Fall 2007

Critical Analysis of Problems Encountered in Incorporating Indigenous Knowledge in Science Teaching by Primary School Teachers in Zimbabwe

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The Alberta Journal of Educational Research *Vol. 53, No. 3, Fall 2007, 302-319*

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In Zimbabwe the need to incorporate indigenous knowledge in science education to reflect local cultural settings cannot be overemphasized. Current policies on science are situated in Western cultural definitions, thus marginalizing indigenous knowledge, which is misconceived as irrational and illogical. This study used qualitative research methods. Ten teachers were purposively selected and interviewed to gain their insights into problems faced in incorporating indigenous knowledge into science teaching. The study found that the problems were attitudinal, institutional, and systemic. Teachers were found to be conservative "gatekeepers" who exhibited negative attitudes toward indigenous science and supported maintaining the teaching of Western science. The study suggests reforming and transforming science curriculum, policymaking, and teacher education to promote cross-cultural science in Zimbabwean primary schools.

Il est impossible d'exagérer le besoin, au Zimbabwe, d'intégrer des connaissances autochtones dans le programme d'études en sciences afin de refléter le milieu culturel local. Les politiques en vigueur relatives aux sciences se situent dans une optique culturelle occidentale, ce qui marginalise les connaissances autochtones, considérées comme étant irrationnelles et illogiques. Cette étude s'appuie sur des méthodes de recherche qualitatives. Dix enseignants ont été retenus par échantillons au jugé pour passer des entrevues portant sur leurs perspectives des problèmes liés à l'intégration des connaissances autochtones dans l'enseignement des sciences. Les résultats indiquent que les problèmes sont de nature attitudinale, institutionnelle et systémique. Les enseignants sont des 'portiers' conservateurs dont les attitudes négatives face aux connaissances scientifiques autochtones maintiennent en place les programmes d'études basés sur les sciences de l'Occident. Nous proposons des réformes relatives aux programmes d'études en sciences, à l'élaboration des politiques et à la formation des enseignants de sorte à promouvoir un enseignement transculturel des sciences au primaire au Zimbabwe.

Introduction

Every child has a right to education and to a system of education that values the child's culture, language, and community and access to schooling and participation without discrimination or hindrance (UNICEF, 2004). The legal systems and cultural traditions that guarantee these rights are articulated in the 1989 Convention on the Rights of the Child. In the Convention are a universally agreed set of non-negotiable standards and obligations that children everywhere have basic human rights: the right to survival; to develop to the fullest; to protection from harmful influences, abuse, and exploitation; and to

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participate fully in family, cultural, and social life without discrimination (UNICEF). Every right spelled out in the Convention is inherent to the human dignity and harmonious development of every child. States that are party to the Convention are obliged to develop and undertake all actions and policies in the light of the best interests of the child.

The rights of children to education in cultural contexts familiar to them are also found in the conventions on the Rights of Indigenous People and preservation of Indigenous Knowledge (United Nations, 2005). Indigenous knowledge systems are gaining significant global prominence as exemplified by the United Nation's declaration of The International Decade of the World's Indigenous People (1995-2004) the objective of which was to strengthen international cooperation and search for solutions to problems faced by indigenous people in human rights, the environment, development, education, and health. UNESCO and the World Bank acknowledge the complementary role of indigenous science knowledge and modern science in sustainable development, community empowerment, and poverty reduction (Gorjestani, 2000; UNESCO, 1999). Numerous international conferences such as the 1992 Earth Summit in Rio de Janeiro, Brazil have recognized the importance of indigenous ecological knowledge systems in environmental protection and care. World-wide research centers (e.g., Centre for World Indigenous Knowledge and Research, Athabasca University, Canada; African Resource Center for Indigenous Knowledge, Nigeria; Bangladesh Resource Centre for Indigenous Knowledge; Brazilian Resource Centre for Indigenous Knowledge; Centre for Indigenous Knowledge for Agriculture and Rural Development, United States) have been established to document this rich store of knowledge. In Africa studies that focus on indigenous knowledge and education are growing, as attested at the SCECSAL conference of 2002, which was fully dedicated to indigenous knowledge research.

The battle by indigenous communities to achieve empowerment and self-determination through the preservation, protection, and revitalization of their cultures eroded by colonization, Western culture, and more recently by globalization has experienced a renaissance as indigenous communities have recognized the importance of documenting and sharing their cultural heritage (Hunter, 2002). Recent events and studies indicate that indigenous knowledge has been recognized as a valuable science that deserves recognition in the school science curriculum. Some indigenous writers have argued the importance and relevance of connecting school science to the students' cultural background (Cajete, 1995; Kawagley, 1995; Kawagley & Barnhardt, 1999) in order to improve indigenous students' learning through appropriate culturally based pedagogical approaches and models (Bishop & Glynn, 1994; Ladson-Billings, 1995). Students' participation takes on a special dimension in the area of education when indigenous knowledge is made visible in science education. It brings students' school experiences closer to their home lives and gives them the opportunity to develop their talents and abilities to full potential, gain confidence and self-esteem, use their initiative and creativity, gain life skills and make informed decisions, and to understand and experience pluralism and democratic coexistence (UNICEF, 2004).

