

Unveiling Indigenous knowledge in South African life sciences curriculum for integration into classroom teaching

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Abstract

The South African Curriculum Assessment and Policy Statement (CAPS) emphasises the importance of Indigenous knowledge (IK) integration across all subjects; however, its implementation varies across topics. With this study we explored IK specificity, focusing on how IK is conveyed in life sciences and specifically in healthcare-related topic/content(s) for integration into classroom teaching. While the CAPS for life sciences explicitly indicates that some topics are suitable for IK integration, many lack such integration. Underpinned by an interpretivist paradigm, data collection and analysis involved a juxtaposition of document analysis and a step-by-step process of thematic analysis of the CAPS for life sciences. Data analysis involved an inductive approach to coding, category formation and theme development. The following themes reveal how IK is included, excluded or marginalised in life sciences topics and content: IK-explicit; IK-implicit; IK-ubuntu implicit; IK-healthcare implicit and IK-healthcare explicit. By articulating IK-specificity, this study offers educators a framework to seamlessly integrate IK into life sciences instruction. This fosters cultural relevance and a holistic understanding to enrich classroom learning experiences. Such relevance is particularly significant considering an increasing global dependence on traditional medicine in the form of herbal remedies and medicinal plants' central position in many communities' healthcare.

Keywords: Curriculum and Assessment Policy Statement (CAPS); Indigenous knowledge (IK); IK-explicit; IK-health explicit; IK-health implicit; IK-implicit; IK-ubuntu implicit; life sciences; traditional medicine; ubuntu

Introduction

Indigenous knowledge (IK) cuts across various endeavours of life. It can be defined as a “network of knowledge, beliefs, and traditions intended to preserve, communicate, and contextualise Indigenous relationships with culture and landscape over time” (Bruchac, 2014:3814). This characterisation aligns with the educational and cultural framework of South Africa's National Curriculum Statement Grades R¹–12 (NCS), comprising the Curriculum and Assessment Policy Statement (CAPS) that provides comprehensive guidelines for teaching and learning in South African schools. The NCS emphasises the significance of Indigenous knowledge systems (IKS) as a way of nurturing the values enshrined in the Constitution of the Republic of South Africa (RSA), 1996 (Department of Basic Education [DBE], RSA, 2011). In essence, the NCS/CAPS accentuate the importance of students comprehending IK, which is developed within IKS deeply rooted in diverse South African cultural contexts. Aim 3 of the CAPS for life sciences specifically stresses the importance of integrating IK into classroom teaching of the subject.

Furthermore, the examples of IK selected for integration into classroom teaching “should, as far as possible, reflect different South African cultural groups [and] also link directly to specific areas in the life sciences subject content” (DBE, RSA, 2011:17). However, a gap pertaining to non-integration of IK into classroom teaching has been traced to curricula documents' lack of clarity regarding topics that are IK-infused (Handayani, Wilujeng & Prasetyo, 2018; Mavuru & Makhunga, 2020; Yeseraw, Melesse & Kelkay, 2023). Mavuru and Makhunga report the curriculum's inadequacy “to articulate clearly to the teachers the different IK suitable for integration to various life sciences topics...” (2020:6557). Mkhwebane (2024) identified inconsistency in IK integration resulting from the CAPS's ambiguity on IK-infused topics, which causes teachers to not know which lesson outcomes can legitimately include IK. This signals a vital curriculum inadequacy, which is examined further in our study. Therefore, we explored IK-specificity included in the South African life sciences curriculum.

In the context of this study, IK-specificity or being IK-infused is described in reference to how IK is implicitly or explicitly conveyed in a life sciences topic or content. In other words, IK-specificity denotes the aspects or components of IK that may be integrated into life sciences classroom teaching whilst examining the articulation of the content in the topics. As a result of the issue of non-integration, Yeseraw et al. (2023) suggest a more inclusive curriculum that considers the incorporation of IK prevalent in the educational context where the curriculum is implemented. Furthermore, Seehawer (2018:91) found that “while the South African science curriculum explicitly invites knowledge integration, it hardly contains any IK.” This notion may have resulted because the IK-specificity of topics is not adequately delineated in the curriculum. Therefore, science teachers may not appreciate and understand the relevance of IK integration into classroom life sciences teaching.

Further investigation into the IK-specificity of life sciences topics is crucial, as previous studies, including those mentioned earlier, may have overlooked this perspective. Integrating IK into classroom teaching,

particularly in topics with clear IK relevance, acknowledges the rich sociocultural heritage of South Africa. This heritage, rooted in ubuntu's philosophy of interdependence and humanness, underscores the importance of recognising and valuing Indigenous perspectives (Mlondo, 2022). Given the prevalence of traditional medicine (TM) as a form of IK in South Africa (Abdullahi, 2011), ubuntu plays a crucial role in fostering moral integrity and ethical healthcare practices (Nicolaidis, 2023).

Consequently, this study is guided by the main research question: How is the IK-specificity of the different topics articulated in the life sciences CAPS? To answer the main question, the following sub-questions were addressed:

- 1) In what ways does the CAPS convey IK in life sciences topics/content?
- 2) In what ways does the CAPS convey IK in healthcare-related life sciences topics/content?

Literature Review

As documented by scholars, Africa's rich cultural heritage has long been intertwined with abundant IK across various aspects of life (Momoh, 2020). This knowledge spans fields like agriculture, natural resource management, healthcare, and technology, reflecting the diverse endeavours of African societies (DBE, RSA, 2011; Momoh, 2020). Particularly noteworthy is African traditional medicine (ATM) being increasingly integrated into South Africa's post-apartheid educational and healthcare system, with a reported 72% of Black South Africans favouring ATM over Western medicine (Mothibe & Sibanda, 2019). Globally, curricula documents include concrete statements about valuing IK (Angelo, Disbray, Singer, O'Shannessy, Simpson, Smith, Meek & Wigglesworth, 2022; Da Silva, Pereira & Amorim, 2024; DBE, RSA, 2011). Hence, in recent years and for the purpose of preserving the rich cultural heritage and diversity of Africa, attention has been drawn to the integration of IKS into classroom teaching (Photo & McKnight, 2024). Despite this, there are reports of lack of meaningful integration of IK into classroom teaching (Mavuru & Makhunga, 2020; Yeseraw et al., 2023). A key barrier to this integration results from curriculum ambiguity regarding lack of clarity on IK-infused content (Mkhwebane, 2024; Seehawer, 2018). Specific to this study is curriculum ambiguity pertaining to how life sciences topics either explicitly or implicitly espouse IK-infused content.

