Cultural Studies of Science Education (2022) 17:863–874
https://doi.org/10.1007/s11422-021-10085-1

FORUM

Indigenous artefacts and physics curriculum: teaching science as a cultural way of knowing

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Received: 21 August 2021 / Accepted: 20 September 2021 / Published online: 14 March 2022

Abstract
This article considers science teaching and learning as may be understood through the integration of indigenous artefacts into physics curriculum in Zimbabwean schools. It comments significance of and elaborates on the issues raised in Nadaraj Govender and Edson Mudzamiri's paper entitled: Incorporating indigenous artefacts in developing an integrated indigenous-pedagogical model in high school physics curriculum: views of elders, teachers and learners. At the outset, I examine the study's conceptualisation of the terms indigenous knowledge (IK) and school science. Then, I offer an alternative view on the findings in light of the *ubuntu* theoretical framework, as used in other studies. The article foregrounds theoretical and methodological arguments put forward by Govender and Mudzamiri for the incorporation of IK artefacts with physics education in schools. After that, I analyse the applicability of the article's proposed integrated indigenous physics pedagogical model in the school curriculum. The paper ends with the contention that school science should be taught as a cultural way of knowing rather mere facts divorced from learners' culture.

Keywords Indigenous knowledge · Indigenous artefacts · Culture · Integration · School science

To start-off my commentary, I would like to note that Nadaraj Govender and Edson Mudzamiri's study adds a voice to other science educators' call for IK integration into school science curriculum. In justifying their study, Govender and Mudzamiri noted that, in high school physics, learners were not taught within their everyday lived indigenous experiences. Their observation may be pertinent given that there has been an

Lead Editor: A.W. Oliveira

This commentary addresses theoretical and methodological aspects of Nadaraj Govender and Edson Mudzamiri's study entitled: Incorporating indigenous artefacts in developing an integrated indigenouspedagogical model in high school physics curriculum: views of elders, teachers and learners. https://doi.org/10.1007/s11422-021-10076-2

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acknowledgement by numerous researchers in science education that the science curriculum does not usually include IK found abundantly in the communities around the schools. For example, Meshach Ogunniyi (2011) concurs with this view arguing that in Southern Africa schooling is largely Eurocentric. Similar observations were made in Zimbabwe by Edward Shizha (2006), who found that school science curricula content and methodology were framed in western style, disregarding IK found in the indigenous communities. Also, in Zimbabwe, Pharaoh Joseph Mavhunga, an educationist, analysed the Ministry of Education's plans to localise the curriculum by adopting indigenous values and technologies. He concurred with Shizha's (2006) observations and further noted that "…the school curriculum has fundamentally remained Western" (2008, p. 38).

In this context, the influence of western-oriented education remains important to Govender and Mudzamiri's study, who attributed exclusion of IK to colonialism and globalisation. As a result, for them, this has led to indigenous learners' poor performance in school science as well as a lack of motivation to pursue science careers. Their article explains why indigenous learners perform poorly in school in terms of the science curriculum failing to recognize that science is a social construct. Such a situation is unfortunate in light of Angayuqaq Oscar Kawagley, Delena Noris-Tull and Roger Noris-Tull's argument that "…no single origin for science exists; that science has a plurality of origins and a plurality of practices" (1998, p. 134). Their view places school science as a cultural way of knowing. Other authors like Catherine Odora-Hoppers (2002) examined the nature of school science that should be offered to learners in indigenous communities. She noted that science is a product of culture. Furthermore, she noted that teaching is a social practice and cultural action.

In addition, Govender and Mudzamiri's article argues for the promotion of hands-on and minds-on approaches to teaching and learning in schools through incorporation of IK artefacts. Such methods are in sync with Overson Shumba and Royda Kampamba's (2017) curricula approaches which underscored two critical issues: science teaching should be connected to the lives of the learners, and, localised curriculum should attempt to bring local knowledge into schools so that it can be recognised and so that it can be given respect by learners as they make "connections" with their cultural values with schooling. However, this localisation of the curriculum requires critical engagement with local cultural issues as these relate to wider systems of emergence and divergence, as noted by Govender and Mudzamiri's study. Taking full cognizant of local issues is precisely what Heila Lotz-Sisitka (2008) highlights in the context of Education for sustainable development (ESD) that learning involves connection in/with communities and society (situated/social learning).

