Science education and worldview

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Abstract   Is there a place for Indigenous Knowledge in the science curriculum for a Zulu community in rural Kwa-Zulu Natal, South Africa? This article argues "yes," based on a participative research and development project that discovered relevant science learning in a Zulu community. Among community concerns for relevant factual and performative knowledge, we found that culture and worldview are critical to community identity, to visioning educational outcomes, and to learning in school science. Cultural practices may contribute to pedagogy and curriculum; curriculum, in turn, may affirm cultural practices. Further, worldview needs to be understood as an aspect of knowledge creation. By understanding key aspects of an African worldview, science educators can contribute to both meaningful science education and community well-being. By fostering culture and worldview, a rural community can make a unique contribution to science education.

Keywords   Worldview · Indigenous knowledge · Rural education · Science education · Community-centered curriculum

> We need to return to our roots – to cultivate the land –
> everything comes from the earth. (Elder, September 2002, C30c[1])

Introduction

South Africa's *Curriculum 2005* prescribes Indigenous Knowledge (IK) for inclusion in schools. It allows for the development of localized content and the accommodation of different ways of learning (Department of Education 2003). What this might mean, however, for teachers, teacher trainers, and communities, is not at all clear. Dekkers (2005)

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[1] Reference refers to data coding system in Keane (2006).

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poses the following questions about Indigenous Knowledge (IK) in science education: Where can teachers find this IK-for-learners? How does school science relate to it? What does integration of both look like (as opposed to teaching first one, then the other)?

South Africa's National Research Foundation formed a focus group on Indigenous Knowledge Systems and earmarked funding for IK projects. As well, calls for the development and inclusion of IK come from academics. "Education must not be simply an assimilation of Western values, but must also be directed towards the strengthening of indigenous culture" (Mboya 1999, p. ix). Furthermore, by drawing on IK one could help solve practical problems especially in relation to the environment (Ortiz 1999). A focus on relevant school science includes this practical aspect. Even more, the inclusion of IK in the science curriculum extends the meaning of practical to include an enhancement of self-esteem and social identity.

In a country still going through dramatic transformation, it is critical to seek ways to value marginalized epistemologies and identities for the sake of human rights, democracy, and reshaping education. South Africa may have an important contribution to make on a global level in resolving tensions between IK and science education in rural schools. These schools are in a particularly strong position for exploring IK. Rural communities have ways of knowing and being that could contribute to enriching science education.

In this article I draw on data from a participative research and development project in which school science attempted to contribute to both knowledge and economic development in a rural community. This research focused on exploring features of a relevant science education for two schools and their community. The expression and influence of Zulu traditional knowledge (or IK) would, I felt sure, form part of the context and outcomes of this curriculum development project. Indigenous Knowledge, I anticipated, would contribute not only to immediate school interventions, but to pedagogical understandings and curriculum policy. A remote rural community could potentially offer knowledge on traditional medicine, farming practices, local animals, plants, etc. All of this could be crafted into the school science curriculum, if the community felt it appropriate.

I draw upon this project's data to consider the following:

- What are the community's hopes and purposes for the exploration of IK?
- What IK is present and what knowledge is appropriate for inclusion in curricula?
- Who decides which knowledge is explored, exposed, developed, and taught in schools? Is this determined by policy, history, community needs, the school teachers, and/or the community elders?
- Why choose particular knowledge? What would the criteria be for practical use, identity affirmation, and/or holistic development?

I argue that an underlying worldview of a rural community needs to contribute to and inform our teaching and curriculum design.

Why focus on Indigenous Knowledge and worldview?

> Foremost among the challenges facing rural South Africa is the task of improving the quality of education. What is often overlooked, however, is the immense, untapped potential of rural communities to take the lead in shaping a better future for themselves. (Nelson Mandela, quoted in HSRC 2005, p. vii)

Research into including IK in school science curricula leads to a number of potential outcomes, for instance, it can contribute to educational relevance and to redressing past

colonizing hegemony. There are also sound pedagogical reasons for considering IK in the science curriculum, as community beliefs and student cultural identity contribute to learning (Lemke 2001). During the process of knowledge creation, the worldview of a community causes people to value and validate some knowledge above others (Cobern 1996). In rural South African schools, this validation becomes distorted through the imposition of a Eurocentric science curriculum. By including IK in school science, Zulu children would be advantaged by the inclusion of their cultural heritage rather than disadvantaged by the deficit model of learning, currently in use.

Attempts to include IK in textbooks usually consist of traditional "bits that fit" into the current syllabus (i.e., only fragments of IK). This is a gross oversimplification of IK preservation, and it demonstrates our Western science hubris. IK is not just about "woven baskets" and "traditional dances per se" (Dah-Lokonon 1997, in Odora Hoppers 2002, p. 9). This is not to say, however, that local examples are not fitting. Malcolm (2002, p. 26) points out that even within a social-constructivist framework "these approaches are designed to lead students to particular (predetermined) explanations." While there may be some merit in using examples of traditional practices in teaching Western science concepts, the inquiry into IK in science education needs to go deeper than this.

This research project attempted to discover illustrative aspects of relevance, that is, local examples to teach both prescribed science concepts and community IK. Anticipated examples were traditional farming methods, nutrition, and understandings of nature. However, data emerged to indicate that a student's underlying worldview was possibly more essential for students than any "illustrative examples" of Western science. I suggest that even when IK examples are currently included in science curricula, the examples occur within a Western science paradigm.

To bring IK into the science curriculum in a legitimate way means that the students' underlying, pervasive, and often implicit ontologies, need to be explored and accorded respect (Odora Hoppers 2002). Western science's epistemological dualism, materialism, and mechanistic thought have been a source of repression in non-Western cultures (Moodie and Thomas 2002). This repression of IK has contributed to its loss of status and its threatened demise. As a result, African academics and intellectuals are calling for the construction of authentic African knowledge paradigms (e.g., Soudien and Nekwheva 2004).

Odora Hoppers (2002) advocates a "new synthesis that incorporates the existing diversity" (p. xiv). In our exploration of relevant science curricula, aspects of Afrocentric worldviews emerged. These worldviews are not only perspectives formed into a set of beliefs, they are an expression of profound knowledge systems and ontologies that shape and guide perception and thinking. It is also knowledge at this level (foundational presuppositions) that needs to be considered when designing relevant science curricula.

What is Indigenous Knowledge and worldview?

The community elders in this project were interested in preserving traditional values and practices. There were also the deeper ontological aspects of worldview that seemed more indefinable and elusive, but which deeply shaped life in the community more so than explicit knowledge defined in our policy documents. Indigenous Knowledge Systems are described in the South African *Revised Curriculum Statements* as "a body of knowledge embedded in African philosophical thinking and social practices that have evolved over thousands of years" (DOE 2002, p. 9). But even the phrase "body of knowledge" conveys a certain Western stance on knowledge-as-object. A similar starting point is used by

George (1999) in her four categories of cultural knowledge that assumes a Eurocentric backdrop:

Category 1: The cultural knowledge can be explained in Western science terms. For example, the practice of using a mixture of lime juice and salt to remove rust stains from clothes can be explained in conventional science in terms of acid/oxide reactions.

Category 2: A conventional science explanation for the cultural knowledge seems likely but it is not yet available. For example, traditional medicines may have recognized pharmacological properties.