Defining Indigenous Knowledge

Indigenous knowledge is shared knowledge, skills, and attitudes belonging to a community arising from personal and community experiences (Ocholla & Onyancha, 2005). It is the local knowledge that is unique to a given culture or society, but continually influenced by internal creativity and contact with external systems. According to Nakashima (2000),

> Indigenous or local knowledge refers to a complete body of knowledge, know-how and practices maintained and developed by peoples, generally in rural areas, who have extended histories of interaction with the natural environment. These sets of understandings, interpretations and meanings are part of a cultural complex that encompasses language, naming and classification systems, practices for using resources, ritual, spirituality and world view. It provides the basis for local-level decision-making about many fundamental aspects of day-to-day life; for example hunting, fishing, gathering, agriculture and husbandry; food production; water; health; and adaptation to environmental and social change. (p. 433)

A closer look at definitions of indigenous knowledge reveals that it is locally bound and indigenous to a specific area; situational, tacit, culture- and context-specific; intangible and nonformal knowledge; orally transmitted from generation to generation, and generally not documented; dynamic and adaptive; holistic in nature; and closely related to survival and subsistence for indigenous people around the world. Indigenous knowledge exists in many forms that include literary, performing and artistic works (including music, dance, song, ceremonies, symbols, and designs); spirituality (cosmos, indigenous sites of significance, sacred sites, and burials); languages; scientific, agricultural, technical, and ecological knowledge (including medicines and sustainable use of flora and fauna); cultural property including burial artefacts; and cultural environmental resources (UNESCO World Intellectual Property Organization, 2001). Indigenous management systems involve conservation of biodiversity through a number of practices that embrace the use of a variety of species in agronomy (e.g., domestication of crops), agroforestry (combining food crops and domesticated trees), and agriculture (seed selection and preservation).

Science, Culture, and Traditional Ecological Knowledge (TEK)

It is essential to point out that indigenous knowledge was misunderstood and misrepresented as unscientific by colonial knowledge constructions. The colonial science community challenged the authenticity of indigenous science from a point of ignorance. Indigenous knowledge that is embedded in the customs, habits, rituals, and social institutions of the community was regarded as "ignorant knowledge" (Shizha, 2005, p. 70). For example, the use of traditional herbal medicines (*mishonga*) and traditional healing systems, consultation of traditional healers (*n'anga*), and ancestral spirits (*vadzimu*) were viewed as superstitious and unscientific. However, these cultural practices were the backbone of indigenous people's health system. The perspective of Western science was shaped by the logical empiricism of scientific inquiry requiring objectively verifiable evidence, verifiable sense experience, or verifiable observations in order to support knowledge claims (Baker, 1996; Makhurane, 2000). Thus indigenous science was rejected because it existed outside

the so-called scientific community and lacked "scientism—an ideology that identifies valid knowledge only with [Western] science" (Habermas, 1974, p. 4).

Researchers in science education have held several positions toward the relation between science and culture (Ogawa, 1995). An earlier stance saw traditional culture as a barrier of science teaching (Wilson, 1981). This research has uncovered various kinds of cultural factors such as indigenous world views, language, and educational policies that inhibit effective learning of science. Of concern is how to eliminate negative factors that marginalize indigenous science from science teaching. Western science gives the impression that science is a culture for the privileged, hence a closed culture, which is not open to everybody. Yet Western science is a subculture of science and a subculture of Western culture (Snively & Corsiglia, 2001).

Every society/community, Western or non-Western, has a culture and science that is particular to it. Consequently, Kawagley (1995) and Ogawa (1995) conclude that the culture of Western science is equally foreign to Western and non-Western students. All students have been socialized in a traditional or commonsense cultural understanding of the physical world (Snively & Corsiglia, 2001). Common sense shapes their perceptions in learning school science. Every culture has its own perspective of science that exists in cultural context. There are many ways of understanding and giving meaning to nature. Science is a cultural construct, and there are many "cultural scientific communities" (Ogawa, 1995) that are not exclusive to Western societies. Arguably, the differences between modern science and indigenous science exist not so much in the content, but in the ways of knowing and the interpretative framework that underpins such knowledge.

There is a growing body of literature on the value of TEK throughout the world. In recent years researchers have seriously examined the potential of using this knowledge in conjunction with Western science (Easton, 2004). TEK is a term used to describe the knowledge held by indigenous cultures about their immediate environments and the cultural practices that build on that knowledge. TEK can be defined as

> A cumulative body of knowledge and beliefs, handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment. Further, TEK is an attribute of societies with historical continuity in resource use practices; by and large, these are non-industrial or less technologically advanced societies, many of them indigenous or tribal. (Berkes 1993, p. 3)

Traditional ecological knowledge is vital to ecological restoration and conservation among indigenous people. Its role in environmental restoration and conservation heightens the need to integrate TEK into development projects and processes and collaborate with local people in research and policy decision-making. TEK is grounded in moral, ethical, and spiritual world views (Ford & Martinez, 2000), and it is a common misperception that because of this grounding, TEK is somehow mystical. One of the most difficult tasks in achieving this integration will be to create a framework for research and planning that views science and TEK as complementary—not competing—forms of knowledge (Berkes, 1993).