I offer an alternative view that learning as a connection has both curriculum and teaching implications. This is not to dismiss the important work done by Govender and Mudzamiri as they argue for the inclusion of learners' prior experiences in science through incorporation of their IK artefacts. Their argument reflects directly Mavhunga's (2008) contention that to Africanise or indigenise school curriculum is facilitated through the teaching and learning that draws from learners' cultural experiences. In the next part of my commentary, I give a summary of the article.

A summary of Govender and Mudzamiri's study

In their study, on incorporating indigenous artefacts in developing an integrated indigenous-pedagogical model in high school physics curriculum, Govender and Mudzamiri explored the concept of indigenous artefacts of community elders, teachers and learners.

The *ubuntu* and Levi Vygotsky's (1978) social learning theoretical frameworks were used to guide their study. These researchers collected and analysed data using a transformative participatory research design and explained the interaction between culture and knowledge for learners located in indigenous communities. Seen in this context, their study contributes immensely to suggesting ways of teaching western science using indigenous methods found in indigenous communities. As Christopher Diwu and Meshach Ogunniyi succinctly affirm that, "there are points of intersection between the two thought systems" (2012, p. 334). By looking at Govender and Mudzamiri's study, it is possible that IK could be incorporated into physics teaching through the use of indigenous artefacts existing in the learners' communities.

In the following sections, I examine how important concepts (school science and IK) were differentiated in the article. After the distinction, the commentary further examines the role of culture in science education, since it is considered pivotal in science education, as alluded to earlier on in this commentary. It is important to note that the Govender and Mudzamiri chose to give characteristics rather than definitions of these terms. More importantly, they noted the different epistemological and ontological underpinnings of these concepts. In this regard, Shizha (2013) reminds us that IK and school science have diverse philosophical assumptions and worldviews.

School science

To begin with, it is prudent to note how the Govender and Mudzamiri understood the concept school science. They argue that school science epistemology is based on experimental work, which is conducted in laboratories or research centres. According to them, proponents of the science epistemology regard school science as universal and teaches concepts as separate entities. As Shizha (2013) advises that school science emphasises western culture since the reality of schooling is constructed in terms of objectivity and empirical validation. Shizha (2009) contends that this objective bias of school science contrasts the IK's pragmatic epistemology as well as practical metaphysics. This is an important view as also put forward by Govender and Mudzamiri's article who argue for the incorporation of IK artefacts into physics curriculum; which are useful in the communities from which learners live.

In defining a curriculum, Denis Lawton (1978) posits that it is a selection from a culture and, in this case, from *ubuntu* cultures, that emphasise social responsibility, and spiritual and moral values among other virtues in the African context. Lawton's (1978) view is consistent with Masakata Ogawa's (1995) definition of science as a rational perception of reality. This definition accommodates both IK and school science perspectives.

What is the study's view of the concept IK?

Indigenous knowledge (IK)

Govender and Mudzamiri's article describes IK's ontology as that of trial and error based on spirituality, and has a holistic and collective approach to life issues. These researchers acknowledge that proponents of western science believe that IK is based on superstition and lacks epistemology. This observation may be due to the fact that IK is people-centred and sometimes not so easily measurable, and it is found in community cultural practices (Shizha 2006). Furthermore, Shizha noted that IK, therefore, "is a social construct that evolves out of the peoples' social world and cultural experiences" (2006, p. 23). To this end, the article argues for decolonization of the science curriculum through recognizing IK resources and epistemic knowledge that learners bring from their cultural experiences at home.

Govender and Mudzamiri regard IK teaching as a community-oriented informal knowledge. In simpler terms, for indigenous people, teaching is done in a meaningful real-life context, such as '*padare*' (meeting place), or when performing household chores. This view had a bearing on the methodology they used to develop their culturally aligned teaching and learning model for physics education in schools.

The concept culture in science education needs unpacking.

Culture in science education

The term culture carries different meanings in various disciplines. As Glen Aikenhead (2006) clearly claims that culture is a broad concept and has various meanings; therefore, there is need to unpack this concept as used in this commentary. The culture policy of Zimbabwe (MOESAC 2007, p. 6) defines culture as.