Category 3: A conventional science link can be established but the underlying principles are different. The cultural knowledge states that sugars cause diabetes, whereas Western science claims sugars can worsen the condition.

Category 4: The cultural knowledge cannot be explained in conventional science terms. For example, there is no conventional science explanation for the claim that spells cause lightning.

Although categories 1 and 2 pose little threat to the conventional science curriculum, and are in general acceptable to science teachers, a problem arises when using an entrenched Eurocentric system. Keeping definitions of IK broader (and deeper) than those in curriculum documents may be more helpful.

Semali and Kincheloe (1999, p. 3) define IK as a way for people to "understand themselves," and Nakashima and Roue (2002) define IK as understandings and interpretations that guide interactions with nature. Odora Hoppers (2002) broadens the definition to include recognition of economic, legal, and governance systems. From the start of the research project, I was interested in keeping the concept of IK open, more in line with Ogunniyi's (2002) description of worldview as a thought system that determines to a large extent the habitual way in which an individual copes with experience. There is a blurring between the notions of IK and worldview.

Of course, IK is not one concept, and IK is not always public. This obviously has implications for its appropriate place in curricula. Thus, many aspects of the "way we understand ourselves" are not meant to be teased into categories and definitions by academics. Some IK is private, known only to shamans, elders, or gender groups. I explore neither the broad categories outlined by Odora Hoppers (2002) nor hidden esoteric knowledge, but instead, I focus on the general ways of knowing, more in line with the notion put forward by Nakashima and Roue (2002), described just above.

While IK is often defined as arising from experience, intuition, and revelation, the critical-reflective aspects of it are not always acknowledged. African academics recognize the importance of this. IK is not a fundamentalist position: "African culture has both critical elements, philosophers, poets, prophets and uncritical elements: religion, custom, myths. The critical also needs to be given attention" (Oruka 2002a, p. 121).

Not only are definitions of IK varied, but the nature of IK is dynamic and evolving. Changes to African culture can mean that African beliefs and ways of thinking are strongly shaping the national culture of South Africa. Modernization need not mean Westernization.

For convenience of categorizing data in our project, I offer three types of knowledge: knowledge expressed by the community, knowledge lamented as generally lacking in the community, and knowledge deduced from the data collected from the community during our project. Each category corresponds loosely to one of the three related concepts of IK, culture, and worldview.

1. *IK*. Factual knowledge, such as community histories and understandings of the environment.
2. *Culture*. Performative knowledge and values; including talents usually manifested in cultural practices.
3. *Worldview*. Deep, ontological/philosophical, representational knowledge; foundational presuppositions about reality.

The importance for considering IK in our project was the strong value that the rural community assigns to their traditional knowledge. One of the first questions a student asked in an early meeting was: "What are we going to learn about beliefs? Are we going to learn about our beliefs or the beliefs of other races?" (Girl student. SS3 2002). At the first community meeting, parents and elders expressed a wish that students learn cultural practices and values (C30b 2002). Sihle, a young man who worked with us as a community researcher, said at the end of the project that he now sees the importance of traditional leaders and his cultural heritage.

Summary of project and research method

The study was a participative research and development project in a remote rural area called Chibini, in Kwa-Zulu Natal, South Africa (Keane 2006). The research team was comprised of university-based researchers, led by Prof. Cliff Malcolm, and community-based participants: two young community researchers, teachers, students, parents, *izInduna* (Headmen), *Sangoma*, (traditional healer), *Inkosi* (Chief), Non-Government Organization (NGO) members, and local farmers. The team spent four years exploring relevant science education. All members worked on visions, plans, needs, and concerns, as they focused on historical, social, and economic contexts. Students produced data on their community, on science, and on their worldview, through community-based projects carried out in conjunction with parents and farmers. Our direction was shaped through regular community meetings and our learning was shared with the community.

The community set up a committee (the Mbumba committee) to advise the research process and to manage the chicken-farming project. Community meetings were open. Usually 40–45 community members attended. The Inkosi (Chief), an Education Advisor, an Agricultural Department representative, and funding agencies played a guiding and supportive role throughout the project. In its second year, the farming NGO, Heifer International, joined the project. The choice of participants was a community decision.

The research method was deliberately flexible to allow for community guidance, school availability, and changing circumstances. The project's intervention activities were embedded in classroom assignments. For instance, data creation often emerged from assignments called "learning-through-work." These assignments included: (a) photo essays; (b) written accounts of "living in nature," "personal histories," and "life of the community;" (c) an "inventory of interest" questionnaires; and (d) workshop outcomes from discussing the interests, beliefs, and goals of students, parents, and the community in relation to science and education. The student assignments provided feedback on the development of our community-based curriculum. The assignments culminated in two major events: a "Science Fortnight" staged for a group of 40 secondary students, and a "Science Festival" for the whole community. The Science Festival showcased and synthesized insights from the curriculum interventions and from the research of all

participants. Primary school pupils and their teachers participated, along with the team from the secondary school and members of the community.

Key participants in the curriculum intervention included:

- teachers and about 100 students at Sinevuso Secondary School, Grades 8–11. One teacher was involved in the Science Fortnight and the Science Festival along with a volunteer group of 40 students.
- teachers and students from Lusiba Primary School, mostly a Grade 7 class of 40 students.

Other specific data-collection activities included: collecting base-line information on the school and community through questionnaires and interviews, and evaluating the process of setting up a chicken farming project in conjunction with the NGO Heifer International.

Analysis of data was ongoing, allowing theories to emerge during the research process. New insights, perceptions, and observations were discussed with participants and fed back into the planning and curriculum design process. Research assistants and community friends checked issues of translation between Zulu and English when necessary. Having so many different groups of participants meant that I could compare inputs and observations of students, parents, farmers, teachers, principals, NGO facilitators, leaders, and researchers; partly to obtain "triangulation" but more often to obtain different perspectives.

There is a link between researchers' use of rhetorical conventions and their assumptions about the nature of knowledge. It was fitting, therefore, to mediate this link by the inclusion of other voices, particularly in the presentation of selected data such as quotes, drawings, photos, and the presentation of findings. This process of inclusion provides a richer picture and shows how there are many ways of seeing, experiencing, and interpreting "reality" and research data.

From the start, the community's main concerns were poverty, sickness, and cultural erosion. Heifer International provided new farming initiatives and training. This was then linked to the curriculum. The community's achievements were demonstrated during the Science Festival.

Research method brought together interests in education, in research, and in community development. This paralleled our model for learning science. In this sense, research is science and science is research. For instance, toward the end of the project students said: "Science is everywhere." "Now we believe there is HIV/AIDS." "Knowledge is available outside school." "We have learned to believe in ourselves … that what we think is important." A teacher stated, "Children will benefit because it is them who chose what they thought would help them."

This study was linked to two other partnership sites that occasionally I draw on for comparison. One was a township in the Western Cape, and the other was in rural Ndwedwe in Kwa-Zulu Natal. All three sites (Chibini, a Western Cape township, and Ndwedwe) contributed to the research project entitled "Human Rights, Democracy, and Social Justice." Details on the project and its research method are found in Keane (2006).

Knowledge lost

Our research team's search for IK as prescribed by the South African Education Department policy (i.e., "body of knowledge") proved futile. Even though this definition seemed the most straightforward available, we could find no evidence for the obvious practice or enunciation of a "body of knowledge." Neither the izInduna nor the Sangoma gave us any examples of traditional knowledge when we asked them. I had difficulty eliciting any kind

of knowledge about nature from students. In reference to George's (1999) four categories of cultural knowledge (described above), I found little knowledge that could be classified that way. We tried various methods: worksheets about farming practices, collecting stories about nature, oral and written questions in both Zulu and English, drawing assignments, and chats while walking informally through the village.