In view of the above, teachers may be unsure and, therefore, left to use their discretion on how IK is incorporated into the life sciences content framework (De Beer & Petersen, 2016). The confusion of teachers in this regard may be due to the misalignment between life sciences and IK because while life sciences is grounded in Western scientific epistemology, IK is more context-based

and often experiential or spiritual (Ogude, 2019). According to Ogude (2019:17), "the epistemological grounding of Indigenous knowledge does not always align with the compartmentalized nature of school science." Plausibly, ubuntu, a philosophy in the African context expresses relationality and interconnectedness among people (Chigangaidze, Matanga & Katsuro, 2022; Ewuoso & Hall, 2019). Ubuntu is encapsulated in the Nguni phrase *umuntu ngumuntu ngabantu* meaning "becoming human through others" (Mugumbate, Mupedziswa, Twikirize, Mthethwa, Desta & Oyinola, 2024:1125). This maxim enunciates interconnectedness that applies to the interrelatedness of life sciences concepts and the hierarchy of the organisation of life (Momsen, Speth, Wyse & Long, 2022).

Within the life sciences context, ubuntu underscores the interconnectedness of scientific concepts such that one topic relates to the other to make a holistic entity. Hence, the interconnectedness is emphasised by the hierarchy of organisation that exists in the build-up of an organism (cells-tissues-organs-systems-organism) showing that life sciences treat living systems as nested and interacting levels as depicted in ubuntu. Although teachers may understand the interconnectedness of life sciences concepts, they lack the knowhow of how ubuntu, as a form of IK, may be integrated when teaching related topics. Recognising the significance of IK in post-apartheid South Africa, the government enacted the Protection, Promotion, Development and Management of Indigenous Knowledge Act, 2019 (Act No. 6 of 2019) to safeguard and harness IK (RSA, 2019).

Despite ongoing efforts, TM faces persistent challenges, including commercialisation pressures and the lasting sociocultural impacts of colonialism and apartheid (Abdullahi, 2011; Marschall, 2019). Consequently, integrating IK into curricula remains a global endeavour in educational contexts, as reflected in South Africa's National Curriculum Statement/Curriculum and Assessment Policy Statement (NCS/CAPS) (DBE, RSA, 2011; Keikantsemang, 2017). However, while some life sciences topics explicitly acknowledge IK, others with implicit IK elements may go unrecognised (Handayani et al., 2018). For instance, while the NCS mentions TM in a topic like "plant and animal tissues" (DBE, RSA, 2011:28), it may have overlooked many IK-infused topics not explicitly labelled as such, potentially hindering teachers' awareness and integration efforts (Handayani et al., 2018; Yeseraw et al., 2023).

Moreover, the hierarchy or levels of organisation in life (i.e. molecules → cells → tissues → organs → organisms → populations → communities → ecosystems → biosphere) relate

with interconnectedness embedded in the IK philosophy of ubuntu. This philosophy of interconnectedness reveals itself in life sciences topics such as biodiversity, environment, and the overlap of systems in an organism. However, because ubuntu is not explicitly expressed pertaining to those topics, teachers may not see any reason why IK can be integrated in the teaching thereof.

Theoretical Framework

The study is underpinned by an adaptation of two Indigenous theoretical conceptions comprising a newly developed theoretical and methodological tool known as “indigenous institutional theory” ([IIT], Coates, Trudgett & Page, 2023:904) and “ubuntuism” (Chigangaidze et al., 2022:320). According to Coates et al. (2023), the IIT is influenced by two existing theories: indigenous standpoint theory ([IST], Nakata, 2007) and institutional theory ([IT], Coates et al., 2023). The IIT offers an indigenous perspective as a conceptual framework for exploring how indigenous inquiry and “experience within institutions can be interpreted and analysed” (Coates et al., 2023:903). Thus, the IIT is an indigenous theoretical framework that guides the proper integration of IK into institutional setups, such as educational contexts (Coates et al., 2023). Similarly, ubuntu, as discussed in the literature review, connotes an indigenous worldview that depicts interconnectedness. Therefore, adapting the IIT and ubuntuism offers a formidable theoretical framework that creates an opportunity to incorporate IK development into African ways of knowing in the post-colonial educational system.

The IST “inevitably produce[s] more in-depth, culturally inclusive knowledge informed by history, politics, policies and, more importantly, indigenous knowledges” (Coates et al., 2023:906). The theory considers a discursive method of enquiry that foregrounds how IK is constructed in cultural contexts, establishing “indigenicity of the researcher” (Coates et al., 2023:906). By this, the IST emphasises how the researcher brings awareness to areas of Indigenous significance that might not have been recognised. The theory, therefore, underscores how IK-specificity of life sciences topics, that have not been expressed explicitly or implicitly in the CAPS for life sciences, are detailed. Although the policy document acknowledges the inclusion and valuing of IK in life sciences teaching, gaps remain regarding certain topics that do not fully express IK principles. The IST, therefore, provides the conceptual grounding for exploring how IK is articulated in life sciences content areas such as biodiversity, ecosystems, and human-environment interaction.

Further, this study draws on IT as a lens for understanding how educational systems, policies, and practices influence the integration of IK into the South African life sciences curriculum. The IT relates with how this policy statement is influenced by the South African post-apartheid context in terms of valuing and integration of IK in life sciences teaching. As previously mentioned, the South African government enacted the Protection, Promotion, Development and Management of Indigenous Knowledge Act, 2019 (Act No. 6 of 2019). Therefore, IT provides insight into how higher educational institutions respond to such policy expectations, especially in training future teachers that will implement them. Moreover, IT underscores how, as the final implementers, teachers understand curricular principles on IK integration and ensure its implementation during classroom teaching of life sciences. This includes an understanding of which life sciences content, either implicitly or explicitly, is incorporated with IK. IT as a theoretical perspective underpins how people behave in organisations, usually guided by schemes, rules, and norms as inspired by the life sciences curriculum. This relates to issues that impact how teachers may positively behave towards integrating IK into classroom teaching of life sciences through understanding which topic is IK-complaint, and which is not.