> a sum total of a way of life a society can offer in terms of material implements and possession; … in terms of values and value systems and in terms of social relations between members of the society, in terms of arts and crafts and in terms of religion.

The above definition suggests that culture can manifest itself in both visible (tangible) and invisible (intangible) ways. For Govender and Mudzamiri's article, the concept of culture refers to ways of life which are determined by a group's response to a particular environment. For example, school science as a cultural way of knowing. How might school science be viewed as a cultural way of knowing?

School science knowledge as a cultural way of knowing

The issue of regarding science as a cultural enterprise has received mixed reactions from scholars in science education. For example, Elizabeth McKinley and Georgina Stewart (2009) believe that science is governed by a set of rules that are culture-free and deny difference. However, Shizha (2013) explains that the reluctance to include other cultures contrasts a multicultural epistemology position that recognises science as socially and culturally constructed and, as such, recognises differences. This means that there are multiple ways of understanding the natural world which may be compatible or incompatible with the scientific worldview. Hence, schools play an important role in transmitting culture when IK is incorporated with science teaching as also noted by Govender and Mudzamiri.

Rationale for incorporating IK into school science

Govender and Mudzamiri's article suggests that there would be epistemic decolonization processes in schools when IK is incorporated into science. A number of reasons have been forwarded by different authors regarding the rationale of integrating IK with school science. Marie Battiste (2004) argues for the inclusion of indigenous voices in the curricula; Odora-Hoppers (2002) proposes a curriculum that provides a redress, equity and acknowledgement of valuable resources; Shizha (2009) calls for a learner-centeredness or relevant curricula; Elizabeth McKinley (2005) emphasises a curriculum that promotes visibility of

IK and raises self-esteem and interest in schooling; Odora-Hoppers (2005) calls for education that cultivates cultural identity formation, and Mavhunga (2008) suggests a shift to the teaching of science towards the experiences, values and practices of African learners.

Pathways for inclusion of IK into school science

Scholars have suggested various pathways regarding inclusion of IK in the school science curriculum. Central to these pathways is the view that an understanding of epistemological differences between the knowledge systems will provide important markers for ways to proceed with integrating IK into a science curriculum. For example, Constantino Pedzisai (2013) identified three approaches that have been suggested by different authors for the inclusion of IK into the school curriculum. These are: the incorporationist approach which seeks how IK best fits into science syllabus; a separatist approach which puts IK side-by-side with scientific knowledge, and an integrationist approach that links and makes connections between IK and science. Govender and Mudzamiri's approach fits the first case. These approaches are useful pointers to school science education, as for example, William Cobern and Cathleen Loving (2001) highlight the integrity and validity of IK as knowledge in schools and other developmental systems. These scholars believe that the best way of acknowledging its value is by keeping IKS separate from the western scientific knowledge systems.

Other authors regard IK and science as different but equal systems that complement each other. Diwu and Ogunniyi (2012) call this approach an 'integrationist position'. As alluded to above in this paper, they noted that there are points of intersection between the two thought systems. These authors conclude that knowledge system integration should be done with the provision that what is taught at school is sensitive to the current multicultural classroom.

Govender and Mudzamiri's article considers incorporation of IK into school science teaching and learning. I suggest integration rather than incorporationist pathway could make learners be more connected with their culture. In explaining the later pathway, some authors suggest how the integration of knowledge systems should be done. For example, Ogunniyi (2011) suggests that integration of knowledge systems range from total exclusion to inclusion through cautious and partial inclusion. Ogunniyi (2013) uses the term 'exclusion' to mean a way of knowing that takes one form of knowledge as inferior to the other, for example, regarding IK culture as inferior to western science culture. This view constitutes what Shizha (2013) calls a 'colonial mentality', where one knowledge system dominates the other. In contrast, by inclusivity, Ogunniyi (2013) means education that is liberating and empowering. This is in line with the relevant science education by Shizha (2006), where an individual learner is an active participant in negotiating learning while moving mentally from one cognition to another. It also resembles Vongai Mpofu, Femi Otulaja and Emmanuel Mushayikwa's (2013) proposal on pathways to integrate IK into classroom science, namely parallel, divergent, convergent and substitutive. Parallel integration occurs when indigenous knowledge ideas and western science are both recognised as legitimate and allowed to coexist. Divergent integration maintains IK and western science in disparate positions until such time as IK is well developed. Convergent integration occurs when these two knowledge systems are synthesised into one comprehensive and holistic system. Substitutive integration is the displacement of one knowledge system by another that precipitates charges of epistemological and cultural imperialism. In the context of multiculturalism, Cobern and Loving argue that, "the solution is to resist this scientific practice by emphasizing throughout schooling that the concept of epistemological pluralism reminds us that truth is never…proprietorship of any single domain of knowledge-not even science" (2001, p. 65).

