

INTEGRATION OF INDIGENOUS KNOWLEDGE IN THE TEACHING OF 'ANAEROBIC RESPIRATION' IN GRADE 11 LIFE SCIENCES

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Abstract

Indigenous Knowledge (IK), which encompasses the cultural practices, experiences, and knowledge systems of local communities, plays an important role in making science education more relevant and meaningful to learners. In the South African context, the Curriculum and Assessment Policy Statement (CAPS) advocates for the integration of Indigenous Knowledge Systems in Life Sciences teaching. However, the integration of IK into science classrooms remains limited, particularly in abstract topics such as anaerobic respiration. Anaerobic respiration is a fundamental biological process that is often perceived as difficult and abstract by learners, resulting in challenges in conceptual understanding. To address this challenge, the use of culturally familiar contexts drawn from IK has the potential to enhance meaningful learning. The study explored Life Sciences teachers' perspectives on the integration of IK in the teaching of anaerobic respiration in Grade 11. Guided by a qualitative research approach and framed within a phenomenological research design, data were collected from five Grade 11 Life Sciences teachers from different provinces in South Africa using online open-ended questionnaires. The data were analysed using thematic analysis. The findings revealed that teachers recognise the value of Indigenous Knowledge in promoting learner engagement and contextualised understanding through practices such as traditional beer brewing and food fermentation. However, the study also found that limited teacher training, insufficient resources, and a lack of clear policy guidance constrain effective classroom integration. The findings highlight the need for targeted professional development, resource provision, and stronger collaboration between schools and communities to support the meaningful integration of IK in Life Sciences teaching.

Keywords: *Anaerobic respiration, contextualised learning, indigenous knowledge, life science teaching.*

1. Introduction

Indigenous knowledge (IK) refers to the long-standing traditions, customs, and practices of indigenous communities that have been passed down orally through generations. This knowledge system is dynamic, evolving alongside the communities it originates from, and is deeply embedded in their cultural and environmental contexts (Anor, 2024). The integration of IK into Life Sciences teaching is increasingly recognized as a meaningful step toward preserving local heritage and enriching scientific understanding. As noted by Ronoh (2018), incorporating indigenous perspectives serves not only to sustain cultural traditions but also to establish a more relatable and inclusive foundation for science education.

1.1. Problem statement

In the Grade 11 Life Sciences curriculum in South Africa, Anaerobic respiration is a core concept, which is often taught using examples such as beer and wine production. While the examples used are scientifically accurate, they are, however, not culturally relatable to learners in rural or township schools across South Africa. This lack of contextualisation can make the content seem irrelevant to the learners' real-life experiences. Indigenous or traditional South African examples are excluded, which, however, does not align with the Life Sciences Curriculum and Assessment Policy Statement (CAPS), which emphasises the need to use examples of IK that reflect the diverse cultural groups within the country (Department of Basic Education, 2011). Despite this policy aim, the practical integration of IK in Life Sciences classrooms remains limited. According to Mkhwebane's (2024) study, many Life Sciences teachers struggle to integrate IK when teaching concepts such as anaerobic respiration, not because of insufficient content knowledge, but a lack of pedagogical content knowledge. The disconnect between policy stipulation and the implementation thereof restricts opportunities for inclusive, culturally responsive teaching.

Previous studies, such as Mavuru and Ramnarain (2017), found that the effective integration of IK fosters authentic learning environments that support critical thinking and learner engagement. Therefore, there is a pressing need to explore how IK can be meaningfully and effectively integrated into the teaching of anaerobic respiration to enhance curriculum relevance and deepen learner understanding.

1.2. Purpose of the study

The study aimed to determine how IK from different groups of people can be integrated in the teaching of 'anaerobic respiration' in Grade 11 Life Sciences. It sought to address two objectives: 1. To identify IK from various South African communities that is relevant to the concept of anaerobic respiration and can be meaningfully incorporated into classroom teaching; and 2. To investigate the different ways in which indigenous knowledge can be integrated by teachers when teaching anaerobic respiration in Grade 11 Life Sciences.

2. Literature review

Local and Indigenous Knowledge is a comprehensive societal system that encompasses worldviews, behaviours, experiential knowledge, and culturally embedded guidelines for interacting with the natural environment (Latip & Kadarohman, 2024). In their systematic literature review on the integration of Local and Indigenous Knowledge in science education, Latip and Kadarohman (2024) highlighted the value of incorporating indigenous knowledge into educational practices. They state that such integration not only deepens learners' understanding of their regional and cultural contexts but also promotes meaningful collaboration between indigenous perspectives and scientific knowledge.