Ultimately, the IIT is a theoretical framework that considers IK when investigating human actions within organisations and institutions (e.g., teacher actions within educational institutions) (Fitzsimmons & Callan, 2020). Plausibly, the IIT underscores how policy documents (e.g. curriculum) are used within such contexts. In accordance with the proponents of the IIT, the rationale behind proposing the theory was that “integrating an Indigenous perspective allows a deeper analysis of the social, political and cultural intricacies associated with colonisation, across Western institutions” (Coates et al., 2023:911). Being an Indigenous perspective, the philosophy of ubuntu links up directly with this rationale (Figure 1). This is because, as an Indigenous African philosophy, ubuntu emphasises interconnectedness, human dignity and collective identity (Mugumbate et al., 2024). By foregrounding interrelation and communal dimensions of human life, ubuntu brings to the fore how African Indigenous social systems have been dominated by Western institutional logics (Mlondo, 2022). Consistent with this, life sciences education has long been shaped and dominated by Western philosophy resulting in the exclusion of African IK (Joshi, Mansfield, Ting & Hubbard, 2024). Accordingly, African IK such as Indigenous medical systems, and community-based healing practices that integrate spirituality and herbalism may be deemed “unscientific.” Thus, in

this study, ubuntu enriches data analysis by offering an Indigenous lens that uncovers how IK

is implicitly or explicitly espoused by life sciences content.

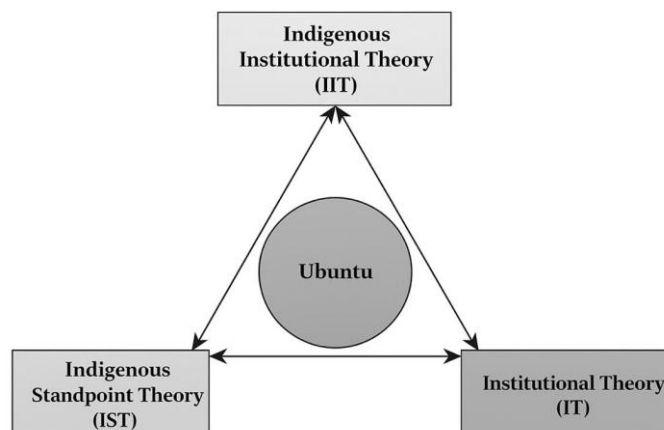


Figure 1 The adapted IIT/ubuntu theoretical framework

Considering the above, the theoretical framework guides the research questions of the study. Hence, the framework is informed by IK epistemology to determine how forms of IK are included, excluded or marginalised in life sciences topics. The framework shapes IK's place in the life sciences curriculum consistent with the tenets of an IK Act enacted within the larger South African sociocultural context. The theoretical perspectives of the framework provide lenses that position knowledge as culturally situated, socially mediated, and context dependent. Hence, the integration of IK into the South African life sciences curriculum aligns with a broader approach of recognising multiple ways of knowing (epistemological pluralism) school science. Guided by the IK lens, the framework is used to examine the representation of IK in the life sciences curriculum directing attention to the positioning of IK in specific life sciences topics. This lens is employed to analyse data collected from the CAPS for life sciences. The framework thus guides how data were analysed to foster teachers' understanding of the positioning of IK in life sciences content. The teachers are, therefore, regarded as culturally situated mediators or cultural brokers (Lee, Robles & Small, 2023) of curriculum knowledge. The theoretical framework foregrounds how IK is constructed within cultural contexts, such as schools, to underline the study's indigenicity (Coates et al., 2023).

Ultimately, the IST component of the framework underlines how the curriculum principle of valuing and integrating IK into classroom teaching can be accomplished by identifying life sciences content that is infused with IK or is IK-complaint. The IT element of the framework underpins how the study is embedded within

institutional parameters. The NCS is a policy document/statement entrenched in the purview of the DBE, which oversees primary education in South Africa. Moreover, the same institution supervises teachers, who, with other stakeholders in the educational sector, are the final implementers of the curriculum. The IIT and ubuntu perspectives embrace contextual sociocultural interdependency. This is in relation to how institutions are relationally responsible for developing and implementing the CAPS for life sciences. Consequently, ubuntu and IIT connote IK philosophical foundations for the study, while offering analytical tools to understand and conceptualise how IK is included, excluded or marginalised in life sciences topics.

Methodology

Research Design

The qualitative study was guided by an interpretivist paradigm that underscores how IK is framed/interpreted regarding its meanings, assumptions, representations and non-representations in the life sciences curriculum. An interpretivist paradigm "assumes a subjectivist epistemology, relativist ontology, a naturalist methodology, and a balanced axiology" (Kivunja & Kuyini, 2017:33). Accordingly, subjectivist epistemology indicates that researchers interpret data through their cognitive processes and construct knowledge based on personal experiences with the data collected. The relativist ontology view holds multiple realities within the research context, which can be explored and understood by engaging with the data. Through naturalist methodology, researchers collect data from "natural" sources, such as in-depth meanings expressed in textual forms derived from the

subjective world of human experience/thoughts. By a balanced axiology, the research outcome aims to reflect the researcher's values while striving for a balanced and objective presentation of findings.

Data Collection

Data were collected from the NCS/CAPS for life sciences (and analysed) using a juxtaposition of document analysis (Bowen, 2009) and a step-by-step process of thematic analysis (Naeem, Ozuem, Howell & Ranfagni, 2023). The document analysis approach comprised an iterative process of skimming (superficial examination), reading (thorough examination), and interpretation, with a combination of elements of content and thematic analyses.

Skimming and reading were done individually by both authors, while at intermittent intervals notes were compared to determine areas of similarity and/or divergence in the findings. The skimming and reading exercises were guided by the following pre-codes: (i) agriculture and food production; (ii) natural resource management of biodiversity; (iii) pastoral practices and animal production; (iv) environmental conservation/management of soil and water; (v) forestry and plant classification; (vi) healthcare/traditional or Indigenous medicine/medicinal plants; (vii) food preservation; (viii) fermentation/brewing (DBE, RSA, 2011; Momoh, 2020) and ubuntu (Chigangaidze et al., 2022; Ewuoso & Hall, 2019). These pre-codes were considered as major aspects of life sciences that are IK-infused or contain IK components. Therefore, the pre-codes were used as indicators for examining life sciences content/topics that may either be explicitly or

implicitly aligned with IK. This assisted in identifying keywords/phrases from the life sciences topics/content that tally with the pre-codes (see Table 1).

Hence, how the life sciences content/topics within the CAPS align with one or more of these pre-codes were noted and recorded. Therefore, guided by the research questions, the focus of the skimming and reading exercises were to identify and categorise: (i) content/topics in which aspects of IK (including ubuntu) were explicitly or implicitly conveyed in life sciences content/topics (related to Research Question 1); and (ii) healthcare-related life sciences content/topics in which aspects of IK are explicitly (or implicitly) conveyed. Overall, skimming and reading enhanced data familiarisation and transcript creation (Naeem et al., 2023). A transcript composed of a list of life sciences topics/content in relation to how they align with pre-codes and keywords/phrases was created. Throughout the study, each author initially worked with and on a transcript individually before joining forces to discuss and compare notes.