Students' practical everyday knowledge and skills in farming were also weak, according to community members. I was surprised the community wanted students to learn about agriculture. This knowledge erosion in the community perhaps resulted from labor practices imposed on many Black South Africans over decades, practices that still continue in some places. The few community members who have employment typically work as laborers on White-owned farms or for large timber companies. Karl Marx apparently asserted that in capitalism the laborer is severed from his/her knowledge, will, and judgment—a body part of a distant brain (in Kaomea 2003). This seemed the case here. I was puzzled by the paradox of a rural community asking for help teaching farming skills.

This lack of knowledge by young people seemed to extend to the natural environment. During walks through the village our young companions could not name trees or say what they were used for. Odora Hoppers (2002) warns, "The erosion of a people's knowledge associated with natural resources is under greater threat than the erosion of the natural resources themselves" (p. 7). Twenty-five years ago, this erosion was noticed:

> Today, my own children can neither identify the antelope and the waterbuck nor name them in their own language. They cannot identify a single indigenous tree or shrub with its uses and values to humans. … Africa has changed. (Chief Minister, Enos Mabuza – Wilderness spokesman – 1982. p. 43)

In our second research site, Ndwedwe (also in rural Kwa-Zulu Natal), the Sangoma (traditional healer) who is also on the School Governing Body, said that children should learn about traditional medicine at school. When I asked him if he would be willing to talk at the school, he readily agreed. Interestingly, the Biology teacher voiced reservations. She emphasized that the Sangoma should only mention the "good things and not the bad" (O40a, 8/8/2004), implying some distrust of "magical" processes. Inviting elders and leaders into the classroom was recommended in Kenya (Thomson 2003, p. 90) because "It was Indigenous Knowledge and values that allowed me to have my teaching resources located just outside my classroom door." Kaomea (2003), who has been studying programs that promote cultural practices in Hawaiian schools, cautions that when traditional elders (*kupuna*) are bought in to teach, "They need to be accorded real authority and autonomy. In current programs they are treated as little more than hired hands. Virtually homeless in the schools" (Kaomea 2003, p. 23). Issues of status, validation of knowledge, and identity begin to emerge in the perceptions of what counts as knowledge, and who decides. Not surprisingly, therefore, there were often tensions between the school and community. While the community struggled to remember itself, the school pretended to offer access to a better future. The Chief was clear that both goals were needed. (The Chief's wish for harmony expresses a worldview that I address below in the section "Worldview Concepts.")

Knowledge found

> The great strength of the cultural approach to issues of science and technology is in challenging people to consider how other cultures and groups may have new and different ways of defining the true and the useful. (Hess 1995, p. ix)

Attempts to uncover factual knowledge had been unsuccessful, yet aspects of culture were present; so too was a distinct way of expressing views of the world. I draw distinctions here between performative knowledge and ontology (worldview). In discussing performative knowledge, I consider history, medicine, health, and food.

History

I had not anticipated the importance of historical knowledge in my consideration of relevant school science. One of Africa's foremost intellectuals, Obenga (2004), emphasizes the importance of history: "History is the salt and leaven of human life. History is the repository whence we fetch our reason for living" (p. 606). For the community there was an inherent respect for past ways of living, as well as for community and family histories. It is worth noting this tendency when evaluating changes in community life. Horton (1967) notes, "… 'before' is usually valued positively … and never negatively" (p. 253).

Ironically, the curriculum we were advocating seemed cutting edge to us; yet to the community it was quite in line with their traditional way of learning. Science learning that took place with the farmers, for instance, engaged students in a way that allowed for cultural expression such as dance, stories, songs, and plays. This type of curriculum innovation has a chance of success whereas school-based modernization may be more difficult to achieve. The community was looking back toward traditional learning structures, processes, and content. This may be a notable distinction between Western scientists who have "the future in their bones" (Snow 1959, quoted in Horton 1967, p. 254) and traditional societies who have a natural reverence for past wisdom (Higgs et al. 2003). This is not to say that the community was only backward looking. Students particularly were keen to use computers and to learn global skills that would give them competitive employment opportunities. The attribute of IK being dynamic is evident here. Striving for "progress" was easily accepted.

Students illustrated their appreciation of historical practices in the posters they displayed at the Science Festival. These posters contained praise and appreciation of farming, water, and the environment. They conveyed the importance of cows, goats, chickens, and forests. As well, the posters communicated two closely related ideas: the importance of cultural beliefs and the fact that beliefs change.

For primary school students (grade 7), grandparents had offered careful input to the children's assignments about "life long ago." Although most students managed only 6–8 lines, these were completed with care. Many were true stories with Zulu words untranslatable into English: *ingqwele*, *iphaphu*, *isidwaba*, *ukuhlalu*, and *inxashu*. Many spoke about clothing, food, and cultural practices (SL 20, 10/2003), but (strangely) they did not mention values, beliefs, Christianity, or AIDS. Primary school children's descriptions of life long ago and of cultural practices included two main perceptions:

- Community life was good (e.g., tradition was strong, people were healthy, and they ate traditional food and entertained themselves with cultural games and activities).
- Violence was a periodic scourge (e.g., apartheid caused oppression and displacements, there was tribal fighting, and huts were burnt).

Negative aspects of the past included the political wars in Kwa-Zulu Natal (through the 1980s and early 1990s).

History in rural Kwa-Zulu Natal moves slowly. The lack of modernity in the community is a striking feature for an outsider. Many aspects of daily life mentioned about the past are

still prevalent: herding cows, collecting water, bathing in the river, and cooking over fire. Although the *izInduna* (headmen) mentioned the increase in villagers' wanting to shop rather than being self-sufficient, other obvious changes were not identified. Moreover, the changes that have come about since 1994 (the official end to apartheid) were not mentioned. These significant changes include a free and democratic country, along with its freedoms of expression, association, and movement. Practical changes include the availability of a social worker and the distribution of child grants. Some old political tensions persist, which may be why no credit was given to the new government.

Secondary school students' written assignments about "life long ago" (students were asked to collect stories from grandparents or parents) showed great care and family co-operation, mostly from the help of grandmothers. Their stories also told of life being better in the past. Life is now harder because family land is smaller, the sun is hotter, and the rain comes less frequently. People are now sick with AIDS. "In olden days we had everything we wanted: cows, goats, sheep, and many foods. In old days people were strong" (SS4e 2003).

In another assignment with older students, the history teacher asked them to write an account of a personal, family, or community history. This exercise was a struggle for the students because they seemed unfamiliar with this genre of writing. However, there was evidence of assistance from parents and grandparents in giving information, which suggests that students took this task seriously and that the elders were willing to be involved with these curricular activities. A 17-year-old boy who received information from different people stated, "The past community was rich, had many cattle and horses. People wore cow skins and were healthy. There was no road, no public school, no public phone and no taxis." A 21-year-old girl wrote, "The past community was rich, happy and healthy and ate African food, *isijingi* and *isigwamba.* They had many horses, goats, and cows. I like the past community." Many students said they are proud of their stories and hope many read them. For them, personal and family histories are part of their sense of identity. These assignments were important indicators that students were interested in gathering and valuing information about their community and culture. It is in this context that it seemed feasible to bring an Afrocentric appreciation into the science curriculum.

