code of conduct for research under the protection of personal information act No. 4 of 2013. *South African Journal of Science, 117*(5/6), 1-3. https://sajs.co.za/article/view/10935

Creswell, J. W., & Creswell. J. D. (2018). *Research design: Qualitative, quantitative and mixed methods approaches*. SAGE.

Creswell, J. W., & Poth, C. N. (2016). *Qualitative enquiry and research design: Choosing among five approaches*. SAGE.

Cronje, A., de Beer, J., & Ankiewicz, P. (2014). The effect of an intervention programme on how science teachers view the nature of indigenous knowledge. In *Proceedings of the ISTE International Conference on Mathematics, Science, and Technology Education* (pp. 588-596). UNISA.

DBE. (2011). *Curriculum and assessment policy statement: FET phase, life sciences*. Government Gazette.

de Beer, J. (2009). Indigenous knowledge in the life sciences classroom: Put on your de bono hats! *The American Biology Teachers, 71*(4), 209-216. https://doi.org/10.2307/27669414

de Beer, J., & Henning, E. (2013). Challenges in the teaching of evolution in the life sciences classrooms. *South African Journal of Science & Technology, 32*(1), 69-83. https://doi.org/10.4102/satnt.v32i1.261

de Beer, J., & Mothwa, M. (2013). Indigenous knowledge in the science classroom: Science, pseudo-science, or a missing link? In *Proceedings of the ISTE International Conference on Mathematics, Science, and Technology Education* (pp. 452-467). UNISA.

Freire, P. (1970). *Pedagogy of the oppressed*. Continuum.

Fullan, M., Quinn, J., & McEachen, J. (2017). *Deep learning: Engage the world, change the world*. SAGE.

Gravett, S. (2022). *Teaching for learning in a fast-changing world*. Creative Commons.

Gravett, S., de Beer, J., & Du Plesis, E. (2015). *Becoming a teacher*. Pearson.

Hayes, A. E. (2010). *A rationale for comprehensive family literacy services: Theoretical and philosophical*

foundations and a summary of findings from follow-up studies. University of North Carolina.

Hoppers, C. O. (2015). THINK PIECE: Cognitive justice and integration without duress. *International Journal of Development Education and Global Learning, 7*(2), 88-101. https://doi.org/10.18546/IJDEGL.07.2.08

Jumba, H. A., & Mwiti, F. M. (2022). Teacher's perceptions on the integration of indigenous knowledge in competence-based curriculum: A selected primary schools in Buuri East sub-Country. *International Journal of Professional Practise, 10*(10), 1-15. https://doi.org/10.31686/ijier.vol10.iss10.3558

Kalolo, J. F. (2015). Towards contextual and cultural relevant science education in North-Western countries: The African experience. *Journal of Studies in Education, 5*(3), 596-615. https://doi.org/10.5296/jse.v5i3.7147

Kaya, H. O., & Seleti, Y. N. (2013). African indigenous knowledge systems and relevance in higher education of South Africa. *Intellectual Educational Journal: Co-operative Perspective, 12*(1), 30-44. https://eric.ed.gov/?id=EJ1017665

Keane, M., & Moyo., D. (2010). Science educator ideas of science in IKS and their willingness to include IKS in their school science curriculum. *Educational Research and Review, 3*(9), 92-98.

Kothari, A. (2002). Traditional knowledge and sustainable development. *International Institute for Sustainable Development, 3*(1), 75-92.

Leibowitz, B. (2017). Cognitive justice and the higher education. *Journal of Education, 68*(1), 1-17. https://doi.org/10.17159/2520-9868/i68a03

Loughran, J. (2010). Exploring pedagogical content knowledge in science teacher education. *International Journal of Science Education, 30*(10), 1301-1320. https://doi.org/10.1080/09500690802187009

Magni, G. (2017). Indigenous knowledge and its implications for sustainable development agenda. *European Journal of Education, 52*(4), 437-447. https://doi.org/10.1111/ejed.12238

Maluleka, J., & Khazamula, D. (2019). Indigenous African philosophy of Ubuntu as a foundation for a conducive environment for culturally responsive teaching and learning in South Africa. In *Proceedings of the International Conference on New Trends in Teaching and Education*. NTTE.