Data Analysis

Content and thematic analyses (Bowen, 2009) with an inductive approach (Byrne, 2022) was employed. Code selection (Naeem et al., 2023) was done based on the pre-codes and keywords/phrases (see Table 1). Content analysis is the "process of organising information into categories related to the central questions of the research" (Bowen, 2009:32). The codes were used in the formation of categories (see Table 2) while these helped in the development of themes (Naeem et al., 2023).

Table 1 Highlight of examples on how coding was done for life sciences topics/content

Examples	Topics as stipulated in the CAPS for life sciences	Specific content as stipulated in CAPS for life sciences	Pre-codes related to content/topics	Keywords/phrases identified from content/topic that tally with pre-codes	Codes
1	“Biodiversity and classification of microorganisms” (DBE, RSA, 2011:39).	“Biodiversity – Traditional technology to produce, e.g., beer, wine and cheese” (DBE, RSA, 2011:39).	Agriculture and food production; fermentation/brewing	Traditional technology	IK-explicit
2	“Human impact on the environment: Current crises for human survival: Problems to be solved within the next generation” (DBE, RSA, 2011:51).	“Food security (link with population ecology dynamics) – Poor farming practices: monoculture; pest control; loss of topsoil and the need for fertilisers” (DBE, RSA 2011:52).	Agriculture and food production	Farming practices; pest control; fertilisers	IK-implicit
3	“Cells: The basic units of life” (DBE, RSA, 2011:25).	“Molecular makeup – Cell structure and function (The role of organelles)” (DBE, RSA, 2011:25).	Ubuntu	Role of organelles (signifying interdependence among the organelles for overall proper functioning of the cell)	IK ubuntu-implicit
4	“Cell division – Mitosis” (DBE, RSA, 2011:26).	“Cancer – uncontrolled cell division and growth” (DBE, RSA, 2011:26).	Healthcare/traditional; Indigenous medicine	Cancer	IK-healthcare implicit
5	“Plant and animal tissues” (DBE, RSA, 2011:26).	“Applications of Indigenous knowledge systems and biotechnology • traditional technology, e.g., traditional medicines and healers” (DBE, RSA, 2011:28).	Healthcare/traditional; Indigenous medicine; medicinal plants	Indigenous knowledge systems; Traditional technology; Traditional medicine; Traditional healers	IK-health explicit

Table 2 Highlight of how categories were formed in relation to the research sub-questions using the codes

Research sub-questions	Codes	Categories
1) In what ways does the CAPS convey IK in life sciences topics/content?	IK-implicit	Category A: Content/topics not implied in the life sciences curriculum as incorporated with aspects of IK or suitable for IK integration.
	IK-explicit	Category B: Content/topics implied in the life sciences curriculum as incorporated with aspects of IK or suitable for IK integration.
2) In what ways does the CAPS convey IK in health-care-related life sciences content/topics?	IK ubuntu-implicit	Category C: Content/topics in the life sciences curriculum conveyed ubuntu IK-specificity.
	IK-health implicit	Category D: IK-specificity of health-related content/topics not implied in the life sciences curriculum as incorporated with aspects of IK.
	IK-health explicit	Category E: IK-specificity of health-related content/topics implied in the life sciences curriculum as incorporated with aspects of IK.

Theme development “involves organizing codes into meaningful groups to identify patterns and relationships, thereby offering insights into the research question” (Naeem et al., 2023:4). Theme development was achieved employing the literature

review approach (Snyder, 2019) (see Table 3). This assisted appropriate interpretation of the codes/categories to answer the research sub-questions.

Table 3 Theme development was achieved employing the literature review approach

Topic	Content	Codes	Literature review
Human impact on the environment: Current crises for human survival: Problems to be solved within the next generation.	Food security – poor farming practices; pest control, loss of topsoil and the need for fertilisers.	IK-implicit	Materechera (2013) reports that smallholder farmers in semi-arid areas of the North West province in South Africa employ IK strategies, including the use of “animal manure, ash from veld fire, agroforestry, fallow, termitaria and earthworm castings to manage soil fertility” (Materechera, 2013:1782) instead of using fertilisers.
	Indigenous knowledge systems and the sustainable use of the environment e.g., devils’ claw, rooibos, fynbos, the African potato (<i>Hypoxis</i>) and Hoodia.	IK-explicit	Also, there is an Indigenous approach to pest control in which chillies and potatoes are protected from biting- and sucking-type insects by spraying ash on the fields where such vegetables are planted (Rathore, Chandola, Raghuvanshi, Kaur & Singh, 2021). This is because ash contains silica, interrupting insects’ feeding and inhibiting fungal pathogen proliferation. In addition, an Indigenous way of forecasting rainfall and its amount due to the lived experiences of farmers assists them with the appropriate farming practices (Rankoana, 2017). The plants mentioned are both biologically valuable and culturally significant. For example, Indigenous communities, particularly the San and Nama people, have long used the tubers of devil’s claw (<i>Harpagophytum procumbens</i>) medicinally for pain, fever, and other ailments (Kambizi & Bvenura, 2023). Rooibos is also endemic to the Fynbos biome of South Africa. And because some fynbos species are harvested for traditional medicine, thatching, and other uses, managing harvesting is critical (El Mohamadi, 2025).

Research rigour: investigator triangulation ensured research rigour (Bans-Akutey & Tiimub, 2021). In this regard, both authors were deeply immersed in all the steps of the methodology. These steps comprised iterative skimming and reading the document through data analysis, which includes coding and interpretation. All the steps were done individually before the authors compared notes for discussions. For example, the

two coders discussed inconsistencies in the codes obtained and repeated the coding process until an intercoder rate of 80% was achieved. Investigator triangulation ensured that the authors discussed irregularities that occurred individually during any steps involved before conclusions were reached.

Results

The results are presented below showing how the themes answer the research sub-questions.

Research Sub Question 1: In What Ways does the Life Sciences Curriculum Convey IK?

Theme 1: IK explicitly conveyed in topics/content (IK-explicit)

Topic: “Biodiversity and classification of microorganisms” (DBE, RSA, 2011:39).

Pre-code: Natural resource management of biodiversity; Forestry and plant classification.