Evidence indicates that TEK has been implemented successfully in a number of communities in Africa. Easton (2004) reports that farmers in Ghana use their traditional knowledge to enhance agricultural production by effectively using locally selected and retained varieties of seed for improvement of land use, a practice that has existed for centuries. In Southern Africa (Zimbabwe, Zambia, Malawi), conservation and sustainable use of trees and medicinal plants (*mishonga*) has been implemented by preventing logging (Ramphele, 2004). At the center of Shona socioeconomic activities in Zimbabwe is the land, regarded not only as a productive resource, but also as a link between the dead and the living, the present and the past. The land binds the people together. This is why Gelfand (1972), one of the early colonial settlers in Zimbabwe, noted with some admiration the attitude of the Shona people toward their environment and noted,

> Not only must man avoid change, but he must not alter nature more than is necessary for his basic needs … Not a tree may be chopped unless required for firewood. Nor land cleared unless required for cultivation. No one should hunt an animal except for his own family requirements. So strong is this feeling among the Shona that one entering a strange area in a forest, a mountain or a beautiful spot is not allowed to comment on it least he upset the ancestral spirits (*vadzimu*) of this region. (p. 54)

Sustainable environment management has been practiced in Zimbabwe for centuries. The killing of animals was traditionally restricted to male and older animals, and it is an offense to kill female and young ones. The practice ensures sustainable resource use. In Zimbabwe and Namibia the use of cattle manure, kraal, and homestead rotation and selection of indigenous crops (e.g., finger millet) have been used to maintain soil fertility (Sibanda, 1998; Verlinden, Seely, & Hillyer, 2006). In Mali and Zimbabwe the Jatropha Curcas Plant is being grown as an alternative renewable energy (Easton, 2004), thus contributing to environmental conservation. Biodiversity and biotechnology practices in Africa are assisting in ecological protection and poverty reduction in rural communities. TEK is an important source of information and understanding for anyone who is interested in the natural world and the place of people in the environment and can contribute to an understanding of science in the cultural context in which it is being implemented.

Language and Indigenous Science

The exclusion of indigenous knowledge systems including indigenous languages in schooling in Africa has been viewed as a form of "cognitive imperialism" (Battiste & Henderson, 2000, p. 12). Indigenous thoughts and voices are silenced and dominated by Western cultural symbols such as languages (Shizha, 2005). Therefore, the recovery and restoration of indigenous identities, knowledge, and experiences is strongly linked to the revitalization of indigenous languages (McKinley, 2005). Language is not just a tool for communication, but expresses our cultural view of the world and our existence. It is a vital component for incorporating indigenous science into the school science curriculum. Every indigenous culture has an orientation to learning that is metaphorically represented in its art forms, its way of community life, its language, and its way of understanding itself in relationship to its natural

environment (Cajete, 2000). When indigenous languages are incorporated into the science curriculum, they help students understand scientific principles and link Western science to indigenous ways of knowing, thus sustaining indigenous languages and heritage (McKinley). Indigenous languages are important in facilitating border crossing among students. When students move from their everyday culture into the culture of school science, the move is called *cultural border crossing* (Aikenhead & Jegede, 1999; Giroux, 1992).

The language of instruction in African schools is the major obstacle in students' cognitive development and learning outcomes (Shizha, 2005). However, studies in various countries have shown the positive value of incorporating indigenous languages into science teaching. In New Zealand, McKinley, Stewart, and Richards (2004) found that Maori language was used in teaching science activities such as *hangi* (a form of cooking), *kowhaiwha*i and *taniko* (Maori patterns), *Papatuanuku* (Mother Earth), and names of native plants. Based on a longitudinal study in Nigeria, Bamgbose (1984) concluded that children taught in the home language performed significantly better than those in a control group in all subjects, including English. In a Kenyan study, Cleghorn (1992) discovered that when code-switching into home language was used to foster understanding of key concepts, grade 5 Kenyan students could use the home language (in this case Kikuyu) to write about the contents of a science lesson on water. In another study in Kenya, Bunyi (1999) found that when the use of English dominated in science instruction, students could not apply what they had learned to practical situations at home, thus documenting the subtractive nature of English.

One's language is vital to understanding the cultural reality that surrounds one's life (Shizha, 2005). The studies cited above reveal the importance of using the home language to enhance students' understanding of science and making it meaningful to their realities. However, a problem arises when teachers use indigenous languages as an additive while using a foreign language to express the world view of indigenous students. When the technical and utilitarian approach to indigenous knowledge systems, that is, using cultural contexts to teach science in a foreign language (English, French, Spanish, or Portuguese) is applied, "language and culture are alienated, remaining in a dialectical relationship" (Aoki, 2005, p. 237). The effect is that of drawing cultural knowledge at the expense of indigenous languages, and the use of indigenous knowledge becomes symbolic and rhetoric, and indigenous culture is "deontologized—it becomes an object, an artefact" (McKinley, 2005, p. 233) instead of becoming a subject.