In light of Govender and Mudzamiri's article, I believe that parallel form of integration may be useful in attaining relevant science education in schools. To do this, teachers can help learners to negotiate this 'border crossing' by creating culturally relevant frameworks for students to make connections between school science and their culture (Aikenhead 2001). Such connection is what Quigley argues that it may cultivate equitable instruction and assessment practices for diverse students as it allows them to connect with science and maintain their identity" (2011, p. 550). So, such connection maintains learners' cultural identity.

Challenges of integrating IK with school science

Many scholars acknowledge that integrating IK with school science remains a daunting task. According to Diwu and Ogunniyi (2012), problems related to integration have been linked to their incompatibility in terms of different epistemology (a view and justification for what is knowledge), ontology (claims about the nature of social reality—what exists, what it looks like, what units make it up) and assumptions (background used for coming to conclusions or decisions). Mariana Hewson (2012) believes that understandings of philosophical differences will provide important markers for how to proceed with integrating IK into the school science curriculum. These differences arise since science is embedded in a mechanistic and reductionist worldview while IK is located in an anthropomorphic, pluralist and holistic worldview. Ogunniyi (2013) defines a worldview as a culture's collection of thoughts, beliefs and values. Thus, a worldview as a guide to people's everyday interactions in life and in the world. In the context of IK, Aikenhead (2006) contends that it involves a holistic, communal knowledge, ancestral knowingness and wisdoms. Meshach Ogunniyi, Olugdeniro Jegede, Masakata Ogawa, Cephas Yandila and Femi Oladele advice that "…a worldview has an organising value for experience" (1995, p. 818). So, a worldview is a way of looking at life. This means that IK and western science have distinct elements, beliefs and cultural practices.

In spite of these challenges posed by varied worldviews, there is consensus among researchers worldwide that IK should be integrated with school science. For example, in South Africa, Ogunniyi (2013) observes that the debate has shifted from 'why' IK should be included in science to considerations of 'how' it could be integrated with school science. Similar views have been raised by other authors in many other Sub-Saharan countries (including Zimbabwe). Key to their views is that there are possible areas of commonality between IK and school science with the possibility of each stimulating and supporting the other in the classroom contexts. It is this commonality in practice which Govender and Mudzamiri's article sought to understand in light of other studies that have been done regarding the integration of IK with school science teaching.

Context for incorporating IK into school science

Govender and Mudzamiri's article took note of the importance of context with regards to use of learners' prior experiences in the physics classroom. I shall add other issues that may provide useful contexts for the development of a culturally aligned teaching model.

These include theory of knowledge domains, incorporation of learners' worldviews, cultural border crossings, culturally responsive teaching and the third space theory.

I concur with the authors' position in the article that use of participants' prior experiences had a bearing on the development of their teaching model. I also believe that prior experiences are important for the teaching and learning of science in schools. As Ogunniyi (2011) describes prior knowledge as what learners do bring as their own ideas about the world into the classroom science teaching and learning. In other words, what learners 'bring to the table' before engaging in instruction and use to make meaningful connections to-be-learned concepts, information or strategies. Some authors, for example, Shumba (2015) and Aikenhead (2006), argue that, in using prior experiences, learning is seen as-a-connector principle, where the aim of learning is to generate knowledge through social interactions.