Medicine

Although medicine is an obvious category of IK upon which to design a curriculum, very little factual knowledge about medicine emerged from either Sangomas (traditional healers) or community members. A neighboring principal and friend confirmed that the whole community certainly used traditional healing; "Even the principal here," he laughed, as the three of us chatted in the principal's office. The principal conceded it was so. The Sangoma said that community members used both Western and traditional medicine depending on the complaint.

Few students mentioned medicine, however. In the Grade 10 photo assignments, a student wrote about his photo on corn: "The maize is like science because when you plant maize we use science and use your brain … and maize is important for Zulu medicine." Another student wrote, "Wild flowers has a nature to make medicine" (SS5 2003). On the Inventory of Interest Questionnaires, "Herbs for medicine" was relatively popular in Grade 10 (SS4 2002). When asked what their students should learn, primary school teachers mentioned "training to be traditional doctors" (T22 2002). Here again is the performative aspects of IK are seen to be important.

Food

Not surprisingly in a poor community, food is an all-pervasive preoccupation. In students' stories of their lives in Ndwedwe, food featured in every story. In the "Science in My Life" photo stories from Chibini, 21 out of 50 stories mentioned food. Leaders expressed concern about the loss of farming skills and poor nutritional habits. When we asked the Induna (Headman) how many people grow their own food he replied, "Very few. The majority buy from the shop; they are lazy" (C36 2002). He told us that health in the community has deteriorated and people have a lot of diseases, possibly because of not knowing about healthy food, for example, the new habit of cooking with oil, which people had not used in the past (C36 2003). In the old days, people had grown more of their own food (C38d 2003). The primary school principal spoke often about his concern for promoting healthy eating. Primary school teachers identified learning about healthy food as an important outcome of the Science Festival (TL 28 2004).

Discussion about food also had deeper significance. The practice of sharing food is a manifestation of *ubuntu* (humanism), discussed below. Learning to share food is a crucial socializing lesson in a culture where social responsibility and nurturing are more important than autonomy (Nsamenang 1999).

As with medicine and history, knowledge about food sits somewhere between "knowledge lost" and "knowledge found." Unequivocally, food cultivation and marketing, along with nutritional information, are important for income generation, improved health, and survival. There is great potential of this readily fitting into the science curriculum. IK of food and farming fits well with performative knowledge, but aspects of factual knowledge are also needed.

Worldview concepts

> In the case of Blacks in South Africa, the school curriculum should reflect the philosophy of Blacks and not that of any other group. (Lutuli, in Morris 1984, p. 57)

Cobern (1996) defines worldview as a person's fundamental collection of beliefs about the world, while Nisbett (2003) claims that worldview is more than a collection of values and beliefs, it is the way one views and experiences life. Cobern sees worldview more as an input into experience, while for Nisbett, worldview *is* the experience. I take these distinctions to be too philosophical for this context. Certainly both beliefs and experiences are iterative and build on each other. I am interested in how worldview has ramifications for social structures, identity, education, and ways of perceiving and thinking. At the core of relevance of science education in Africa is the recognition of ontological systems and their contribution to human understanding. African metaphysics has suffered derision and subjugation since the invasion by missionary education. Even factual IK has been excluded from school science (Thomson 2003).

There is, for most people, a general unconscious acceptance of beliefs and notions of reality, often with little awareness of how these shape our perception of the world. My own such tendencies struck me during the research project. Having trained in a Western scientific paradigm, I have noticed the tendency to imagine myself as objective and open-minded. It has been enlightening to discover the distortion and fixedness in my views that I tacitly assumed to be more or less universal "basic axioms" of existence. Particular worldviews are also embedded in social relationships, cultural practices, and conceptions

of consciousness (Obenga 2004; Horton 1967). An unexamined acceptance of a particular worldview can lead to repressing or ridiculing alternative views (Moodie and Thomas 2002).

To distinguish between different worldviews, Lewis-Williams and Pearce (2004) in *San Philosophy* lays out a spectrum of human consciousness along an axis from "alert" to "autistic." "At one end are those states that Western scientists most value: alert thinking and a rational response to the environment … the 'consciousness of rationality'" (p. 31). This continuum branches into, on the one hand, a "normal trajectory" through dreaming to unconscious (familiar to most people), and an "intensified trajectory" branch, on the other. This intensified trajectory of consciousness is usually excluded from a Western investigation into knowledge creation (excluding perhaps psychology experiments with mind-altering drugs). Nonetheless, the intensified trajectory is characterized by neurologically based and measurable experiences. These include experiences of entoptic phenomena through to hallucinations. This intensified trajectory provides modes of access to different kinds of knowledge that are excluded from the Western scientific paradigm. Such knowledge is often secret. Lewis-Williams is, of course, writing in relation to the San people (original indigenous inhabitants in Southern Africa). The point, however, illustrates how worldview shapes our perceptions and ways of creating knowledge. Thus, there are realms of knowledge in a particular culture that may be hidden from outsiders. When an outsider judges the presence or absence of knowledge by the response to questions framed from the outsider's (different) worldview, the results are likely problematic.

With this in mind, I tentatively identify clues that point to Afrocentric ways of knowing still present in the Chibini community. These aspects deserve deeper exploration. Themes that recurred are: nature, interconnection, water, time, ubuntu (humanism), interdependence, self-concept (identity), taboo, and culture. These are not discrete categories, but I discuss them separately.

Nature

Within in traditional Japanese culture, Ogawa (1998) explains that to study nature means more than objective observation. It includes communion with nature that enriches an appreciation of nature. This sense of communion was also evident in students' writings about their photographs of nature.

The photographs in students' assignments "Science in My Life" provided the deepest insights into the role of nature in the life of the community. In spite of being a first attempt at using a camera, most of the pictures were careful and well-considered expressions of students' concepts of science in their lives. In order to draw more on students' ideas and to provide more opportunities for them to express their ideas, students were asked to write two stories about their photographs. One was a "literal" description (what the picture represents), while the second was a "story" about the picture. A few examples illustrate students' concepts of nature.

A Grade 10 child wrote the following story about his photograph:
A donkey is a quiet animal. It is beautiful and has long ears and a long face. I like donkey but people are cruel to donkey and make it slave to carry heavy goods. Other people make donkey their horse. People abuse the donkey and make it do the job they can't do themselves. But I love my donkey. Donkey eat grass and mielies [corn]. Long time ago I saw this donkey lies on the road. It was very injured and I took it

Fig. 1 Student photo: "Nature is beautiful"

> home and nursed it. And my parents asked me what's his name and I said his name is
> Lorry. I always wake in the morning and give him food to eat, in the middle of the
> day I thought that I have to build house - small house for him then I showed him to
> sleep there. I was very happy for my donkey. I love my donkey.

Affection for animals was a recurring theme, especially when the animals are clever! All
animals had names. Students told a number of stories of caring for animals (SS6a, SS6b
2003). Similarly a chicken farmer said about the project, "It is good but the cages are too
small—chickens are not comfortable" (C38g 2003).