Studies on cultural beliefs and science in Africa conclude that the teaching and learning of science in school is not successful because the subject is not linked to everyday life experiences and the language of instruction alienates students (Clark & Ramahlape, 1999; Dlodlo, 1999; Dzama & Osborne, 1999; Shumba, 1999). In a study conducted in South Africa, Clark and Ramahlape found that students underachieved in science because the subject was stereotypically presented in conventional textbooks as a fixed body of knowledge and as absolute truth, and science teaching is dominated by English as the medium of instruction. Science education in Africa can be transformed by counter-inventing the language of instruction that presently lacks Africanness

and African rationality. The usual justification for the use of foreign languages such as English in teaching science in Zimbabwe is that indigenous languages lack scientific terms (Dlodlo). To overcome this "problem" Dei (2002) suggests the use of both languages (Western and indigenous languages), which he describes as "language integration" and "an educational inclusive practice" (p. 175). A student whose mother language has not been used in scientific discourse has added difficulties of cognition and understanding. Students must undertake dual translation to make sense of what they learn; they have to translate what is taught in a Western language to their indigenous language and then retranslate to the Western language to communicate ideas to the teacher (Shizha, 2005). The fact that science in Africa is not taught in an African language seems to imply that Africans have no science, a misrepresentation of what science is given that it is a social and cultural construction (Dlodlo).

Schooling as a Colonial Legacy in Zimbabwe

In Zimbabwe schooling is largely a legacy of British elitist colonial hegemony that promotes an alienating world view. Hegemony occurs "when an already dominant social group, like educational and other professionals, establishes the authority of its ideas and processes with other groups and thereby gains popular acceptance, even support" (Leach, Neutze, & Zepke, 2001, p. 294). For example, teachers in Zimbabwe hold the view that they are purveyors of universally true knowledge. However, the central role assigned to teachers in knowledge dissemination entrenches a false consciousness in the objectivity, validity, and reliability of the teacher as the source of scientific knowledge. Accordingly, hegemony negates views that emphasize difference and diversity and the notion that knowledge is subjectively and socially constructed. The schooling system inherited from former colonial powers, therefore, marginalizes the local people's world view and everyday life experiences. What is defined as scientific knowledge is largely embedded in the Anglo-Saxon sociocultural reality.

The prevailing teaching and learning styles in Zimbabwe alienate both teachers and students from the process of knowledge acquisition. Western meanings of science oppress students who are from non-Western backgrounds (Jegede, 2000), causing cultural alienation and symbolic violence, the unintentional devaluing of a learner's cultural beliefs and values (Bourdieu, 1973; Tobin, 1996). Cultural alienation occurs when schooling seeks to replace traditional, indigenous culture instead of blending with it or building on it. Although the government of Zimbabwe has taken steps to make schooling relevant to Zimbabwe, the colonial world view still persists in pedagogical practices and scientific knowledge constructs. Knowledge constructs and pedagogical practices used in colonial educational system are deeply embedded in science curricula and are reproduced by the Zimbabwean education system. Integrating indigenous science and Western modern science liberates students and teachers from cultural alienation.

Johnson (1990) observes that despite great strides in quantitative improvement in access to formal education in the 1980s, schooling in Zimbabwe remains locked into a pre-independence mode. In the classroom the colonially defined power differential between the teacher and the student persists and remains largely in place. Teachers continue to depend on their authority and

strict discipline to put across a narrowly defined and largely alien science world view. Teachers' practices have remained embedded in the colonial world view, which largely contradicts both teachers' and students' personal, social, and cultural realities. For example, in Zimbabwe teachers discourage students in rural areas from chewing fiber from a tree known as *mugang'acha* because the teachers believe it is a valueless and unhygienic habit. However, the fiber cleans and strengthens teeth, and the sap is sweet and nutritious and treats stomach pain. Its nutritional and medicinal significance is valued in the Shona culture. The teacher in Zimbabwe is "just another brick in the wall" that serves to encourage passivity and social conformity rather than create spaces and voices for students (Johnson). Teachers devalue indigenous experiences, ways of knowing, and understanding, and in the process prevent students from experiencing culturally inclusive and relevant science. Science is a cultural knowledge vital for people to adapt to the natural environment (Snively & Corsiglia, 2001). The solutions to health used by indigenous Zimbabweans may be different from those of Western science, but they are by no means inferior.