Madlela (2023) also highlights IK as a key approach to decolonising education, positioning it as a valuable method for challenging dominant Western epistemologies within the curriculum. Building on this idea, Blackie (2024) employs critical realism to examine the relationship between Indigenous Knowledge Systems and Western science. This perspective suggests that engaging with both knowledge systems not only enriches pedagogical practices but also supports more holistic and inclusive approaches to assessment. Integrating IK into science education enhances learners' experiences by making the socio-cultural relevance of scientific concepts more visible, accessible, and meaningful, particularly for learners from diverse cultural backgrounds (Ogegbo & Ramnarain, 2025).

3. Methodology

The study followed a qualitative research approach. According to Creswell and Creswell (2018), qualitative designs are effective when the aim is to examine complex educational phenomena that cannot be adequately captured through numerical data alone. The study adopted a phenomenological research design to explore teachers' lived experiences when integrating IK in the teaching of anaerobic respiration. Phenomenology seeks to uncover and describe how participants experience and interpret a specific concept or practice (Groenewald, 2004).

3.1. Selection of participants

Using a purposeful sampling technique (Creswell & Creswell, 2018), five Grade 11 Life Sciences teachers from five provinces in South Africa were selected as participants. By involving teachers from different geographical and cultural contexts, the study sought to explore varied indigenous perspectives and practices, thereby enriching the understanding of how such knowledge can be meaningfully integrated into classroom teaching.

3.2. Data collection

To collect data, an online questionnaire was administered to the five participants to limit the movement between provinces. This instrument elicited detailed, descriptive responses from participants, allowing them to share their personal experiences, perceptions, and insights regarding the integration of IK in the teaching of anaerobic respiration. According to Kothari (2004), a questionnaire is a versatile and effective tool for data collection across various fields of study, as it can be adapted to suit both qualitative and quantitative research approaches. In this study, the questionnaire served a qualitative purpose, enabling the collection of rich, narrative data rather than numerical responses. Its open-ended format allowed participants to express their thoughts freely, providing depth and context that might not have been captured through structured or closed-ended questions.

The data was analysed using thematic analysis. Thematic analysis is useful for examining complex data sets, as it allows researchers to uncover underlying themes and narratives that emerge from participants' responses. According to Dawadi (2020), thematic analysis enables the researcher to organise and make sense of detailed qualitative data by identifying recurring themes through a process of careful reading and re-reading of transcribed material.

4. Findings

Analysis of data yielded four themes, which are: The existing indigenous practices related to anaerobic respiration; Relevance of IK to anaerobic respiration; Strategies teachers use during integration; and Challenges teachers face when integrating IK. The findings are reported under each theme.

4.1. Existing indigenous practices related to anaerobic respiration

This theme addresses the research question of whether there are any indigenous practices or knowledge related to fermentation, brewing, or food preservation that exist within the teachers' cultural or community backgrounds. The data collected from the teachers indicates that there are already well-established indigenous practices within their communities that align closely with the scientific concept of anaerobic respiration. These practices include traditional beer brewing, such as *Umqombothi*, *Buganu*, and sorghum beer. Examples of food preservation methods included salting and drying of meat, vegetables, and some edible seeds. The participants also identified fermentation in foods, such as in the preparation of *maas* (sour milk) and *dombolo* (steamed bread or dumpling). One of the participant teachers, Lihle, highlighted:

The indigenous practices that exist in my home community, which are related to fermentation are Umqombothi, a Zulu traditional beer, and Buganu, which is an indigenous beer made by marula fruits (Amaganu) from the marula tree (umganu).

This response reflects the deep cultural roots of fermentation processes across communities and demonstrates how these practices can be meaningfully integrated into Life Sciences teaching. By drawing on familiar examples such as traditional brewing and food preservation, teachers can contextualise the scientific concept of anaerobic respiration, making it more accessible, relatable, and engaging for learners.