The first aspect deals with knowledge domains within IK and western science perspectives. For example, Dominic Mashoko, Vongai Mpofu, Emmanuel Mushayikwa and Moyra Keane (2016) adapted a tetrahedral model by Mpofu et al. (2013) and proposed a five-sided model of knowledge: product, process, enterprise, paradigm and pedagogy. Mashoko et al. (2016) developed an E4P tetrahedral knowledge model to encompass multicultural views of knowledge acquisition. In this tetrahedral metaphor, the human element (enterprise-E) generates knowledge using the cultural way of knowing (paradigm-P) that guides the inquiry (process-P) of the natural world to generate knowledge (product-P). This knowledge can be used in pedagogy (P). This can provide useful insights into Govender and Mudzamiri's model. In this model, examples and learners' prior experiences of mechanics may be used to show relationships between two knowledge systems.

In the case of Govender and Mudzamiri's article, discussions might be focused on who the community members involved in the process are, how these members generating knowledge on mechanics, how they are doing it culturally (paradigm), what knowledge do they generate (product) and how this knowledge can be used in teaching of physics (pedagogy). In juxtaposing ideas from two worldviews, convergences existing in knowledge systems could be revealed. Convergences may occur due to some areas of commonality in practices on mechanics, which might be found in an IK perspective may also be practiced in western science. This understanding may be a result of interrogating strengths and limitations of each food preservation approach.

The second issue that can be used for developing a culturally aligned model is how to go about theorising the incorporation of IK into school science considering their distinct worldviews (as explained above). In the scientific worldview, mechanics is understood in terms of specific concepts. There is evidence in the literature that worldviews held by learners are regarded as important motivators to learning science (see, for example, Ogunniyi 2013). The two worldviews may complement each other rather than being opposing perspectives.

More importantly, Bagele Chilisa (2012) summarises the attributes of an IK worldview, in terms of a perspective which recognises a relational existence that promotes relations among people, the living and the non-living, the environment/land and the cosmos. In the context of Govender and Mudzamiri's study, IK perspectives should be understood in relational to ontology (what is reality), epistemology (nature of knowledge) and axiology (values and biases). By implication, this relational philosophy regards knowers as beings with connections to other beings, the spirits of the ancestors and the world at large.

A third issue is the concept of 'border crossing'. Glen Aikenhead and Olugbemiro Jegede (1999) call it 'border crossing', where learners cross cultural boundaries from their homes to schools. This affected how Govender and Mudzamiri planned to generate their data in terms of specific cultural practices that may be different from school science situations. For example, the way people are demonstrating physics mechanics concepts like forces using IK artefacts was found to be different from that which is done at school. This might confuse learners if such differences arise during class discussions.

The fourth aspect in relation to their framework is the emphasis of science education on culturally responsive teaching approaches. As Cassie Quigley (2011) calls it a culturally responsive teaching approach that refers to practices that are grounded in the belief that all culturally and linguistically diverse students can excel in academic endeavours when their culture, language, heritage and experiences are valued and used to facilitate their learning.

The fifth aspect which may be useful regarding the development of their conceptual framework is the idea of a third space in science education. Quigley (2011) believes that the idea of a third space involves practices of a shared humanity, a profound obligation to others, boundary crossing and intercultural exchange in which difference is celebrated. Furthermore, Quigley noted that third spaces could be achieved through interaction of three aspects, namely: instructional, scientific and everyday discourses. These spaces accommodate IK as everyday discourses from the communities. Vygotsky (1978) believes that third spaces are zones of proximal development since they are productive adult-centred scaffolding spaces where every day concepts are related to scientific concepts. With regard to pedagogical spaces, Quigley (2011) posits that learners' worlds (first space) and school science (second space) may be combined to construct a space where students feel comfortable dialoguing in science and no longer see the two spaces (home and school) as in opposition to each other. The following section provides a description of the theoretical framework used for the study. In doing so, I will elaborate on the relevance of the framework to the study.

Theoretical framework

The *ubuntu* and the Vygotsky's (1978) social learning theorical frameworks informed the study. Govender and Mudzamiri chose *ubuntu* as an African philosophy, describing it as a multi-dimensional concept representing the core values of African ontologies. Their selection of this framework for the article is relevant given that the study was based on the cultural practices of the selected group of people. As Moyra Keane (2008a) argues that *ubuntu* is an ontological perspective, an interconnectedness of all beings in the community. In the *ubuntu* philosophy, an African individual is a member of the community with one's existence defined with reference to others and one's relationship with them. Also in tandem with what Jose Cossa (2009) refers to as African renaissance, *ubuntu* redefines human relationships that reflect African perceptions and reality. Thus, in the context of Govender and Mudzamiri's suggestion on teaching and learning of physics, this community life is based mostly on '*mushandirapamwe*' (working as a community, or working with others) as collective responsibility.

