THE CONUNDRUM OF INTEGRATING INDIGENOUS KNOWLEDGE IN SCIENCE CURRICULUM THEMES: A REVIEW OF DIFFERENT VIEWPOINTS

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ABSTRACT

The leitmotiv of this paper is the relationship between the natural sciences and indigenous knowledge, and whether indigenous knowledge has a place in the school science curriculum. In this review paper, various perspectives on the role of indigenous knowledge in the science classroom are explored. Based on the tenets of respective science and indigenous knowledge, three different perspectives on such epistemological border-crossing are explored: the inclusive, the exclusive, and the 'overlapping domains' perspectives. The authors also consider factors that influence such border-crossing, such as teacher and learner factors.

Keywords: Indigenous knowledge, science education, border-crossing, tenets of science, tenets of indigenous knowledge

BACKGROUND

During the *#FeesMustFall* campaign that disrupted higher education since 2015, the focus was on the decolonisation of the curriculum (De Beer, 2016). During the colonialised era, indigenous knowledge was not considered important and much of the knowledge was lost (Diwu & Ogunniyi, 2012). In the new democratic South Africa, this concern has been addressed, with indigenous knowledge being accommodated in the school science curriculum. In the Curriculum and Assessment Policy Statements (CAPS), Specific Aim 3 focuses specifically on the integration of indigenous knowledge in the science classroom (Diwu & Ogunniyi, 2012; DOE, 2011). This Specific Aim is concerned with learners' understanding and appreciation of the connection between the scientific content (curriculum) and their everyday lives, and how this scientific knowledge can enrich their lives (DOE, 2011). Indigenous knowledge holds affordances to better contextualise science for learners. However, Zinyeka, Onwu, and Braun (2016) also indicate that a particular learner might decide to not choose science as a subject, because of the perceived clash between his/her cultural principles and the scientific aspects. The epistemological border-crossing between science and indigenous knowledge in the classroom is, therefore, of utmost importance.

DEFINITION OF INDIGENOUS KNOWLEDGE

Indigenous knowledge is defined as knowledge that is transmitted from one generation to another, through storytelling, drawings, and dancing (Nyang, Adesina & Elasha, 2007). This knowledge is unique to a specific group of people or culture living in a specialised socio-cultural environment (Shizha, 2013). Anazifa and Hadi (2017) emphasize the importance of the interaction between indigenous people and the environment in which they live in. This knowledge has evolved over centuries and is especially focused on sustainable agriculture, food preparation, health and environmental conservation (Anazifa & Hadi, 2017). Unfortunately, not much of this knowledge has been documented (Anazifa & Hadi, 2017) and

some knowledge has been lost for next generations (Fraser, 2012). According to Anazifa and Hadi (2017), this loss of indigenous knowledge could be accredited to a communication gap between the elders and the youth of the community. The youth of the community often moves away from the rural areas and consequently also loses contact with their culture (Anazifa & Hadi, 2017). Anazifa and Hadi (2017) explain that indigenous knowledge has a great influence on our “modern” life, like medicine, architecture, engineering, agriculture and pest control (Diwu & Ogunniyi, 2012). For this reason, the infusion of indigenous knowledge in the school science curriculum is of paramount importance.

DEFINITION OF NATURAL SCIENCE (WESTERN KNOWLEDGE)

Shizha (2010) explains that Western science focuses on repeatable observation descriptions, predictions and experiments related to the physical world. Scientific knowledge refers to abstract concepts such as theories and laws, and the scientific methods (Le Grange, 2016). According to Lederman, Lederman and Antink (2013), scientific knowledge is based on experiments, observations, theories, and laws. De Beer and Mentz (2016) add that the formulation of hypotheses, selecting the appropriate method of investigation and testing the hypotheses play important roles in the collection of scientific knowledge. There are strict protocols that exist when hypotheses and experiments are done to ensure that information is reliable (De Beer & Mentz, 2016).

THREE DIFFERENT VIEWPOINTS ON THE INTEGRATION OF INDIGENOUS KNOWLEDGE INTO THE SCHOOL SCIENCE CURRICULUM

According to Zinyeka et al., (2016:257) and Taylor and Cameron (2016), there are three different perspectives on the integration of indigenous knowledge in the natural science school curriculum:

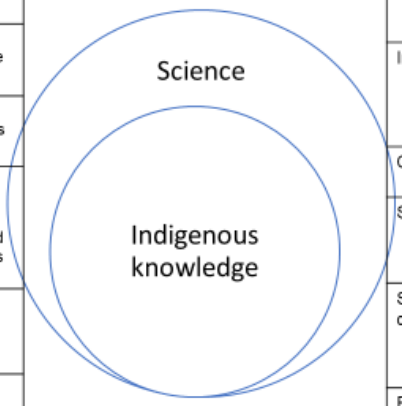
(1) The **inclusive perspective** – this perspective considers indigenous knowledge as part of science.
(2) The **exclusive perspective** – sees indigenous knowledge and science as separated knowledge domains. The many foci of the science domain are in the material world. The indigenous knowledge domain is in contrast with the science domain because this domain also recognises the possibility of supernatural elements.
(3) **Overlapping perspective** – with this perspective there is an overlap between the indigenous knowledge domain and the science domain. This perspective highlights that there are some aspects or elements of both domains that are similar, yet each of the domains also has unique elements.