Content: “Biodiversity – Traditional technology to produce e.g., beer, wine, and cheese” (DBE, RSA, 2011:39),

Keyword/phrase(s): Traditional technology

Induction/interpretation: The topic of “biodiversity and classification of microorganisms” (DBE, RSA, 2011:39) fit into a pre-code of natural resource management of biodiversity. The subject matter of biodiversity in the topic makes it directly fit to be categorised under the pre-code (also containing “biodiversity”). The phrase “Traditional technology” in the content is an indication that it conveyed aspects of IK. Hence, aspects of IK are explicitly conveyed in the topic/content as stipulated in the life sciences curriculum.

Theme 2: IK implicitly conveyed in topics/content (IK-implicit)

Topic: “Human impact on the environment; Current crises for human survival; Problems to be solved within the next generation” (DBE, RSA, 2011:51).

Pre-code: Agriculture and food production.

Content: “Food security (link with population ecology dynamics) – Poor farming practices: monoculture; pest control; loss of topsoil and the need for fertilisers” (DBE, RSA, 2011:52).

Keyword/phrase(s): Food security; farming practices; pest control; loss of topsoil; fertilisers.

Induction/interpretation: The subject matter of “human survival” makes the topic directly fit to be categorised under the pre-code (Food production). Unlike in Theme 1, IK is not explicitly contained in the topic/content. However, as indicated in Table 3, there are aspects of IK pertaining to content such as farming practices and pest control. Hence, it is considered that the IK aspects are implicitly expressed in the topic/content.

Theme 3: IK not implicitly or explicitly conveyed but ubuntu implied (IK ubuntu-implicit)

Topic: “Cells: The basic units of life” (DBE, RSA, 2011:25).

Pre-code: Ubuntu.

Content: “Molecular makeup – cell structure and function: Roles of organelles” (DBE, RSA, 2011:25).

Keyword/phrase(s): Cell wall – support structure in plant cells only; nucleus, chromatin material, nuclear membrane, nucleopores, and nucleolus: the

control centre, heredity; cytoplasm – storage and circulation of materials; mitochondria – release energy during cell respiration.

Induction/interpretation: Ubuntu is neither explicitly nor implicitly conveyed in the topic. However, ubuntu as form of IK is incorporated in the content to the extent that interconnectedness is expressed therein. This is with respect to the interconnectedness of the role of each organelle in relation to the proper functioning of the cell. The complete integrity and survival of the cell are maintained and secured through the “interdependence” of all the organelles in the cell. For example, according to Sengupta and Levy (2024), the mitochondrion ensures energy supply through adenosine triphosphate (ATP). At the same time, the cell membrane controls the movement of substances in and out of the cell, utilising that energy. Meanwhile, the nucleus, deoxyribonucleic acid (DNA), messenger ribonucleic acid (RNA), transfer RNA, and ribosomes work hand in hand in protein synthesis to meet cell protein requirements (Sengupta & Levy, 2024).

Research Sub Question 2: In What Ways does the CAPS Convey IK in Healthcare-related Life Sciences Topics/Content?

Theme 4: IK explicitly conveyed in healthcare-related topic/content(s) (IK health explicit)

Topic: “Plant and animal tissues (continued)” (DBE, RSA, 2011:28).

Pre-code: Healthcare/traditional or Indigenous medicine/medicinal plants. Considering the topic was not enough to classify it under the pre-defined code, the nature of the content aided categorisation under the pre-defined code.

Content: “Applications of Indigenous knowledge systems and biotechnology – Traditional technology, e.g., Traditional medicines and healers” (DBE, RSA, 2011:28).

Keyword/phrase(s): Indigenous knowledge systems; Traditional technology; Traditional medicines and healers.

Induction and interpretation: The keyword/phrases identified in the topic/content indicate that they conveyed aspects of IK. Hence, the policy statement implies that the topic is infused with aspects of IK. The keyword/phrases(s) were used to search the literature and shed more light on the topic’s IK-specificity. For example:

- (i) Traditional medicines: Ssenku, Okurut, Namuli, Kudamba, Tugume, Matovu, Wasige, Kafeero and Walusansa (2022) in their study document plant species used to treat human diseases and their associated Traditional medicine knowledge (TMK). The conservation methods for medicinal plants are also evaluated.
- (ii) Traditional healers: These are spiritual healers or diviners who use divination to communicate with

ancestral spirits to diagnose their patients' ailments or medical conditions. Such spiritual specialists use plant medicines for spiritual healing (Ssenku et al., 2022).

Theme 5: IK implicitly conveyed in healthcare-related topic/content(s) (IK health implicit)

Topic: "Cell division: Mitosis" (DBE, RSA, 2011:26).

Pre-codes: Healthcare/traditional or Indigenous medicine/medicinal plants. The topic appears not to immediately fit into the pre-code. However, the content under consideration aided the categorisation under the pre-code.

Content: "Cell division: Mitosis – Cancer (uncontrolled cell division and growth) – Causes of cancer and treatments for cancer" (DBE, RSA, 2011:26).

Keywords/phrases: Causes of cancer; treatments of cancer; beliefs and attitudes concerning cancer.

Induction and interpretation: Unlike in Theme 4, the keyword/phrase(s) in the content do not indicate that the topic conveys aspects of IK. Hence, the curriculum may not have indicated that the topic is infused with aspects of IK. However, the keyword/phrase(s) provided clues for a literature review into the topic's IK-specificity. Examples include the following: Causes and treatment of cancer:

- i. Msoka, Dwampudi, Billings, Stone, Mwageni, Beavers, Mmbaga and Gutnik (2025) review evidence from many studies on how traditional healers participate in cancer treatment across sub-Saharan Africa using herbs and spiritual therapies (prayer, divination, incantation).
- ii. Many rural South African women are reported to interpret breast cancer in terms of sociocultural beliefs about witchcraft, sin, punishment, and spiritual causation (Sarmah, Sibiyi & Khoza, 2023).

Discussion

Against the background of the support for Indigenous people by the United Nations Permanent Forum on Indigenous Issues (UNPFII), research on IK, including its accompanying benefits for integration into curricula, has been explored globally and in South Africa (Zazu, 2007). Specifically in South Africa, the National Indigenous Knowledge Systems (IKS) Policy and Protection, Promotion, Development and Management of Indigenous Knowledge Act, 2019 (Act No. 6 of 2019) prioritise promoting IKS as a fundamental element of transformation and human capital development. This assists to promote and preserve cultural identity and maintain cultural sustainability. Studies such as by Handayani et al. (2018), Mavuru and Makhunga (2020), Yeseraw et al. (2023) examine curriculum challenges in incorporating IK into classroom teaching of various subjects, including life sciences, abound in the literature. Among other reasons, challenges related

to teachers have been suggested in the conclusions reached in some of these studies. However, our study was motivated by a gap in the literature regarding how the curriculum (CAPS for life sciences) may have or have not explicitly expressed the IK-specificity of certain life sciences content. For this reason and considering the pressure on teachers to exhaust the teaching of an enormous quantum of topics in life sciences approved in the curriculum, it is most likely that IK incorporation into classroom teaching may be overlooked or not considered necessary.