Govender and Mudzamiri's article also uses Vygotsky's sociocultural theory in suggesting how cultural artefacts could be incorporated into physics education. As Mashoko (2018) observes that in the context of sociocultural theory, learning is a social process and that human intelligence originates in a society or culture. It is this form of learning, which Vygotsky (1978) explains, occurs through interaction, negotiation and collaboration. Thus, this theory might be useful in providing insights into how knowledge systems could be integrated. In the following section, I will discuss the methodology used in the article.

Methodology

In this section, I intend to explain the relevance of the methodology used for the article. Govender and Mudzamiri used a qualitative research approach and qualitative transformative participatory research (TPR) design. The research approach was appropriate, as Paul Leedy and Jeane Ormrod (2010) contend that a qualitative research investigates the search objects in their natural settings and attempts to make sense of or interpret phenomena in terms of the meanings people bring to them. The methods selected by these authors are suitable given that their methodological choice was influenced by the Shona cultural contexts. Also given that the paradigm, research design and data collection methods under study were linked to cultural practices. As suggested by Constance Khupe (2014) that when researching IK for classroom practices, the best approach should be to root the study in an African indigenous research methodology. Thus, Govender and Mudzamiri's article framed within the indigenous research methodology explored use of knowledge holders' language, terminology and metaphors and sociocultural research protocols and methods.

In addition, their methodology is in tandem with what others like Dennis Martinez (2010) call it a multiple evidence-based (MEB) approach in research; a strategy where the integrity of each knowledge system is preserved by recognising that its interpretation and authentication takes place primarily within rather than across, different knowledge systems. This strategy probably might have influenced Govender and Mudzamiri to make use of anthropological tools such as open-ended interviews to study elders' metaphors, stories and taboos, and conduct cultural meetings that gave a better perspective on the IK artefacts for physics education in schools.

The inter-linked community relationships had a bearing on the way Govender and Mudzamiri's study accessed their participants. As noted in their article, they followed cultural protocols and negotiated their access through community leaders, 'v*ana sabhuku*' (village heads) and 'v*atungamiri vezvikoro*' (heads of schools). As John Creswell (2007) refers to these leaders as 'gatekeepers'. Through these 'gatekeepers', I suggest that the study could go beyond conventional ethics requirements and ask each participant to express verbally his/her willingness to participate in their study as, in IK research, "ethical obligations cannot be sufficiently met through conventional contractual agreements" (Keane 2008b, p. 1).

Conclusions and implications

The conceptualisation of IK terms by Govender and Mudzamiri provides a useful way for understanding incorporation of indigenous artefacts into physics teaching and learning in schools. Far from a silver bullet, the use of IK artefacts has the potential not only to improve teaching and learning of physics but to ensure cultural identity for learners in schools. It would seem therefore that the study by Govender and Mudzamiri is a very important on in adding a voice that science educators raise for science curriculum to incorporate both tangible and intangible cultural artefacts into teaching and learning in schools.

As can be seen from Govender and Mudzamiri's article, IK artefacts could be used as mediating tools in the teaching and learning physics in schools. More importantly, such cultural tools which constitute both theoretical and practical knowledge, could provide a platform for integrating IK artefacts into school science. Currently, there is yawning gap between science taught in schools and IK which learners bring from their communities.

This status core is unfortunate given than learners' prior experiences have proved to be useful enhancing relevant science education in schools (Odora-Hoppers 2005; Shizha 2013). Thus, I concur with Govender and Mudzamiri's recommendation that there is need for the documentation, protection and preservation of IK artefacts which learners bring into schools from their communities.

The six themes which the authors identified were quite relevant for the development of their integrated indigenous-physics pedagogical model (IPPM). Such themes were: African philosophy, cultural views and indigenous language, African cultural contexts and local environments, indigenous resources, indigenous teaching and learning methods, and indigenous context approach to assessment. This is especially true given that the themes that have emerged from the participant's data cover content, methodology and method of assessment for physics education in schools. Hence, it is my contention that school science should be taught as a cultural way of knowing rather mere facts divorced from learners' culture.