It is interesting that when presenting a concept of science, many students chose aesthetic
qualities of nature. In response to the photo assignment "Science in My Life," one Grade 8
boy's depiction of science was called "Nature is beautiful" (Fig. 1). He explained his
dependence on nature and the role of trees in village life. His essential concept of science
was the connection of life and the beauty of this interconnection (The appreciation of
interconnections is a fundamental idea discussed in the next subsection). Similarly, another
photo-story was entitled "Cabbages are beautiful," while another focused on the idea that
water from a tap is beautiful.

There was a strong emphasis on the positive in the students' photo-stories. No student
chose to include pollution, erosion, exotic plant invaders, crop pests, or drought. This
struck me as contrary to our tendency in science education to focus on problems and issues
in the environment. The beauty in nature was a prevalent theme for students in Chibini.
This finding is similar to George's (1999) research with Indigenous peoples in Trinidad and
Tobago who saw nature as the source of all good things.

There is an increasing awareness that this capacity for aesthetic appreciation in science
is lost to many of us. Through beauty we feel a sense of belonging; awe connects us to the
cosmos. "Through beauty we can feel our sense of belonging" (Fox 1983; in Reason and
Bradbury 2001, p. 11). In answer to the question, "What is the warrant of your knowing?"
Reason (1993, p. 8) proposes, "One sound answer—It is beautiful."

Interconnection

African philosophy is holistic and anthropomorphic (Ogunniyi 2002). Aspects of the
students' photo stories reveal both of these orientations. Obenga (2004, pp. 609, 610)

criticizes the "hypertrophied technological modernity" for losing sight of "social community and psychological transcendence." To me, "interconnection" means the specific view that one action affects others or one being affects others; and simultaneously, one action or being is dependent on others. It is the realization that everything owes its existence or cause to something else. Hence, the proper attitude is one of gratitude and mutual care.

Concepts of social community are akin to both identity and ubuntu. As discussed in the subsections "Self-Concept—Identity" and "Ubuntu—Humanism" (below), the Western conception of an individual does not exist in African culture.

An 18-year-old girl in her photo-story of a garden explained, "I'm not hungry if my mother plant mielies [corn] and animals are not hungry if the grass must be made to grow." Another young woman, Nosipho Mngeni, wrote, "If you don't like plant flowers at your home your home it is not good. You cannot survive without plants, and plants need the care of people. Plants even make clothes … and wood makes homes …" (SS6a; SS6b 2003.). In a similar narrative accompanying his photograph, a boy wrote about both beauty and interconnection:

> And maize is important thing because we could make mielie-meal, and plants I learn about in my science I find that it is important because if the land can't have plants land can't be there. I think the plants make the land beautiful and if there is no plants, animals can die. I suppose that if trees aren't there we cannot live, we can die as we know that in trees we find fresh air and it make land be not erosion … I saw is nice for everything to make its own thing. (SS6a, SS6b 2003.)

Although students expressed views of interconnection in nature and interdependence of people and nature, sustainable practices of hunting and harvesting are no longer followed in Chibini. This may be due to community depletion through AIDS and migration to cities. Parents are not teaching children traditional ways of living with nature to the same extent as a few decades ago. A school principal criticized bark collecting techniques that damaged trees and hunting practices that did not consider breeding seasons of the wild buck. He also criticized the lack of connection between the community's activities and the school.

> I remember in our first meeting, the superintendent of education was there, it even came to a point where the whole community had a say about what they wanted their children to be taught at school. I distinctly remember there were Sangomas (traditional healers) and all relevant stakeholders in the community, because some of them affect science but they are not aware of the science in their environment and the interconnection between the two. (P29, I 2003)

This interconnection between community and school made IK and school learning a challenge.

Water

Water has a primal place in ancient African cosmology. According to Obenga (2004) almost everything in existence—"goddesses, gods and stars, sky and earth, the world of the living and the abode of the dead"—has a genesis (p. 46). However, "*Nwn*, the absolute reality of the primal waters" does not (p. 46). The names for water and *Nommo*, the female "watcher of the universe," are interchangeable (p. 360). I am not asserting that this worldview emerged as a conscious ontology in our project. Rather, I perceived hints of the

primal place of water in people's thinking. One student simply stated, "There is nothing more important than water" (SS11 2003). In his photo-story another boy wrote:

> Water is important in our lives, we can't live without water. We drink water, wash, cook with water. If we don't use water nothing is going to be right. Water changes human beings' lives. Water makes plants grow, animals are all living with water. If there is no water people can die and animals, flowers can contract … we are all clean just because of water. Many things are here: it is water's business. The earth is beautiful because of water, trees are growing with water. We build houses with water and mud. So many things are used with water. (SS6a 2003)
> On two occasions the Induna said, "The first need is water" (C36 2003; C38e; 2003).

Lewis-Williams and Pearce (2004, p. 123) explain, "In addition to being a cosmological mediator, water has restorative, or healing powers." Further, the connection between this world and the spiritual world is via water. It links upper realms of sky and underground. The above realms are mediated through rain and the underground through the waterhole.

I am not asserting that stories and conversations with students and community reflect the ancient cosmology of primal water. Instead, the focus of water by participants in the study approaches an appreciation beyond the utilitarian. Water was the chosen subject in three photo assignments. Students wrote about its role in growing plants, cooking, and health. They also wrote of the care of water, its beauty, the interconnection of water with nature, and the act of helping people by getting water for them. Evidence of this deep knowledge of cosmology is not explicit in the data; nor is there evidence that it is tacitly understood. However, intuitive remnants of the idea emerge through recurring themes. It would be valuable for educators and curriculum designers to understand these concepts more fully.

Time

The concept of time was not a focus of my investigation; neither was it talked about explicitly. But the perceived relaxed attitude to time, free from clocks and calendars, struck me as a very different framework from that of urban life. As mentioned, Induna Chiya told us, "Good things take time" and "Be patient."

There were many exhortations to be patient! One Sinevuso teacher said, "This project makes sense; we are designing together. I like this. I am learning a lot. Thank you. Please be patient with us" (Journal 02–August 2003). An elder explained, "We live one day at a time" and "ancestors play an important role in community life." For me, this perspective suggests a different perception of time. The immunity from rushing toward the future allows an ease for being in the moment. Horton (1967, p. 252) explains that in Africa different time scales are used in different contexts. These scales all tend toward a cyclical or non-linear conception of time. For example, there is a scale correlating events with ancestors and the cycle of life and death. Another scale concerns the seasonal cycles, and yet another relates to a daily cycle.

Similar alternative notions of time are interesting, of course, when found in a scientific perspective. Einstein stated, "People like us who believe in physics, know that the distinction between past, present, and future is only a stubborn, persistent illusion" (quoted in McFarlane 2002, p. 126).

The African, cyclical, non-linear conception of time needs to be brought into awareness in decision-making. The African concept of the "fourth state"—a combination of past,

present, and future, all together (Armah 2005)—perhaps comes closer to Einstein's understanding of time than it does to the common scientific concept of time.

> An elder in the community was also surprised at seeing how we view time differently. He explained:
> I have gained much to know different people … If a person is using educational knowledge, he looks at things from a different perspective and range. He looks at the past, present, future and even the possible outcomes of what one is thinking. We just look at what is happening here. We are not looking at the distant future. This has disadvantages: for example, the chicken farming and "passing on the gift"—farmers just think of right now. They do not plan for the future. (O40a TT 2004)

Linear time is eradicated by symbolically re-enacting a past event. The day may be seen as recreating archetypal events. The daily cultivation of the fields is symbolic of the creation of the world (Horton 1971).