Given the above, for IK integration into classroom teaching to be achieved through effective curriculum implementation, teachers should be well-versed not only in the knowledge or awareness of topics infused with IK but also in the IK-specificity of such topics. Although the NCS/CAPS policy statement enunciates the importance of incorporating IK into classroom teaching of life sciences, it is not clear, in many instances, which topics are suitable for such purposes. Thus, we examined the IK-specific content of topics in life sciences, which may not have been expressed in the CAPS life sciences curriculum as IK-compliant. Findings in the study reveal that in certain instances, the CAPS conveyed IK-specificity of some life sciences topics. An example is the content of "applications of Indigenous knowledge systems and biotechnology: Traditional technology, e.g., Traditional medicines and healers" (DBE, RSA, 2011:28) which is clearly expressed as IK-infused.

Nonetheless, a life sciences teacher may be unaware that the IK of ubuntu may be incorporated into classroom teaching of a topic such as "Cells: The basic units of life" (DBE, RSA, 2011:25). How this can be conceptualised is suggested through revealing the IK-specificity of the topic. Furthermore, we particularly examined IK-explicitness or implicitness of healthcare-related topics. This is considering the increasing global dependence on TM in the form of herbal remedies and how medicinal plants remain central to many communities' healthcare (Latif & Nawaz, 2026). For this reason, we propose that teachers need to embrace incorporating the traditional medicine IK as a form of science in schools. Consistent with this, Handayani et al. (2018) explains three curriculum integration strategies (fragmented, sequenced, integrated) for IK integration in life sciences teaching. This is to make learning more impactful, meaningful, culturally relevant, and sustainable for learners.

Furthermore, Sefoka and Chuene (2025) report that integrating IK (including TM) into life sciences teaching improves learners' active engagement, comprehension and better connection to concepts. Because learners are not *tabula rasa*, they come into classrooms equipped with value

orientations imbued in them by their sociocultural backgrounds (Steenkamp, 2021). Such orientations may include their knowledge of TM. Therefore, for cultural sustainability, appropriate elaboration of IK in the science curriculum and the science classroom is “potential for building meaningful learning and connecting the gap of science education pathways that a student obtains in schools and community” (Handayani et al., 2018:74). According to these authors, contemporary science education is enhanced by including IK in curricula. Moreover, teachers need to appreciate that harmonising IK and classroom scientific knowledge is plausible. Correspondingly, our study brings awareness to a gap in curricula information; and assists teachers on how such gaps may be filled in classroom teaching. Considering such a gap, further studies are suggested to analyse curricula documents used in different educational contexts.

Conclusion

Given the limited studies on how the South African CAPS for life sciences articulates IK-specificity of life sciences topics were explored. In some topics, IK was explicitly expressed, and they are regarded as suitable for IK integration (i.e., IK-specificity expressed). However, in many other topics, IK was either implicitly conveyed or completely lacking (i.e. IK-specificity was not clearly expressed). Concerning these topics, the literature was used to highlight the IK components in them to elucidate that they may be integrated into classroom teaching. The study also created awareness about IK-specificity of TM-related topics and content of life sciences. This is to assist teachers on how IK could be integrated when teaching such topics. Additionally, it prepares teachers for culturally responsive teaching (Abacioglu, Volman & Fischer, 2020) and helps to create a culturally relevant or culturally sensitive classroom (Garcia & Pantao, 2021) in a multicultural society such as South Africa. We, therefore, propose IK integration (especially TM) not just as cultural content but as what should be a vital aspect of sustainable science, technology, engineering, mathematics Indigenous knowledge system (STEM-IKS) curricula. Kaya and Seleti (2013:37) argue that the “process of traditional knowledge should be deliberately and vigorously sought and implemented in the education system of South Africa and the continent at large.”

Conclusively, the study creates awareness and articulates how a vital IK African philosophy such as ubuntu may be incorporated into classroom teaching of life sciences topics. This enhances teachers’ perceptions of classroom incorporation of IK as it expounds: (i) how life sciences topics and specific contents are infused with IK (IK-specificity); (ii) what components of IK are

infused in life sciences topics and content; and (iii) clues that may be navigated for IK to be incorporated into classroom teaching of such topics and content. Similarly, we aimed to raise awareness among teachers regarding teaching health-related life sciences topics infused with IK, especially considering the increasing popularity of TM in South Africa (Mothibe & Sibanda, 2019). Recognising South Africa’s multicultural society and the diverse cultural backgrounds of learners (Mavuru & Ramnarain, 2020), we sought to guide teachers on (i) the interconnectedness between life sciences topics and IK, or vice versa, (ii) how these topics incorporate aspects of IK; and (iii) the suitability of these topics for IK integration into classroom teaching practices.

Acknowledgement

This work is based on the research supported by the University of Johannesburg and in part by the National Research Foundation of South Africa (Reference/Grant Number: PSTD250331307529).

Authors’ Contributions

EJA: Conceptualisation, methodology, formal analysis, data interpretation and curation, writing original draft preparation, and visualisation. LM: Supervision, writing-review and funding acquisition. Both authors critically reviewed the manuscript for important intellectual content, approved the final version of the manuscript, and agreed to be accountable for all aspects of the work.

Notes

- i. “In South Africa, Grade R [referred to as ‘Grade Reception’] is the first point of entry into a 4-year Foundation Phase of learning (Grades R–3) in the school system for most children between 5 and 6 years of age” (Kathard, Parusnath, Thabane, Pillay, Hu, Le Roux, Harty, O’Carroll & Mallick, 2022:2).
- ii. Published under a Creative Commons Attribution Licence.
- iii. DATES: Received: 15 April 2024; Revised: 27 October 2025; Accepted: 11 February 2026; Published: 31 August 2026.