References

Aikenhead, G. S. (2001). Integrating Western and aboriginal sciences: Cross-cultural science teaching. *Research in Science Education, 31*, 337–355. https://doi.org/10.1002/1098-237X(200103)852<1080:AIDCSE50>3.0C02-1.

Aikenhead, G. S. (2006). *Science education for everyday life: Evidence-based practice*. Teachers College Press.

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

Battiste, M. (2004). Respecting postcolonial standards of indigenous knowledge: Toward "a shared and sustainable future." *The Journal of Aboriginal Economic Development, 4*(1), 61–71. https://doi.org/10.1003/200402.

Chilisa, B. (2012). *Indigenous research methodologies*. Sage.

Cobern, W. W., & Loving, C. C. (2001). Defining "science" in a multicultural world: Implications for science education. *Science Education, 85*(1), 50–67. https://doi.org/10.1002/1098-237)(200101)85:1%3C50:AIDSCE5%3E.3.0.C02-G.

Cossa, J. (2009). African renaissance and globalization: A conceptual analysis and a way forward. *Ufahamu: A Journal of African studies, 36*(1), 1–25. https://doi.org/10.5070/F7361009576.

Creswell, J. W. (2007). *Qualitative inquiry and research design: Choosing among five approaches*. Sage.

Diwu, C., & Ogunniyi, M. B. (2012). Dialogical argumentation instruction as a catalytic agent for the integration of school science with indigenous knowledge systems. *African Journal of Research in Mathematics, Science and Technology Education, 16*(3), 33–347. https://doi.org/10.1080/10288457.2012.11740749.

Hewson, M. G. (2012). Traditional healers' views on their indigenous knowledge and science curriculum. *African Journal of Research in Mathematics, Science and Technology Education, 16*(3), 317–332. https://doi.org/10.1080/10288457.2012.10740748.

Kawagley, A. O., Norris-Tull, D., & Norris-Tull, R. A. (1998). The indigenous worldview of Yupiaq culture: Its scientific nature and relevance to the practice and teaching of science. *Journal of Research in Science Teaching, 35*(2), 133–144. https://doi.org/10.1002/SICI)1098-2736(199802)35.2%3C133:AID-TEA4%3E3.0.C02-T.

Keane, M. (2008a). Science education and world view. *Cultural Studies of Science Education, 3*, 587–621. https://doi.org/10.1007/s11422-007-9086-5.

Keane, M. (2008b). Science learning and research in a framework of ubuntu. In C. Malcolm, E. Motala, S. Motala, G. Moyo, J. Pampallis, & B. Thaver (Eds.), *Democracy, human rights and social justice in education* (pp. 978–981). Centre for Education Policy Development (CEPD).

Khupe, C. (2014). Indigenous knowledge and school science: Possibilities for integration. *Doctor of Philosophy Thesis in Education.* University of the Witwatersrand, Johannesburg.

Lawton, D. (1978). *Theory and practice of curriculum studies*. Routledge and Kegan Paul.

Leedy, P., & Ormrod, J. E. (2010). *Practical research: Planning and design* (9th ed.). Pearson.

Lotz-Sisitka, H. (2008). Environmental education and educational quality and relevance: Opening the debate. *Southern African Journal of Environmental Education, 25*, 5–12. https://doi.org/10.10121/2411-5959.

Martinez, D. (2010). The value of indigenous way of knowing to western science and environmental sustainability. *Journal of Sustainability Education (JSE), 2*(1), 31–34. https://doi.org/10.1009/201002

Mashoko, D. (2018). Integrating indigenous knowledge of food preservation with school science teaching in Zimbabwe. *Doctor of Philosophy Thesis.* University of the Witwatersrand, Johannesburg.

Mashoko, D., Mpofu, V., Mushayikwa, E., & Keane, M. (2016). Indigenous knowledge for school science: Insights into the issue of intellectual property rights from three South African studies. *Indilinga Journal of Indigenous Knowledge Systems, 15*(3), 178–189. https://doi.org/10.10520/EJC-533BCAA43.