In this paper, we shall critically discuss each of these perspectives.

1. Inclusive perspective

The inclusive perspective views indigenous knowledge as part of science. Figure 1 shows that certain tenets are shared by both these knowledge domains, which ease this epistemological border-crossing in the science classroom.

Natural science tenets	
Empirical	It is real, observable of natural phenomena and testable. The world is orderly and predictable.
Tentative	Science is ever changing, there is an element of uncertainty.
Inferential	Observations are made of nature and conclusions are made from the observations.
Creative	Human creativity also plays a role, and not only based on observations and experiments
Subjective (theory-laden)	Scientists try to be objective and culture free, but they are only human. Human beings are subjective and are easily influenced by their prior knowledge and values
Socially and cultural influenced	Science has a human element therefore it cannot really be objective, because one can easily be influenced.
Based on theories and laws	Science focuses on why things happen in nature. Scientists use laws and theories to help them explain how nature works.
Approached in a reductionist manner	Scientific knowledge can be broken down into smaller units, to be analysed. Part or the whole of the methods can be used.



Indigenous knowledge tenets	
Empirical and metaphysical	It is real, somewhat testable, and observable. The world is orderly, metaphysical and somewhat predictable.
Tentative	This knowledge is always changing because of experiences. The elders also decide what is true and what not.
Inferential	Knowledge is tested e.g. through careful observations and information experiments. Metaphysical components are important as well as natural and unnatural causes. Metaphysical aspects are implant.
Creative	Human creativity, imagination and myths also form part of knowledge.
Subjective	This knowledge is based on cosmology and intertwine with culture and the religious aspects. Prior knowledge and viewpoints affect the ways of the elders.
Socially and cultural based	The community's everyday life in the natural environment influences their choices and activities. The community is important to the individuals. This knowledge is specific to a certain culture and environment.
Based on functional application	Indigenous knowledge focuses on why things happen in nature. Myths play a role in indigenous knowledge, also the learning of different skills.
Approached in holistic manner	Indigenous knowledge is complex and include science, religion, psychology, metaphysics. Problems and issues are addressed in a holistic way.

Figure 1: The inclusive perspective and the tenets of science and indigenous knowledge (Zinyeko et al., 2016:257-260; Cronje, 2015:37-45; Lederman et al., 2013; Taylor & Cameron, 2016)

Taylor and Cameron (2016) explain that, according to the inclusive perspective, indigenous knowledge is taught as part of the science curriculum and is regarded as a science. Unfortunately, the uniqueness of each knowledge domain can be lost with such an approach. Especially, the identity of indigenous knowledge gets lost because what makes indigenous knowledge special (e.g. its holistic nature) gets overshadowed by science (Taylor & Cameron, 2016). Diwu and Ogunniyi (2012) add that some researchers believe that indigenous knowledge will not receive the necessary recognition in the classroom and will be marginalized. This will result in science being superior over indigenous knowledge (Taylor & Cameron, 2016). Cronje (2015) explains that sometimes indigenous knowledge is seen as unscientific and irrelevant to modern life, and this stigma of indigenous knowledge as "pseudo-science" should be addressed.

2. Exclusive perspective

Zinyeko et al., (2016) indicate that the second perspective weighs indigenous knowledge against scientific knowledge. The exclusive perspective sees indigenous knowledge and natural sciences as two different, independent knowledge domains. Some researchers believe that indigenous knowledge is a valid knowledge domain but is better on its own and not part of the science curriculum (Diwu & Ogunniyi, 2012). Such a perspective, therefore, advocates for the exclusion of indigenous knowledge in the school science curriculum. Figure 2 shows that each knowledge domain has unique tenets that make them special.