Students in Zimbabwe and the rest of Africa need more locally constructed and applicable knowledge that mirrors their social and cultural consciousness than is the case now. They need empowerment through knowledge that is relevant to their social and cultural realities: knowledge that they can easily identify with and can make use of to develop themselves and their communities. The teacher in Zimbabwe should guide students in crossing smoothly the barriers that separate Western science from indigenous knowledge. Cultural border-crossing involves flexibility, playfulness, and a feeling of ease, without mystifying Western science or mythicizing indigenous knowledge (Aikenhead & Jegede, 1999). There should be a relationship between school science and what happens in children's homes for border-crossing to be successful. For example, in Zimbabwe vegetables are boiled during preparation for meals, and usually they boil until they lose their green color (chlorophyll). Suppose a Zimbabwean student is studying photosynthesis in school and comes across terms such as *chlorophyll*, *denaturing*, and *chloroplast*. To reduce the possibility of having problems comprehending these concepts, school science can be made interesting and vivid by bringing the kitchen into the classroom or asking students to observe the mother cooking vegetables at home. A teacher who is a good cultural broker will use situational learning in home-school settings (Aikenhead & Jegede, 1999). Learning school science requires students to cross boundaries between the cultural context of their home, family, and community and the cultural context of Western science (Snively & Corsiglia, 2001).

The government of Zimbabwe is aware of the historical framework in which science and school knowledge in general is situated. Machinga (2000) points out that the post-independence Education Act of 1987 was designed to create a new democratic society in which an egalitarian education system would serve the educational needs of all communities and ethnic groups and extend the right to education to all children. The Presidential Commission of Enquiry into Education and Training of 1998 states that one of the goals of education in Zimbabwe should be to promote local cultural values and norms

through the teaching and learning of appropriate humanities and indigenous knowledge (Government of Zimbabwe, 1998). Although the government seems to appreciate the need for learning to be culturally relevant, it is silent on how this should be put into practice. However, among the major challenges for schooling in Zimbabwe is the need to design a holistic education guided by indigenous philosophy of *unhu* (respect) (Makuwaza, 1996) that promotes cultural values (Chombo, 2000; Machinga). Education in Zimbabwe should shift from the prevalent and pervasive influence of foreign cultures and needs measures to strengthen the bases of local knowledge (Chombo). One of the challenges facing schooling in Zimbabwe is to undertake a change in orientation in order to achieve culturally appropriate science and technologies and increase the participation of previously disadvantaged social groups in science and technology (Makhurane, 2000). The relevance and meaning of science are the challenges that teachers face every day in their classes as they try to make sense of their teaching. In most science classrooms around the globe, Zimbabwe included, Western modern science has been taught at the expense of indigenous knowledge. In this article I argue that Western or modern science is just one of many sciences that need to be addressed in the science classroom.

Methodology

The purpose of this qualitative study was to obtain rural primary school teachers' insights into problems encountered in incorporating indigenous knowledge into the science curriculum in Zimbabwe. It was concerned with teachers' constructions, interpretations, and attempts at legitimizing indigenous science in their classrooms. Purposive sampling (Lincoln & Guba, 1985) was employed to select the 10 primary school teachers who took part in this study. The sample size (n=10) might appear small, but this is typical of qualitative studies. Sample size in qualitative research is typically small, and what determines the sample size is the purpose of the study (Wiersma, 2000). In this study I was not aiming for representativeness and generalizability (Denzin, 1989), but to get thick descriptions of teachers' experiences in incorporating indigenous knowledge into teaching science. All participants were full-time and fully qualified primary school teachers holding a teacher's certificate obtained from a teachers' college in Zimbabwe, except in one case in which a student teacher had replaced a teacher who was ill. The student teacher was in the second year of teaching practice. The teachers had varying teaching experience, ranging from one year to 30 years or more. The assumption was that teaching experience and the period when the teachers were trained might have an influence on their pedagogical practices. Semistructured interviews were conducted to obtain teachers' insights (Morse, 1994).

Findings

Problems are encountered in effectively incorporating indigenous knowledge in science primary schools teaching in Zimbabwe. The study found that some of the obstacles were associated with and embedded in the attitudes of teachers, whereas others had to do with institutional demands, as well as the subtle aims of education as perceived by educational administrators, teachers, students, and parents.

Teachers' Attitudes Toward Indigenous Science

In order to address both overt and hidden biases against indigenous knowledge in schools, teachers must first address their own personal attitudes. Because they are strong role models for children, they must be particularly aware of their underlying preconceptions of indigenous science. To successfully implement a multicultural science curriculum, teachers need to recognize their own biases, be free of cultural biases, and be schooled in cultural awareness. Bias was detected when teachers were asked how they incorporated indigenous knowledge, culture, traditional beliefs, and customs into their science lessons:

> What we are teaching is Western science [laughs]. Traditional science has no place in our curriculum in the teaching of science [laughs again]. Beliefs and customs do not have a place in teaching science, but in other subjects like religious and moral education, and social studies, but in science, no [shaking his head]. Traditional knowledge is important only at home. When teaching science traditional beliefs have to be corrected. We need to correct such beliefs in pupils because here we are trying to explain causes of things. (grade 7 teacher)

> Ah … indigenous knowledge usually has old values, which they carry for generations and hence you find that the experiences that the children have are usually the old information that they are taught by their elders. That information won't work, because you know, everything is developing. With IT (Information Technology) and everything, you can't always rely on the old methods of living. You have to improve because their parents are the only ones who can only use those old methods of living. (grade 5 teacher)