When Zulu behaviors are judged from a Eurocentric worldview, an understanding of time is often distorted unless one appreciates a difference in worldviews. For example, the principal joked that the community worked with "African time." In common usage, African time means simply lack of punctuality, but it is more than this. The principal, who is Zulu, was prepared to be critical of local culture: "The problem with rural people is that they think that nature is natural; period. Therefore it cannot be controlled by human beings" (P29b 2003).

These examples of time illustrate the complexity of understanding IK in South Africa. The foundational idea of time has potential for further exploration, especially considering a school science context where it is taken for granted that time can be signified with a symbol, quantified, and manipulated in equations.

Ubuntu—Humanism

Ubuntu refers to an ontology and way of living in which each person's humanity is ideally expressed through relationship. Ubuntu visualizes a community built upon interdependent relationships. One of South African's foremost religious leaders, Desmond Tutu, has said, "I am a human being because I belong." Students in the project described ubuntu in various ways. When I asked the Grade 7 students to draw their home, many drew the whole village. In drawing their huts many drew their neighbors' huts too. One boy wrote under his drawing, "A person without a neighbor is not a person" (SL17a 2003). Another Grade 10 student said, "Ubuntu is to help people" (R45e 2004). There is an African proverb: "One person's path will intersect with another's before long" (Wiredu 2002, p. 290). The student drawing (Fig. 2) illustrates that concept.

As with concepts of time, it is perhaps ironic that physicists such as Einstein have synthesized ideas that are more closely related to ubuntu than the mechanistic science espoused in science education:

> Human beings can attain a worthy and harmonious life only if they are able to rid themselves, within the limits of human nature, of striving to fulfill wishes of the material kind. (Einstein, quoted in McFarlane 2002, p. 24)

The concept of ubuntu centers on relationships and harmony. African humanism recognizes that our most important need is human relationships (Wiredu 2002). Consequently the "ultimate moral inadequacy" (p. 291) consists of a deep selfishness and a lack of feeling for others.
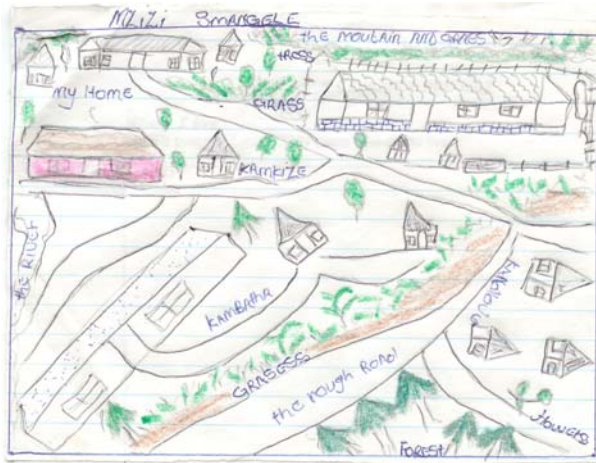
Fig. 2 Student drawing: "A person without a neighbor is not a person"

A typically African way of organizing the conceptual world, compared to a Western way, is by relationships rather than by categories, and by harmony rather than by contradictions. Sharing and reciprocity are norms throughout Africa. This is also more than a localized concept in Africa; it resonates with experiences of African Americans in the USA, and it is found in the philosophy of sudicism (the spiritual commitment to an ideological view of harmony) (Malcolm 2003). Two students presented the following two examples of ubuntu:

> Once upon a time there is a car near my home. The owner of this car is Mr. Dlamini. One day when I came to the town I never had money (for transport). Mr Dlamini told me, "You can get inside my car, my Neighbour." He took me to my home. I will never forget my neighbour. When you don't want your neighbour you are not a person. But now when I go to the town and I see some street kids I try to help them because many people want advice. (SS6b 2003)

> Once upon a time I was see a old Grandmother whose name Florence Sosibo. She gave me a meal and then she was busy to plough. After she finish plough she pick spinach. My Granny is important in my life. (SS6b 2003)

The way of calling people "Mother" or "Granny" (even though they may be strangers) is another example of the sense of belonging. In a class with Grade 9 students, we had a lesson specifically on ubuntu. Students presented the following to describe ubuntu:

- If a person has no food you give him some food.
- You should not look for something in return for helping someone.
- You can never lose your life helping someone.
- There is a thin man Xolani and a fat man Mthembu. Mthembu is handing a plate of food to Xolani. Although Mthembu is wealthy, he does not look down on Xolani who is his neighbour but rather offers him food.

There were drawings of an older person helping a younger person and a boy helping an old woman carry wood. Students had no difficulty identifying instances of ubuntu in the community. However, it would be wrong to say that the community lived in total harmony and in a spirit of generosity. There has been more than one incident of a child hanging

himself for feeling unwanted by family and neighbors. AIDS orphans have become victims of relatives greedy for the child grant. Abuse and neglect are not uncommon. Here too, traditional wisdom is in a precarious position.

Children in rural communities have many duties that interfere with schooling. These are often cited as a feature of poverty (bordering on abuse). Chores do make students late for school (or even miss school) and prevent them from completing homework. But performing community duties is in itself a vital aspect of African education. These duties, as moral obligations, express deeper metaphysical concepts (Gyekye 2002). Educational initiatives striving to provide greater access to schooling need to take these metaphysical concepts into consideration. Although in a democratic society individual rights need protection, there is also the concept here that a human being is inescapably a cultural being (Gyekye 2002), and as such, community obligations are seen as a priority. In fact, it goes deeper: the concept of the separate individual does not exist.

The erosion of the role of ubuntu is not new. Einstein's anti-materialist position (quoted above) is reflected in Steve Biko's (2002) plea:

> We must seek to restore to the black man the great importance we used to give to human relations, the high regard for people and their property and for life in general; to reduce the triumph of technology over man and the materialistic element that is slowly creeping into our society (p. 84).

Self-concept—Identity

I use the term *self-concept* here loosely as a subset of "identity." I take self-concept to mean a self-perceived notion of whom one is. Self-concept relates to self-confidence, motivation, and the formation of identity. These are important features of personal development, especially for teenagers, and hence they deserve strong consideration by educators.

Because a community's IK is related to student identities, the concept of identity is one way to explore IK. I am interested in the contrasts between Western and African attributes of self and factors that contribute to identity formation. This contrasting and categorizing is, of course, a typically Western approach. There are many similarities in worldview identities, there are individual differences, and there are tendencies to see the world in certain ways irrespective of one's inherited culture.

A detailed analysis of the literature on identity is beyond the scope of this article. Instead, I present a summary of this literature adapted from comparisons made by Nisbett (2003) in his analysis of Asian and Western thought (Table 1), along with examples drawn from the research project.

The aspects presented in Table 1 (i.e., self-concept, personal identity, success, relationships, effective actions, progress, freedom of action, freedom of location, hierarchy, managing conflict, causality, and learning) all influence curriculum design and research processes. Without understanding fundamental differences between African and Western cultures according to assumptions and ways of being, the initial research questions were at risk of charting a direction that overlooked these underlying features of IK. For example:

- What are the community's hopes and purposes for the exploration of IK? Data show that the very concept of purpose has a cultural bent, as does the term *community*.
- What IK is present and what IK is appropriate for inclusion in curricula? The Western concept of knowledge also differs from that of the Chibini community.