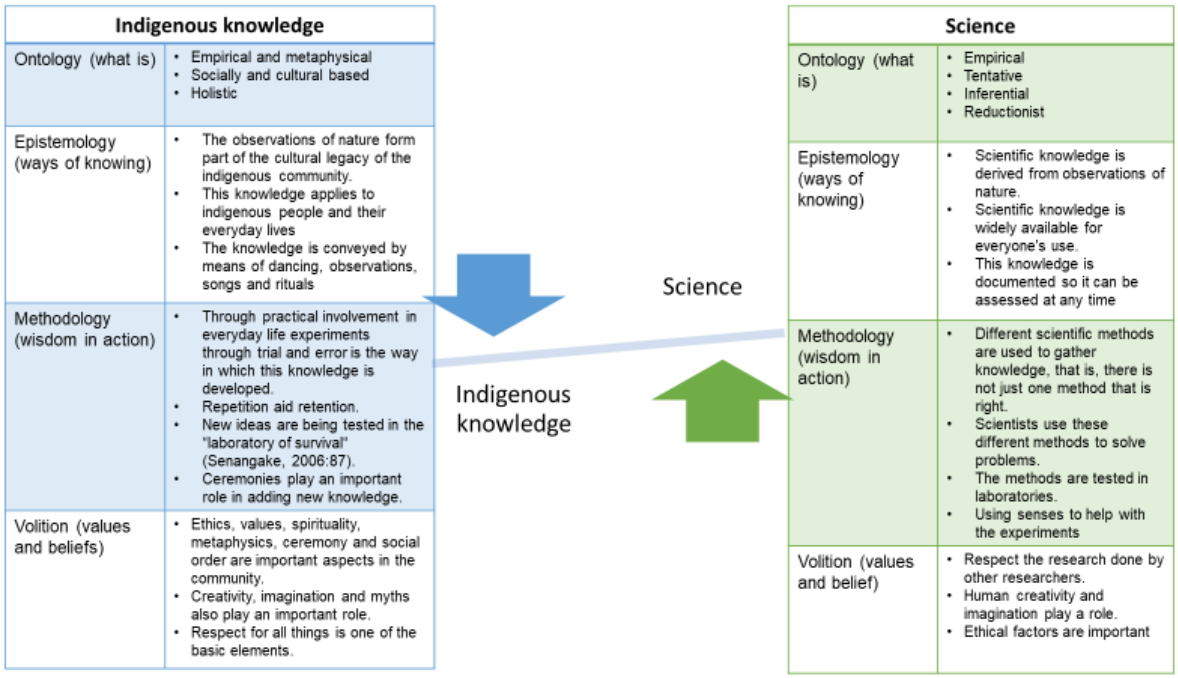


Figure 2: The exclusive perspective, highlighting the unique tenets of science and indigenous knowledge (Zinyeko et al., 2016; Cronje, 2015:37-41; Lederman et al., 2013:140-142)

Due to different tenets- specifically the holistic and metaphysical nature of indigenous knowledge- supporters of this perspective sometimes view indigenous knowledge as constituting "pseudo-science" (De Beer, 2016). Coker (2001:4) describes pseudo-science as having "no review, no standards, no pre-publication verification, (and) no demand for accuracy and precision". Other scholars justify this exclusive perspective by stating that there are big differences in the epistemologies and methodologies of western science and indigenous knowledge (Onwu & Mosimege, 2004). Onwu and Mosimege (2004:6) state: "(V)erification methods and processes can be equated and be made to be similar standards, however, they have to be appropriate for each system, otherwise we would compromise one system at the expense of another and in the process lose the beauty of what the two systems could provide alongside each other". This approach also eliminates the problem that teachers do not have the necessary knowledge or skills for such border-crossing, as they were not trained to integrate indigenous knowledge into their lessons (Zinyeko et al., 2016). Taylor and Cameron (2016) add that indigenous knowledge is better off as a separated knowledge domain to further enhance and appreciate its uniqueness.

3. Overlapping perspective (intersecting domains)

The third perspective's intention is to bridge the gap between science and indigenous knowledge (Zinyeko et al., 2016). Figure 3 shows that this perspective acknowledges both the knowledge domains' uniqueness and their similarities. This perspective celebrates both, the commonalities (shared tenets, e.g. both are empirical and inferential) and the uniqueness of each knowledge domain (e.g. indigenous knowledge is holistic and western science reductionist). In practice, this approach would mean that the focus in the classroom would be the shared tenets of the two domains.

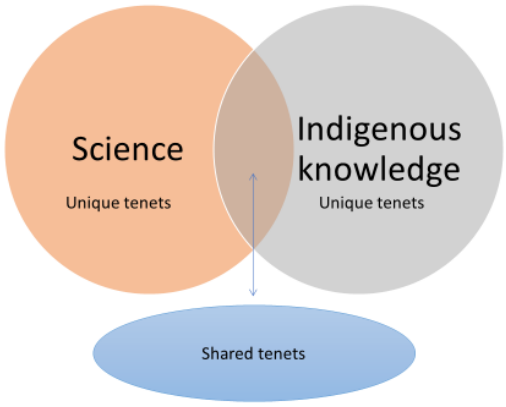


Figure 3: The overlapping perspective, acknowledging the shared tenets of science and indigenous knowledge, as well as the unique tenets of both (Zinyeko et al., 2016; Taylor & Cameron, 2016)

These results in the two knowledge domains supporting and building on each other (Zinyeko et al., 2016). Taylor and Cameron (2016) believe that the distinction between the two types of knowledge domains is important in understanding the uniqueness of each knowledge domain. This perspective provides a place for indigenous knowledge in the school science curriculum.