4.2. Relevance of IK to anaerobic respiration

Teachers highlighted that indigenous knowledge practices, particularly those involving traditional beer brewing and food fermentation, are directly relevant to the scientific concept of anaerobic respiration. When asked about their scientific explanations of the indigenous practices raised in 4.1., the participant teachers' responses reflected a strong awareness of the connection. The following are some of the responses:

Thando: *Yes, because when making beer or maas, the mixture is not exposed to a lot of oxygen to increase the chances of fermentation.*

Lihle: *Yes, it is related to the scientific concept of anaerobic respiration because Umqombothi and Buganu traditional beers are made in the absence of oxygen, and the products are carbon dioxide and alcohol. That process is called fermentation, which is what anaerobic respiration is about.*

Siya: *Brewing of Umqombothi demonstrates a type of anaerobic respiration known as alcoholic fermentation. In this process, yeast ferments sugars from maize and sorghum in oxygen-limited conditions, producing energy for its survival.*

The participant teachers' ability to make this connection highlights the pedagogical value of IK. By drawing on everyday cultural practices familiar to learners, teachers can make abstract scientific concepts more tangible and relatable. This not only enriches teaching but also validates learners' cultural backgrounds, promoting inclusivity and engagement in the classrooms.

4.3. Strategies teachers use during integration

According to the CAPS document, teachers are expected to integrate indigenous knowledge in their teaching of Life Sciences. The participants confirmed that they actively integrate IK into their lessons. The participant teachers employed different strategies in their classrooms when teaching various Life Sciences concepts and anaerobic respiration in particular. Based on the analysis of data, the participants employ learner-centred strategies. These included questioning learners and giving them opportunities to share their indigenous knowledge practices. The teachers also drew on learners' lived experiences to promote active participation. By inviting learners to share and contribute their cultural practices and community-based knowledge in the class discussions, learners become co-constructors of knowledge and

do not become passive recipients of theoretical knowledge. The knowledge becomes grounded in their lived experiences, hence becomes relevant and easier to understand.

The teachers employed contextualized teaching, and the abstract scientific concepts became more comprehensible to the learners. Such strategies foster inclusivity and result in a deeper understanding of scientific concepts. The teachers' approaches illustrate how drawing examples directly from learners' societies can reinforce the relevance of science in everyday life.

4.4. Challenges teachers face when integrating IK

For teachers to successfully integrate indigenous knowledge into their Life Sciences lessons, they emphasised the need for structured support from both within and outside the education sector. Their responses highlighted that integration cannot be achieved through individual effort alone but requires a collaborative and well-resourced approach. For instance, one of the participant teachers, Thami, suggested that schools should draw on community expertise by inviting individuals who are IK holders to share their insights in classrooms. This highlights the value of community partnerships as a form of support, enabling learners to engage directly with knowledge holders and authentic cultural practices. Thando emphasised the importance of teacher training and collaboration with community members, noting also the importance of the community in organising relevant resources. This points to the need for professional development opportunities where teachers can acquire both the content knowledge and pedagogical strategies necessary to integrate indigenous practices effectively.

Similarly, Lihle highlighted the role of practical resources and demonstrations, suggesting that simple, accessible materials such as yeast, flour, and sugar could be used to illustrate fermentation processes in the classroom. Additionally, Lihle suggested that interviewing community members about IK practices related to the various Life Sciences topics will equip teachers with not only the relevant IK but also the pedagogical aspects. In this respect, teachers indicated that IK holders are not always forthcoming to share their time and knowledge. As such, without the support and resources, the integration of IK may remain superficial or inconsistent across various classroom contexts.

5. Discussions

The IK practices teachers identified provide authentic, culturally familiar contexts through which learners can relate to the scientific concept of anaerobic respiration. As supported by Ogebo and Ramnarain (2024), indigenous knowledge systems offer alternative perspectives to Western science and provide unique contexts for learning. The findings showed that IK and Western science are not opposing knowledge systems but rather complementary bodies of knowledge that can work together to enhance learner understanding of scientific concepts. As Daas (2018) argues, IK can be regarded as a preliminary form of science, as it is based on systematic observations and practices developed and circulated within specific communities or regions.

Findings suggest that teachers require support to integrate IK in their teaching; they need support from structures such as the Department of Basic Education and local communities. This same sentiment is echoed by Mkhwebane (2024), who pointed out that to facilitate the meaningful integration of IK in life sciences classrooms, extensive teacher training and professional development are crucially needed.

6. Conclusions

In conclusion, the study illustrates that integrating indigenous knowledge when teaching Life Sciences topics such as anaerobic respiration is both a practical and pedagogical imperative. It not only enhances learners' understanding of anaerobic respiration but also contributes to the broader conversation on decolonising the curriculum by situating science within learners' lived realities. However, for such integration to move beyond isolated classroom practices, systemic support in the form of resources, training, and policy guidance is required. By addressing these needs, Life Sciences education can become more inclusive, culturally responsive, and effective in equipping learners with both scientific literacy and an appreciation of their own cultural heritage.

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