Table 1 Contrasting concepts from data (adapted & extended from Nisbett 2003)

Aspects of identity	African	Western	Examples from research project (not all examples are cited in this paper)
Self-concept	Collective self, complex	Autonomous self	Students' drawings of their home & including neighbors.
Personal identity	Identifies strongly with group, grows through mentors & relationships	Stable attributes, "one true self'," grows through inner reflection; formal courses	"My Grandfather was the person who was to make me who I am;" Science Photo assignments of people
Success	Harmony, humility; Collaborative	Singular achievement, self-advancement; Competitive	Students' personal goals to help the community; Helping community valued above personal goals
Relationships	Basic-essential; extend to plants, animals, nature	Useful; humans separate from nature	People describe themselves in relationship to family, as well as nature. Life is in all things.
Effective actions	Depend on context, complexity	Can be simplified to rules	Lengthy discussions in setting up projects
Progress	Consultative. Time cyclical	Linear, continuing, time efficient. Time linear, a commodity	Meetings repeated; length of time valued for own sake
Freedom of action	Collective, freedom available through community	Individual, unconstrained by relationships	Elders giving ethics permissions for all children; wide consultation of ideas
Freedom of location	Value place-based community	Expect to move often, as part of individual achievement	Induna: "I was born here and will die here." Knowledge of history of area
Hierarchy	Hierarchical (also related to age & gender)	Egalitarian	Teachers unwilling to make decisions without principal; Seeking audience with Inkosi through Induna
Managing conflict	Collective decision-making, practical	Trading, arguing from principles	Ethics protocols were seen as offensive (contractual, assumed agreement unacceptable)
Causality	Complex and differing causes for similar phenomenon	Deterministic forces; mechanistic explanations	"Lightning may have many causes"
Knowledge	Instrumental and goal directed	Valued for own sake; Often disembodied; abstract	Researcher: "What is a relevant science curriculum?" Elders: "We are hungry."
	Participative; age relevant	Self-constructed or transmitted through institutions	Originally learning was through relationship. "Transmission" learning in schools is exaggerated parody of "Western."
	Gained through apprenticeship and ceremony	Formal schooling	Learning through stories of elders and traditional song/dance; farming duties

Not only is the underlying concept of self part of the discovered IK, the concept of self shapes how we proceed with the inquiry.

The importance of understanding identity emerged gradually throughout the project. The complexity of identity in the village first struck me during a meeting with the Inkosi

(the village Chief). Not only is she an unusual woman (being a female and a Chief), a strong leader, and respected traditionalist in a patriarchal society; she is a warm flexible feminist!

My first meeting with her was extremely formal. On another occasion I was invited to phone her to set up an interview. She named a meeting place that was clearly chosen to make me feel at ease. During the meeting when I asked her how I could gain support for the project she replied, "You merely need to speak to the Inkosi." I experienced a wave of confusion; I thought I *was* speaking to the Inkosi! Clearly there was more to her answer than I understood.

Her position as a feminist became clear when, after an interview with Prof. Malcolm (the project leader) and me, I asked her if she needed Prof. Malcolm's contact details. I was assuming that he, being more senior, would be the appropriate contact. She asked for my phone number instead. After she listened to our explanation of who was on the Mbumba management committee, she said simply and emphatically, "You need someone from the church, a woman not a man. Also, there are too few women on the committee" (C34 2003). Women's notions of identity will certainly be influenced by the Inkosi's promotion of gender equity.

Research data included lists of experiences or roles that could be seen as shaping identity for both students and teachers. However, these lists relate less to an ontological framework than to performative knowledge in a rural African context. As such, the lists contributed to discovering the community's educational purposes. During a lesson on identity at the Lusiba Primary school, for instance, Grade 7 children wrote their ideas on the topic, "I am an African because …" Their answers included: "I am Black." "I eat African food." "I sleep on skins." "I speak two languages." "I cook with fire." "I live in a mud home." "I polish [the floor] with cow dung." "I do Zulu drumming." "I pay lobola with cows." "I believe Zulu religion." "I do African culture." and "I speak Zulu" (SL20b 2002).

In a teacher workshop at Lusiba, the teachers made lists of the children's talents. Talents are, in a sense, an aspect of identity through competence. In response to the question, "What are the experiences and talents of the children?" teachers wrote the following: "Look after stock," "Fetch water," "Look after children," "Cook," "Traditional dance," "Fetch and mix herbs," "Plough fields," "Build houses," "Fetch honey," "Clay pottery," "Hunting," "Cleaning," "Parenthood [some of them]" (T22 2002).

Role competencies that emerged strongly for Sinevuso students in their photo assignments were "cleverness/percipience." Interestingly these are qualities they praised in animals too. Students told parables of animals helping each other and helping people, and told humorous tales of animals talking and demonstrating perceptive canniness. In their stories about clever children, the focus was always on helping others and not on individual achievement. For example, a girl wrote the following about her photo of a goat (a shortened version):

> There is a poor family with no breadwinner they had one goat to give milk and got phutu [maize porridge] from neighbour. They decide to sell goat – they desperate for money. Small girl said "no" must get baby goat and sell milk. They keep goat … today family is rich. (SS6b 2003).

This story demonstrates the valued attribute of contributing to community development; an attribute that guided our entire project. A commitment to community strongly links to another role competency: care. An example of care comes out in a story about helping a baby calf get to its mother to drink, and the child's sense of joy and achievement in

accomplishing this (SS6b 2003). Both these competencies (contributing to community development and care) point to the ontology of interdependence.

Among cultures worldwide, self-concept differentiates in degrees of independence and interdependence (Markus and Kitayama 1991). In African cultures, interdependence takes a different form from the interdependence in Western, individualistic, and often materialistic societies where interdependence tends to be transactional and contractual; hence, expedient. In African society interdependence is not simply a fact of expediency, it is an ontological reality. The collective is not a collation of interacting individuals, but a "collective self" (Wiredu 2002).

Although there is a plethora of definitions of self (e.g., Rogers 1977), most psychological studies and theories are based on the Western view of an autonomous independent individual. This is an important consideration in education studies because self-concept is closely tied with cognitive styles, which in turn are pertinent to curriculum design and pedagogy.

Again, my main point is to highlight limitations of our Western assumptions with regard to understanding students in traditional rural cultures. Extending the concepts of self to ontology, Nsamenang (1999) describes the ontogenesis of the self in the African social context as being cyclical and as comprising three components: experiential/social self, ancestral self, and spiritual self. Only the first component corresponds to what would normally be considered as self in a Western framework. The experiential/social self exists within a person's physical life-span. The second two components of self extend beyond this. This is a challenge for Western scientific thinking!

The South African philosopher and theologian Kruger (1995) points out that the "notion of an 'individual' human being in the strict sense is an abstraction. A person comes into existence in a web of human social relationships, and never leaves it" (p. 35). In spite of the rationality of the argument that the self is an abstraction, Westerners focus on self is all-compelling. We Westerners conceive of a self-made person, as evidenced by a glut of self-help and self-development books, as well as a commercial/personal obsession with self-image. These follow the modernist focus on "own-achieved" (individual trait) identities (Gee 2001). Gee went on to state that in modernism, "The ideal of the self-fashioned 'authentic' person tended to celebrate the individual and the accomplishments of the individual and background the workings of the dialogue with others that produced and reproduced these accomplishments as identities" (p. 114).