An example of this approach would be the practice explained by De Beer and Whitlock (2009), whereby a teacher could contextualise a problem in terms of indigenous knowledge and expect the learners to use the processes of science to investigate the problem. How the efficacy of 'muthi plants' be tested in the classroom? De Beer and Whitlock (2009) describe an adapted Kirby-Bauer technique whereby learners can determine the antimicrobial properties of medicinal plants. Similarly, De Beer and Petersen (2017) explain how the ancient Chinese practice of burning incense to ripen fruit could be investigated in the school laboratory. Learners will have to formulate hypotheses and develop a laboratory protocol, to determine the influence of ethylene on plant growth. Criticism of such an approach would be that scientific processes are used to verify (accredit) indigenous knowledge. In this approach, the teacher should also acknowledge that aspects of indigenous knowledge (the metaphysical) fall outside the scope of science.

Benefits of using indigenous knowledge in the science classroom

From the study of Diwu and Ogunniyi (2012), it is clear that learning could be enhanced when it is contextualised by relevant and authentic indigenous knowledge. By using indigenous knowledge in the science classroom, contextual learning could be enhanced (Anazifa & Hadi, 2017). With the integrating of indigenous knowledge in the science classroom community values are furthermore emphasised (Anazifa & Hadi, 2017), thus promoting the affective domain. By incorporating indigenous knowledge into the science curriculum, science is better contextualised for diverse learners. However, the big cultural diversity among South African learners also poses problems for the teacher, as the question arises *whose* indigenous knowledge should be addressed in the classroom (Cronje, 2015). Teacher professional development is, therefore, of crucial importance, as teachers need to be shown how various indigenous knowledge systems could manifest in the science classroom (De Beer, 2019). Assignments should be given to learners to better understand the needs and reality of the local community (Shizha, 2012). For instance, De Beer and Van Wyk (2011) show how learners could engage in ethnobotanical surveys in the science classroom, but such an

approach would only provide good results in communities where there exists sufficient ethnobotanical knowledge. Students' learning can, therefore, be triggered by authentic problems in the local environment, and this could enhance be awareness of the role of science in everyday life, and be the source of data for their assignments, investigations, and experiments (Shizha, 2012).

Disadvantages of integrating indigenous knowledge into the science classroom

According to Shizha (2012) teachers like to teach the empirical scientific knowledge to learners, and this knowledge is usually predetermined. In contrast, incorporating indigenous knowledge is not predetermined or given proper guidance to teach and so teachers find it difficult to teach. One of the disadvantages of integrating indigenous knowledge in the science classroom is that the planning and designing of teaching materials are time-consuming (Diwu & Ogunniyi, 2012), and generally there is a lack of teaching and learning resources. Anazifa and Hadi (2017) explain that teachers should be creative, full of initiative and rich in ideas, and they should also develop the necessary assessment opportunities to pay justice to indigenous knowledge systems. The development of these lessons takes extra time for teachers to plan. The availability of indigenous teaching materials complicates the teaching of indigenous knowledge (Shizha, 2012), and such epistemological border-crossing should receive more attention in both pre- and in-service teacher education.

CONCLUSION

The integration of indigenous knowledge into science themes (thus, better contextualisation of the curriculum) could result in learners developing an appreciation for the role of science in everyday life (Taylor & Cameron, 2016). Shizha (2012) believes that teachers often subconsciously incorporate indigenous knowledge into their lessons when using examples to explain or support scientific concepts and this can result in undervaluing indigenous knowledge. It is important that the incorporation of indigenous knowledge should also address the syntactical nature of science- not just the substantive nature (De Beer, 2019).

Zinyeko, et al., (2016) believes that the integration of indigenous knowledge into the school science curriculum is one way to maximize the socio-cultural relevance of scientific education and to improve learners' performance. Balfour (2019) believes that the nascent scholarship on such epistemological border-crossing represents a powerful act of scholarly reclamation, restoration, and redress, which are so needed in the country. Therefore, there is a place for indigenous knowledge in the school science curriculum.

The three perspectives (the inclusive, exclusive and 'overlapping domains') on the role that indigenous knowledge plays in the school science curriculum are important in both pre- and in-service teacher education, as science teachers should develop nuanced understandings of the tenets of both indigenous knowledge and (western) scientific knowledge.

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