These teachers totally dismissed incorporating indigenous science in school programs. For them social knowledge or cultural knowledge had no place in the teaching of science. School science and indigenous knowledge were polarized dichotomies defined and perceived in their dual context of modernity and traditional. The teachers who equated school science with Western science were cynical about indigenous knowledge. The concept of science and the treatment of science expressed by these teachers are based on drawing a contrast between a "dynamic modern science" and a "static, traditional one," that is, between a "rational" West and a "mythical" Africa whose cultural forms should be "corrected" or "civilized." These teachers portrayed science as a hierarchical structure, with Western science being superior to indigenous science. Western science was accorded a higher status than indigenous knowledge.

Teachers' Attitudes Toward Using an Indigenous Language

Some teachers in my study undervalued the effectiveness of indigenous knowledge in developing techno-scientific skills applicable to scientific principles that can lead to sustainable use of indigenous resources in rural development. In their view, given the globalization and internationalization of English and Western science, indigenous knowledge was retrogressive. Some of them had this to say.

> Hmmm … of course I use some Shona [an indigenous language] and a bit of indigenous knowledge, in my teaching of science but I do not agree with using

> Shona only in teaching science. English and science are found everywhere in the world, so if I teach science in Shona it will not help students who would like to work in other countries in future. Today people are migrating to different countries, and if I teach indigenous science or Western science in Shona, how will they fit in those countries. (grade 5 teacher)

> Western science taught in English … is okay. It's a common science and English is a common language. Pupils need to express themselves proficiently in English because English is an international language and is also our official language. Science exists across nations and pupils are likely to become scientists so they should learn to express themselves adequately in English using the language appropriate to science. (grade 6 teacher)

> Indigenous knowledge and languages are not totally acceptable in the teaching and learning of science. Where are the indigenous materials, such as books, written in indigenous languages? There is a possibility that using indigenous languages to teach science faces problems. The main problem is lack of scientific terms in indigenous languages. It would be difficult for teachers to teach without recourse to an adequate resource of scientific and technical words to use to express the meanings correctly. (grade 7 teacher)

Teachers who provided the above narratives were concerned largely with meeting international recognition through the use of English in science. For them English and Western science are inseparable; English is the language of science. The rationale for opting for English and Western science was that they have been globalized, and students are likely to become global citizens. The globalization of science and English has meant, in effect, a negation of local science, knowledge, and languages. As revealed in the teachers' attitudes, their students were being schooled for the global labor force rather than for local needs. Indigenous science and languages are judged as irrelevant to the understanding of "modern" scientific values and skills that are practiced internationally. This form of learning lacks African moral values considered essential to the welfare of society (Mungazi, 1996). When children use a language they make little sense of and struggle to be heard and understood, learning becomes a battle and a boring engagement. Students who cannot use English competently are likely to perceive the classroom as "an isolation unit" as they find themselves isolated from the learning situations and experiences. If language becomes a barrier to self-expression and building self-confidence in the classroom, how will students acquire the appropriate knowledge, attitudes, and skills to lead their communities toward sustainable development?

Science, Examinations, and the Language Policy

The Education Act of 1987, which classifies English as one of the official languages and also as the medium of instruction in schools in Zimbabwe, creates another obstacle to incorporating indigenous knowledge in teaching science. English has been positioned on a higher language pedestal than all indigenous languages. This has given it official importance that is not accorded to any other language. Teachers said the following about being forced by this Act and administrative officials to use English in teaching science.

> It is our administrators who encourage us and stress that we should use English as a means of communication when teaching science. They state that we should note that policy requires that all teaching in science should be

> taught in English. But when it's vital you have to put in some Shona words to try to simplify what could be difficult for them. (grade 4 teacher)
>
> According to policy, we usually use English. The government policy is that all subjects, excluding indigenous language subjects, should be taught in English. There are times when you can try to explain in Shona when you want to clarify things for children to understand, but we use English as required by the Ministry of Education. (grade 5 teacher)

The schooling system in Zimbabwe is geared toward students passing national examinations that are vital before they proceed to the next level of formal education. At the end of primary education, in grade 7, students write examinations. The school head proudly referred me to the chart on the wall in his office, which showed the *excellent* examination performance of the grade 7 classes every year. So teachers and the head were concerned more with the passing rate for their classes and the school than with integrating indigenous knowledge and ways of knowing in the teaching and learning of science. They capitulated to the pressure for good results from the school administrators, parents, and the Ministry of Education and Culture. The pressure works against the effective use of indigenous languages and the incorporation of indigenous knowledge into the science curriculum. Thus at every grade level students were being prepared for examinations, both in terms of content and the appropriate language to use as expressed by a grade 6 teacher who said,

> Examinations won't have indigenous science or knowledge when they come. They test what is set in the syllabus and is in textbooks. Whatever is outside the syllabus will not be tested. So what is the point of teaching indigenous science if the examiners ignore it?