Mavuru, L. (2024). Teaching life sciences while integrating teachers' and learners' cultural beliefs systems. *EURASIA Journal of Mathematics, Science, and Technology Education, 20*(1), Article em2379. https://doi.org/10.29333/ejmste/13929

Mavuru, L., & Makhunga, X. K. (2020). Relevance of IK integration on life sciences teaching: What do the teachers say? In *Proceedings of the 12th Annual International Conference on Education and New Learning Technologies held hybrid*. IATED. https://doi.org/10.21125/edulearn.2020.1718

Mawere, M. (2015). Indigenous knowledge and public education in sub-Saharan Africa. *African Spectrum, 50*(2), 57-71. https://doi.org/10.1177/000203971505000203

McKnight, M. (2015). *Teachers' experiences of indigenous knowledge found in life sciences curriculum: Access study of life sciences teachers at high school in Pine Town District* [Master's dissertation, University of KwaZulu-Natal].

Merriam, S. B. (2002). *Introduction to qualitative research*. SAGE.

Mothwa, M. M. (2011). *Teachers' experiences of incorporating indigenous knowledge in life sciences classroom* [Masters dissertation, University of Johannesburg].

Msila, V. (2009). Africanisation of education and the search for relevance and context. *Educational Research and Review, 4*(6), 310-315. https://www.jstor.org/stable/j.ctv21ptz4x

Ndlovu, N. I. (2014). *Life sciences teachers' views on nature of science and nature of indigenous knowledge systems: A case study* [Master's dissertation, University of Johannesburg].

Ngcobo, L. P. (2020). *South African township teachers' views on the integration of indigenous knowledge in natural sciences teaching* [Master's dissertation, University of Johannesburg].

Nkopodi, N., & Mosemege, M. (2009). Incorporation of Indigenous games of Morabaraba in the learning of mathematics. *South African Journal of Education, 29*(1), 377-392. https://doi.org/10.15700/saje.v29n3a273

Omodan, B. I. (2022). Conceptualisation of Ubuntugogy as a decolonial pedagogy in Africa. *Journal of Culture and Values in Education, 4*(2), 95-104. https://doi.org/10.46303/jcve.2021.8

Pretorius, J. W. M. (2000). *Sociopedagogics 2000*. J. L. van Schaik Academic.

Sawada, M., Judson, K., Falcon, A., Benford, G., & Bloom, C. (2002). Measuring reform practises in science and mathematics classrooms: The reformed teaching observation protocol. *School of Science and Mathematics, 102*(6), 245-253. https://doi.org/10.1111/j.1949-8594.2002.tb17883.x

Seehawer, M. (2018). South African sciences 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

Selepe, K. F. (2021). *Teachers' perspectives of incorporation of indigenous knowledge in teaching weather and climate to grade 5 social sciences* class [Master's dissertation, University of Johannesburg]. https://doi.org/10.46622/jogea.v5i1.3953

Selepe, K., Ramsaroop, S., & Carolin, A. (2022). Incorporating indigenous knowledge in the teaching of weather and climate in primary schools in KwaZulu-Natal, South Africa. *Journal of Geography Education in Africa, 5*, 1-25. https://doi.org/10.46622/jogea.v5i1.3953

Shihza, E. (2007). Critical analysis of problems encountered in incorporating indigenous knowledge in science teaching by primary school teachers in Zimbabwe. *Youth and Children's Studies, 5*, 302-319.

Sitsha, M. (2022). *Exploring the integration of indigenous knowledge (IKS) into the teaching of life sciences through information and communication technologies* [Master's dissertation, North-West University].

Soiferman, K. L. (2010). *Compare, and contrast inductive and deductive research approaches*. SAGE.

Stemler, S. E. (2000). An overview of content analysis. *Practical Assessment, Research, and Evaluation, 7*(17). https://doi.org/10.7275/z6fm-2e34

Vygotsky, L. S. (1978). *The development of higher mental process*. Harvard University Press.