References

- Abacioglu CS, Volman M & Fischer AH 2020. Teachers’ multicultural attitudes and perspective taking abilities as factors in culturally responsive teaching. *British Journal of Educational Psychology*, 90(3):736–752. <https://doi.org/10.1111/bjep.12328>
- Abdullahi AA 2011. Trends and challenges of traditional medicine in Africa. *African Journal of Traditional, Complementary and Alternative Medicines*, 8(S):115–123. <https://doi.org/10.4314/ajtcam.v8i5S.5>
- Angelo D, Disbray S, Singer R, O’Shannessy C, Simpson J, Smith H, Meek B & Wigglesworth 2022. *Learning (in) Indigenous languages: Common ground, diverse pathways* (OECD Education Working Papers No. 278). Paris, France:

- OECD Publishing.
<https://doi.org/10.1787/e80ad1d4-en>
- Bans-Akutey A & Tiimub BM 2021. Triangulation in research. *Academia Letters*:1–6.
<https://doi.org/10.20935/AL3392>
- Bowen GA 2009. Document analysis as a qualitative research method. *Qualitative Research Journal*, 9(2):27–40. <https://doi.org/10.3316/QRJ0902027>
- Bruchac MM 2014. Indigenous knowledge and traditional knowledge. In C Smith (ed). *Encyclopaedia of global archaeology*. New York, NY: Springer Science and Business Media.
- Byrne D 2022. A worked example of Braun and Clarke's approach to reflexive thematic analysis. *Quality & Quantity*, 56:1391–1412.
<https://doi.org/10.1007/s11135-021-01182-y>
- Chigangaidze RK, Matanga AA & Katsuro TR 2022. Ubuntu philosophy as a humanistic–existential framework for the fight against the COVID-19 pandemic. *Journal of Humanistic Psychology*, 62(3):319–333.
<https://doi.org/10.1177/00221678211044554>
- Coates SK, Trudgett M & Page S 2023. Indigenous institutional theory: A new theoretical framework and methodological tool. *The Australian Educational Researcher*, 50:903–920.
<https://doi.org/10.1007/s13384-022-00533-4>
- Da Silva C, Pereira F & Amorim JP 2024. 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>
- De Beer J & Petersen N 2016. Decolonisation of the science curriculum: A different perspective (#Cookbook-Labs-Must-Fall). In *Proceedings of the ISTE International Conference on Mathematics, Science and Technology Education: Towards Effective Teaching and Meaningful Learning in Mathematics, Science and Technology*. Pretoria, South Africa: University of South Africa.
- Department of Basic Education, Republic of South Africa 2011. *Curriculum and Assessment Policy Statement Grades 10-12 Life Sciences*. Pretoria: Author. Available at
https://www.education.gov.za/Portals/0/CD/National%20Curriculum%20Statements%20and%20Vocational/CAPS%20FET%20_%20LIFE%20SCIENCES%20_%20GR%2010-12%20Web_2636.pdf. Accessed 12 April 2024.
- El Mohamadi A 2025. *Contributing to conversation and sustainable use in the Rooibos industry: A practical guide*. BioInnovation Africa (BIA) project.
- Ewuoso C & Hall S 2019. Core aspects of ubuntu: A systematic review. *The South African Journal of Bioethics and Law*, 12(2):93–103.
<https://doi.org/10.7196/SAJBL.2019.v12i2.679>
- Fitzsimmons TW & Callan VJ 2020. The diversity gap in leadership: What are we missing in current theorizing? *The Leadership Quarterly*, 31(4):101347.
<https://doi.org/10.1016/j.leaqua.2019.101347>
- Garcia KA & Pantao JG 2021. Cultural sensitivity and classroom management of teachers. *International Journal of Professional Development, Learners and Learning*, 3(1):ep2108.
<https://doi.org/10.30935/ijpdll/11093>
- Handayani RD, Wilujeng I & Prasetyo ZK 2018. Elaborating indigenous knowledge in the science curriculum for the cultural sustainability. *Journal of Teacher Education for Sustainability*, 20(2):74–88. <https://doi.org/10.2478/jtes-2018-0016>
- Kambizi L & Bvenura C (eds.) 2023. *Sustainable uses and prospects of medicinal plants*. Boca Raton, FL: CRC Press.
- Kathard H, Parusnath P, Thabane L, Pillay M, Hu ZJ, Le Roux J, Harty M, O'Carroll S & Mallick RB 2022. A survey of communication supports in Grade R classrooms in the Western Cape, South Africa. *South African Journal of Communication Disorders*, 69(1):a871.
<https://doi.org/10.4102/sajcd.v69i1.903>
- Kaya HO & Seleti YN 2013. African indigenous knowledge systems and relevance of higher education in South Africa. *The International Journal: Comparative Studies*, 12(1):30–44. Available at
<https://openjournals.library.sydney.edu.au/index.php/IEJ/article/view/7436>. Accessed 31 August 2026.
- Keikantsemang KZ 2017. Integration of indigenous knowledge systems in the curriculum for basic education: Possible experiences of Canada. PhD thesis. Pretoria, South Africa: University of South Africa. Available at
<https://www.proquest.com/docview/3224180065?pq-origsite=gscholar&fromopenview=true&sourcetype=Dissertations%20&%20Theses>. Accessed 31 August 2026.
- Kivunja C & Kuyini AB 2017. Understanding and applying research paradigms in educational contexts. *International Journal of Higher Education*, 6(5):26–41.
<https://doi.org/10.5430/ijhe.v6n5p26>
- Latif R & Nawaz T 2026. Medicinal plants and human health: A comprehensive review of bioactive compounds, therapeutic effects, and applications. *Phytochemistry Reviews*, 25:2299–2342.
<https://doi.org/10.1007/s11101-025-10194-7>
- Lee J, Robles G & Small L 2023. What should students learn about the importance of cultural brokering in immigrant communities? *AMA Journal of Ethics*, 25(11): E809–817.
<https://doi.org/10.1001/amajethics.2023.809>
- Joshi LT, Mansfield C, Ting IJ & Hubbard K 2024. Why we need to decolonize the biosciences curriculum. *The Biochemist*, 46(2):26–32.
https://doi.org/10.1042/bio_2024_102
- Marschall S 2019. The long shadow of apartheid: A critical assessment of heritage transformation in South Africa 25 years on. *International Journal of Heritage Studies*, 25(10):1088–1102.
<https://doi.org/10.1080/13527258.2019.1608459>
- Materechera SA 2012. Using wood ash to ameliorate acidity and improve phosphorus availability in soils amended with partially decomposed cattle or chicken manure. *Communications in Soil Science and Plant Analysis*, 43(13):1773–1789.
<https://doi.org/10.1080/00103624.2012.684825>
- Mavuru L & Makhunga KX 2020. Relevance of Indigenous Knowledge integration in Life Sciences teaching: What do the teachers say? In L Gómez