The importance with which examinations are viewed makes teachers stick to what is considered factual information: what is going to be tested at the end of the primary school education level. Examinations did not test indigenous knowledge or indigenous ways of knowing, although school science was not much different from science that is applied in local communities. The differences were found in ways of expressing the knowledge and means of verifying this scientific knowledge. As a result, teachers made little reference to the local indigenous knowledge in their teaching. When I observed them teach, I did not hear much of the student's voice. The lessons were primarily question-and-answer sessions that were intended to reveal how much the students had internalized the "factual" knowledge that was presented by the teacher. Science teaching in these classes ignored what Edwards and Alldred (2000) describe as the socially patterned experiences and the social processes that are concretely lived and negotiated. Some of the lived experiences may not have appeared in the science syllabus or in examination questions, but they were vital in assisting and enhancing students' understanding of school science. Learning is not only about passing examinations, but also about helping students to make sense of their physical, social, and spiritual world. In other words, it is about improving their lives.

Material Resources and Problems of Incorporating Indigenous Knowledge

Closely related to the question of examinations was the issue of teaching and learning materials, especially textbooks, which are used by teachers and stu-

dents as the key source of scientific knowledge in school. Textbooks validate knowledge and define and determine what is to be learned and how it is to be learned. Teachers felt confident of and comfortable with their teaching when they had textbooks to which they could refer for information. All the teachers in this study had textbooks, either on their tables or in their hands, to which they continually referred during the course of their teaching. The practice seemed to have developed into an unconscious one, because when I asked one grade 5 teacher why she kept a textbook in her hand during the lesson, she was surprised and responded,

> Ahh! Did I? I am not aware of that. Maybe after writing the work I wanted pupils to focus on I forgot to put it back on the table. But at times you need the textbook to make sure that you are covering all the work for that day. The textbook acts like a guide.

A grade 7 teacher kept referring to the text out of a concern to teach students accurate information. Accuracy, according to this view, is what is stated in the textbook. What is in the textbook is accurate, factual, and truthful. Thus the textbook gives fixed "truth," and the teacher has to be careful that children are not misinformed from the start.

> Well, I refer to the textbook when I am not very sure of the information I am explaining to the pupils. You don't want to give the wrong information. It is not easy to reteach what you have made pupils to accept and believe to be the right information. So I have to be accurate the first time.

Resources such as textbooks are a hindrance to successful integration of indigenous knowledge because they document "facts" and "truths." Teachers rely on documented information and accept it as legitimate knowledge. They tended to focus on what was already prescribed as scientific knowledge. The assumption was that children had to be guided toward what the teachers had gleaned from books as knowledge worth learning. As a result of this assumption, usually teachers did not deviate from what was presented as knowledge in textbooks. Students' agency was ignored; they were not taken as social actors capable of initiating and creating knowledge. The stories and experiences that they brought from home and their communities to the learning situation were overshadowed by the need to fulfill the demands of the syllabus leading to the passing of examinations. As Dei (2000) argues, people's ways of thinking and knowing are rooted in their indigenous lives, and what is required in African schools is a fusion of various forms of knowledge.

Science and Teacher Training

The methods employed and attitudes that teachers hold toward the teaching of science derive partly from their preservice training at teachers' colleges. It would appear from the comments of teachers in this study that teacher preparation and courses taken in teachers' colleges do not incorporate indigenous knowledge in science curriculum and pedagogical practices. A student teacher in one of the grade 4 classes I visited confirmed that there was no indigenous science in teacher education curriculum. According to the file this student teacher had, the following were stated as the criteria used by the college for selecting science content.

> (i) Wherever facts are presented they should be discoverable by the student.
> (ii) Facts selected should be of critical importance to understanding of a scientific principle.
> (iii) Content should help to show how science proceeds through a method of discovery.
> (iv) It must be cheap to do, cheap to find out, economical in time as well as money.

The criteria set out above indicate a paucity of localization and indigenization in the science that student teachers are taught in colleges in Zimbabwe. Indigenization does not mean a simple return to one's own tradition, but the transformation of traditions as a result of self-critique and conversing with other traditions (Dei, 2000; Wang, 2006). It offers a space with not only a sense of self-understanding and respect for others, but also a necessity to go beyond the locality to enter into co-creative globalness (Wang). In such a process, creativity and co-creativity generated by intercultural, international, and interpersonal transactions are essential to sustaining a healthy Western science-indigenous knowledge dynamic. Unfortunately, the content and expectations of students in teaching science lack indigenous African perspectives. Although most student teachers teach in rural schools after completing their training, it appeared that they were not trained to interpret science in a culturally sensitive manner. Of particular interest in the above statements is how knowledge that was presented in the curriculum to be discovered by students was described as facts. Who defines and how is information defined as facts? The teacher education curriculum seemed to provide no room for relativism of knowledge. Does indigenous knowledge or science fall into the same category as "facts?" And does the curriculum give space for the discovery of indigenous knowledge in relation to school science? As one student teacher on teaching practicum in the school pointed out about teaching methods in teachers' colleges and how lecturers prepare students for incorporation of indigenous knowledge into the science curriculum,

> No, they just talk about the science that is found in books and taught in schools. They just say that you must use the environment as your lab. They say don't teach science in the classroom. You have to go out and teach outside the classroom. But they don't say anything about indigenous knowledge.