Mavhunga, P. H. (2008). Africanising the school curriculum: A case For Zimbabwe. *Zimbabwe Journal of Educational Research, 20*(1), 30–48. https://doi.org/10.1013-3445.

McKinley, E. (2005). Locating the global: Cultural, language and science education for indigenous students. *International Journal of Science Education, 27*, 227–241. https://doi.org/10.1080/0950069042000325861.

McKinley, E., & Stewart, G. (2009). Falling into place. In K. G. Tobin & W. Roth (Eds.), *The world of science education handbook of research in Australasia* (Vol. 2, pp. 49–66). Routledge.

MOEASC. (2007). *Cultural policy of Zimbabwe*. Ministry of Education, Art, Sport and Culture.

Mpofu, V., Otulaja, F. S., & Mushayikwa, E. (2013). Towards culturally relevant classroom science: A theoretical framework focusing on traditional plant healing. *Cultural Studies of Science Education, 9*(1), 221–242. https://doi.org/10.1007/S11422-013-9508-5.

Odora-Hoppers, C. A. (2002). *Towards a conceptual and indigenous and the integration of knowledge systems: The methodological framework*. New Africa Books.

Odora-Hoppers, C. A. (2005). Culture, indigenous knowledge and development: the role of the university. *Johannesburg: Centre for Education Policy Development (CEPD), Occasional Paper Number* 5, 1-50.

Ogawa, M. (1995). Science education in a multiscience perspectives. *Science Education, 79*(5), 583–593. https://doi.org/10.1002/sce.3730790507.

Ogunniyi, M. B. (2011). The context of training teachers to implement a socially relevant science education in Africa. *African Journal of Research in Mathematics, Science and Technology Education, 15*(3), 98–121. https://doi.org/10.1080/10288457.2011.10740721.

Ogunniyi, M. B. (2013). Integrating science with indigenous knowledge: the African experience. In *Proceedings of the fourth international conference of the science and indigenous knowledge systems* (pp. 11–23). University of the Western Cape. 29–31 October 2013.

Ogunniyi, M. B., Jegede, O. J., Ogawa, M., Yandila, C. D., & Olandele, F. K. (1995). Nature of worldview presuppositions among science teachers in Botswana, Indonesia, Japan, Nigeria, and the Phillipines. *Journal of Research in Science Teaching, 32*(8), 817–831. https://doi.org/10.1080/1120-095-9011.

Pedzisai, C. (2013). Teachers' perceptions on inclusion of agricultural indigenous knowledge systems in crop production: A case study of Zimbabwe's ordinary level agriculture syllabus (5035). *Journal of Biology, Agriculture and Healthcare, 3*(16), 37–43. https://doi.org/10.2225-093X-013.

Quigley, C. (2011). Pushing the boundaries of cultural congruence pedagogy in science education towards a third space. *Cultural Studies of Science Education, 6*, 549–557. https://doi.org/10.1007/s11422-022-011-9335-5.

Shizha, E. (2006). Legitimizing indigenous knowledge in Zimbabwe: A theoretical analysis of postcolonial school knowledge and its colonial legacy. *Youth and Children's Studies, 2*, 20–35. https://doi.org/10.20355/C5RP4J.

Shizha, E. (2009). Chara chimwe hachitswanyi inda: Indigenizing science education in Zimbabwe. In D. Kappor & S. Jordan (Eds.), *Education, participatory action research and social change: International perspectives* (pp. 139–153). Palgrave MacMillan.

Shizha, E. (2013). Reclaiming our indigenous voices: The problem with post colonial SubSaharan African school curriculum. *Journal of Indigenous Social Development, 2*(1), 1–18. https://doi.org/10.2164-9170-013.

Shumba, O. (2015). Can we achieve pedagogical transformation, quality and relevance in science education with the 'learning as-a-connector' principle. In: *A paper presented at the research degrees weekend schools, at the University of Witwatersrand, Johannesburg, School of Educati*on, 13–14 March 2015.

Shumba, O., & Kampamba, R. (2017). Learning as connection: Pedagogical innovations to support ESD learning process in science teacher education settings. In H. Lotz-Sisitka, O. Shumba, J. Lupele, & D. Wilnot (Eds.), *Schooling for sustainable development in Africa: Schooling for sustainable development* (Vol. 8, pp. 188–203). Springer.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

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