- Chova, A López Martínez & I Candel Torres (eds). *Proceedings of the 12th International Conference on Education and New Learning Technologies*. Spain: IATED Academy.
<https://doi.org/10.21125/edulearn.2020.1718>
- Mavuru L & Ramnarain U 2020. Learners' socio-cultural backgrounds and science teaching and learning: A case study of township schools in South Africa. *Cultural Studies of Science Education*, 15:1067–1095. <https://doi.org/10.1007/s11422-020-09974-8>
- Mkhwebane LN 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>
- Mlondo N 2022. Umuntu ngumuntu ngabantu (a person is a person because of/or through others) and the notion of inclusive education. In MO Maguvhe & MM Masuku (eds). *Handbook of research on creating spaces for African epistemologies in the inclusive education discourse*. Hershey, PA: IGI Global. <https://doi.org/10.4018/978-1-6684-4436-8.ch001>
- Momoh MM 2020. Colonialism and the destruction of indigenous knowledge system: Reflection on African arts, science, and technology. *International Journal of Research and Scientific Innovation*, 7(3):10–18.
- Momsen J, Speth EB, Wyse S & Long T 2022. Using systems and systems thinking to unify biology education. *CBE—Life Sciences Education*, 21(2):es3. <https://doi.org/10.1187/cbe.21-05-0118>
- Mothibe ME & Sibanda M 2019. African traditional medicine: South African perspective. In C Mordeniz (ed). *Traditional and complementary medicine*. London, England: IntechOpen.
<https://doi.org/10.5772/intechopen.83790>
- Msoka EF, Dwarampudi S, Billings R, Stone, RJ, Mwangeni RE, Beavers A, Mmbaga BT & Gutnik L 2025. The role of traditional healers along the cancer care continuum in Sub-Saharan Africa: A scoping review. *Archives of Public Health*, 83:35.
<https://doi.org/10.1186/s13690-025-01521-7>
- Mugumbate JR, Mupedziswa R, Twikirize JM, Mthethwa E, Desta AA & Oyinlola O 2024. Understanding Ubuntu and its contribution to social work education in Africa and other regions of the world. *Social Work Education*, 43(4):1123–1139.
<https://doi.org/10.1080/02615479.2023.2168638>
- Naeem M, Ozuem W, Howell K & Ranfagni S 2023. A step-by-step process of thematic analysis to develop a conceptual model in qualitative research. *International Journal of Qualitative Methods*, 22:1–18.
<https://doi.org/10.1177/16094069231205789>
- Nakata M 2007. *Disciplining the savages, saving the disciplines*. Canberra, Australia: Aboriginal Studies Press.
- Nicolaides A 2023. Considering the philosophy of Ubuntu in South African healthcare ethical practices. *The Journal of Medical Laboratory Science & Technology South Africa*, 5:71–76.
<https://doi.org/10.36303/JMLSTSA.133>
- Ogude J (ed.) 2019. *Ubuntu and the reconstitution of community*. Bloomington, IN: Indiana University Press. <https://doi.org/10.2307/j.ctvh4zgdgk>
- Photo P & McKnight M 2024. Investigating indigenous knowledge awareness among South African science teachers for developing a guideline. *Curriculum Perspectives*, 44:61–71.
<https://doi.org/10.1007/s41297-023-00224-9>
- Rankoana SA 2017. Subsistence food production practices: An approach to food security and good health. *International Journal of Environmental Research and Public Health*, 14(10):1184.
<https://doi.org/10.3390/ijerph14101184>
- Rathore S, Chandola M, Raghuvanshi R, Kaur M & Singh KV 2021. Indigenous pest management practices of Indian hill farmers: Introspecting their rationale and communication pattern for secure ecosystems [Special issue]. *Sustainability*, 13(21):11608.
<https://doi.org/10.3390/su132111608>
- Republic of South Africa 2019. Act No. 6 of 2019: Protection, Promotion, Development and Management of Indigenous Knowledge Act. *Government Gazette*, 650(42647):1–28, August 19. Available at https://media.lawlibrary.org.za/media/legislation/297006/source_file/1fca37e78102f31d/protection-promotion-development-and-management-of-indigenous-knowledge-act-2019.pdf. Accessed 31 August 2026.
- Sarmah N, Sibiya MN & Khoza TE 2023. The sociocultural influences on breast cancer screening among rural African women in South Africa [Special issue]. *International Journal of Environmental Research and Public Health*, 20(21):7005.
<https://doi.org/10.3390/ijerph20217005>
- Seehawer M 2018. South African science teachers' strategies for integrating indigenous and Western knowledges in their classes: Practical lessons in decolonisation [Special issue]. *Educational Research for Social Change*, 7:91–110.
<https://doi.org/10.17159/2221-4070/2018/v7i0a7>
- Sefoka TS & Chuene KJ 2025. Life sciences learners' views on the integration of indigenous knowledge into indigenous knowledge-related topics using a cooperative learning approach: A case of South African grade 10 classroom. *Eurasia Journal of Mathematics, Science and Technology Education*, 21(5):em2633.
<https://doi.org/10.29333/ejmste/16311>
- Sengupta S & Levy DL 2024. Organelle communication with the nucleus. In M Kloc, JZ Kubiak & M Halasa (eds). *Intercellular and interorganellar transfer and communication in biology and medicine*. Cham, Switzerland: Springer.
https://doi.org/10.1007/978-3-031-62036-2_1
- Snyder H 2019. Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, 104:333–339.
<https://doi.org/10.1016/j.jbusres.2019.07.039>
- Ssenku JE, Okurut SA, Namuli A, Kudamba A, Tugume P, Matovu P, Wasige G, Kafeero HM & Walusansa A 2022. Medicinal plant use, conservation, and the associated traditional knowledge in rural

- communities in Eastern Uganda. *Tropical Medicine and Health*, 50:39.
<https://doi.org/10.1186/s41182-022-00428-1>
- Steenkamp U 2021. Cultural diversity and its influence on role players in a full-service school in Soshanguve: A wellness perspective. *European Journal of Education*, 4(1):23–39.
<https://doi.org/10.26417/790dun39d>
- Yeseraw A, Melesse T & Kelkay AD 2023. Inclusion of indigenous knowledge in the new primary and middle school curriculum of Ethiopia. *Cogent Education*, 10(1):2173884.
<https://doi.org/10.1080/2331186X.2023.2173884>
- Zazu C 2007. Exploring opportunities and challenges for achieving the integration of indigenous knowledge systems into environmental education processes: A case study of the Sebakwe Environmental Education programme (SEEP) in Zimbabwe. MEd dissertation. Makhanda, South Africa: Rhodes University.