It is what happens in the lecture theaters in teachers' colleges that influences to a great extent what will happen in the classroom when student teachers eventually complete their training. To disregard cultural fusion in the science program in teacher education denies teachers the skills and techniques for successfully incorporating indigenous science in formal curriculum. Advising student teachers to use the environment as their classrooms without relating teaching and learning to the social and cultural environments of students undermines any effort aimed at knowledge pluralism and alternative ways of understanding science, including science hybridization. This advice will not help much in making preservice teachers become cultural brokers and cross-cultural teachers. It is the responsibility of teachers' colleges to cultivate a change of attitude in teachers such that they are more favorable toward indigenous knowledge and amenable to relating it to school science.

Conclusion: Processes of Change and Implementation

Findings in this study indicate that much needs to be done to change the attitudes of teachers and policymakers toward indigenous knowledge. Given the importance accorded to indigenous ecological knowledge and knowledge systems, as shown by various conventions and international conferences on sustainable development that embraces the cultural knowledge of indigenous people, the education system and institutions in Zimbabwe should undergo transformation. The systemic and structural hierarchies that legitimize and validate knowledge should stop perceiving indigenous knowledge as non-scientific, superstitious, and fatalistic (Snively & Corsiglia, 2001), but recognize it as a science. Teachers and policymakers who prefer Western science to indigenous ecological knowledge fail to recognize that spiritual explanations associated with indigenous science incorporate important ecology, conservation, and sustainable development strategies. Indigenous knowledge and Western science complement each other and are not necessarily oppositional binaries. Complementarities can be enhanced if, for example, centers for indigenous knowledge and science (CIKS) are established in science faculties in universities in Zimbabwe to assist not only teachers, but anyone interested in elevating indigenous science in schools and in sustainable community development. Bringing the two sciences together is likely to reduce the power struggle between them and give full recognition to indigenous knowledge as an epistemology of science.

Educational policies designed and planned by government play a significant role in validating knowledge. Educational policymakers in Zimbabwe are a product of colonial education and Western universities, hence their predisposition toward Western science. To place indigenous knowledge in educational corridors, we need policymakers and curriculum planners who are conscious of the vitality of blending or creating a hybrid of indigenous knowledge and Western science and transforming pedagogies that help students examine important values, assumptions, and information embedded in other cultural perspectives (Aikenhead, 1996). Hybridization has the potential to reduce or deconstruct old prejudices and foster positive attitudes to the multidimensional and multiperspectival cultural world of science. It has the potential to give both teachers and students an enriched understanding of science and its role in promoting sustainable communities and environments through valuing indigenous health practices, environmental protection, and cultivating medicinal herbs, among other benefits.

The Government of Zimbabwe should incorporate policy dialogue in developing an inclusive science curriculum that is meaningful to Zimbabwe's social, cultural, and economic needs. Such a dialogue, which should include community leaders, teachers' associations, and curriculum developers, colleges of education, universities, and civic organizations, should be the cornerstone for a cross-cultural science education. A key element in educational reform is to increase parental involvement in the education of their children. The home and community environment are significant contributors to student success in learning science and in developing positive attitudes toward science. The home functions as the most salient starting point for the out-of-school learning experience for science. Out-of-school science experi-

ences amplify or diminish the school's effect on the learning of formal school science. A planned program for parental involvement is essential if all schools are to succeed in indigenizing science in primary schools in Zimbabwe.

A cross-cultural or multicultural perspective to science education is more meaningful if students have access to the science knowledge in a familiar language. Indigenous students are more likely to grasp scientific principles and skills if the language of instruction makes sense to them. Academics and teachers usually promote hierarchies of knowledge that give power and domination to one form of knowledge and disempower and marginalize the *others* (Shiva, 1997). The mythology of school science (Smolicz & Nunam, 1975, in Snively & Corsiglia, 2001) that true knowledge that can be taught only in a scientific language (English, French, Portuguese, or Spanish) is likely to compel schools to practice "cognitive apartheid" (Cobern, 1996). So teachers should be trained as change agents and cultural brokers who are open to new methodologies and pedagogies of science teaching. Teacher training colleges need to transform and revitalize their curriculum and pedagogical practices. Change in teachers' attitudes can be fostered through education programs that focus on *conscientizating* teachers to advance cross-cultural principles in science teaching. Through *conscientization*, teachers should be able to have a "different understanding of [their] history and [their] role" in the classroom (Freire, 1985, p. 43). Cultural essentialism (Bhabha, 1990) should be challenged in favor of a postcolonial perspective in which cultural translation and cultural hybridity give birth to "something different, something new and unrecognizable, a new area of negotiation of meaning and representation" (p. 211).

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