A lack of perception of a Western self-contained self was shown in the difficulty Chibini students often had in defining personal goals or visioning a future apart from their community (SS11d 2003). This is consistent with the notion that a person is not a person on their own (Ellis 1978). Another example was what I first took to be a grammatical idiosyncrasy when a number of students spoke of wanting to "become *a somebody*." Nsamenang (1999) explains how new-born children are considered "no-body," that is, lacking a self. Through developing social intelligence and role competencies, newborns gradually become a somebody. Yet, this somebody is a *connected self* in deeply established interconnections.

This reminds me of a conversation I had with a youth in the community. He lamented his grandfather's death because "He [the grandfather] was the person who was going to make me a somebody." At the time I did not realize the deep sense of alienation that this caused the youth. Comparative studies of rural and urban youth have shown that rural youth, compared with their urban counterparts, have a stronger global, family and social self-concept (Mboya 1999). Urban youth score higher on physical self-concept. Other common instances of connected self revealed themselves: the practice of referring to

someone as "mother of …;" the practice of introducing someone by placing them in their family structure; and the practice of enquiring after the health of the whole family when greeting someone.

The education system in South Africa is situated in the Western paradigm. In spite of the promotion of leaner-centeredness, students are conceived of, and catered for, from a Western perspective. Education particularly draws more on the autonomous self than the connected self. This raises the potential for complex dissonances for rural students at crucial stages of identity formation. My personal belief is that the qualities of a collective self have much to offer, not only the community but humanity as a whole.

Taboo

Taboo is a ban, restraint, or exclusion of people or behaviors. Taboos are present in all cultures but they differ in their specifics. In European societies some taboos are enforced by law (e.g., incest), while other taboos are enforced through social pressure (e.g., arriving uninvited at a stranger's house). A taboo is a phenomenon that does not fit a society's established categories and is treated with aversion or horror. By definition such an event is bad and needs to be isolated or expelled (Horton 1967).

Some taboos no doubt preserve well-being and ritualize wholesome restraint in a community. However, if we accept the premise that culture is dynamic, taboos need to be critically examined. My analysis of IK in a science curriculum would be incomplete without raising issues of problematic practices and beliefs. The biology teacher who commented that traditional healers could only teach "the good" things, is an instance of expressing a taboo (to teach "bad" things).

An examination of taboos has significance for a number of practices, for example, taboos in relation to HIV/AIDS and to unmarried mothers. One of our community researchers was widely ostracized because she was pregnant but unmarried. One principal said he would not allow her into his home. In another incident, a woman was driven out of her house because her brother discovered she was HIV positive. In a public talk about African culture, Achebe (2003) stated emphatically, "If culture is harming someone it is not culture; it is abuse!" The volunteers for the AIDS NGO Woza Moya deliver this message poignantly in their song "I am So Ashamed": "I am so ashamed of my world, my church, my mosque, my family and my country for being ashamed of me. Ashamed of me being HIV positive" (O43b 2003).

The student Science Fortnight and community Science Festival were constructive interventions for bringing scientific reasoning, evidence-based arguments, a search for information, and a frankness to the taboo of acknowledging the existence of AIDS. Traditional practices were balanced with this new frank acknowledgement, which for some participants would have been shocking and unacceptable. Students asked if they could put on a play to communicate the seriousness of, and solutions for, the scourge of AIDS in Chibini. This was a culturally acceptable way for youth to "teach" other students and community members. The play was well received.

Culture

"A culture is essentially the society's composite answer to the varied problems of life" (Biko 2002, p. 84). This view accommodates the changing nature of culture. When

circumstances and problems change, responses change. Oruka (2002b) offers a more specific definition of culture:

> Culture demonstrates … celebrated achievements in thought, morals and material production. … knowledge, beliefs and values, behaviours, goals, social institutions, plus tools, techniques and material constructions. (p. 58)

Culture in this sense includes an expression of a way of being and a way of knowing, expressed through the formalization of traditional practices. Culture is an expression of a collective identity. In the three subsections that follow, I present specific examples of culture that are still strong in the Chibini community; I discuss tensions between local traditions and modernization; and finally, I discuss the relevance of culture, particularly traditional-modern tensions, to the science curriculum.

Examples of culture. In Chibini, traditional leadership, ceremonies, and dance are strong in spite of debilitating poverty, sickness, and disrupted social organization. This shows that despite many of the elders' concerns, youth still feels connected to tradition in a number of ways. In addition to the many traditional activities already mentioned in this article, I describe three others here.

Sinevuso students were asked to draw pictures of a community activity. In one, men are sitting together drinking Zulu beer. Students explained that during these sessions the men speak about their problems and deliberate solutions. Students feel that these sessions are useful and that problems are shared rather than individualized.

A second picture showed a man in traditional dress doing a Zulu dance. Students explained that it was good that the man practices and respects his culture and has not become Western and has not forgotten about his customs (R45d 2004).

The young community researchers said that traditional education and initiation ceremonies still take place formally for girls and boys. The elders and women run classes and initiate young people through the various levels to adulthood.

These examples represent our extensive data that convey the respect young people have for their culture—a critical finding for developing an Afrocentric appreciation in science education. Striking features of rural culture are the positive attitude of youth toward learning and their positive aspirations to contribute to the community. However, the role of culture is not entirely unproblematic. There is both a concern for loss of culture and a hope for improved access to global opportunities.

Some of the tensions between the traditional and modern. The Induna (Headman) was disappointed at the modern attitude of youth. (Is this not the case everywhere?) We asked, "Are there values and knowledge that young people should be learning?" Induna Ngobo replied, "These things happened before, for example, boys carved wood, girls made mats, brooms, and pots. Children don't value old things; they see it as poor and old fashioned. They need to learn crafts" (C36 2003). Parents also complained of moral degeneration (C30a 2002). Yet from the perspective of a teacher of city youth, I could not help thinking how lucky these parents are. The rural students I met were always motivated and polite. The teachers acknowledged that the students were mostly well-behaved and respectful. Nonetheless, there is an increase in the use of alcohol and marijuana among students, even at school (SS5 2003).

Some elders expressed concern at their own lack of education compared to the current generation. Induna Chiya told me how he had never been to school because his family had been too poor. He said it was difficult for him to comment on specific educational issues, although he believed that young people should go to school (C30b 2002). The chairman of the Mbumba committee explained the knowledge gap he experienced:

> Being uneducated is a problem – I am one of them. … We deal with issues using our general knowledge, and others use school knowledge. These two types of knowledge are not the same. General knowledge has many shortcomings. (O40a, TT 2004)

A third tension is in the conflict between traditional practices and human rights policies. Two examples are patriarchal organization in spite of gender equity policy, and a widespread acceptance of corporal punishment in spite of its abolition in schools.

Science curriculum and culture. For community members, school knowledge and literacy are desired and respected. At the same time, they want culture preservation, skills for survival (particularly farming), and job training (C30a,b,c,d,e; C34–C36 2003). *My* concern was the perceived high value and status of academic science courses even though this value was acknowledged as being largely symbolic.

A particular conflict for me was the community's call for practical skills training, especially in farming, which presented a dilemma that is both political and practical. Although our curriculum interventions based on farming were certainly successful, apartheid education had provided only agriculture courses for Black students. Black students were expected to become laborers who would have no need for academic science courses. Thus I found it unacceptable and embarrassing that one research outcome turned out to be the inclusion of agriculture in the science curriculum for this rural community. When I discussed my discomfort with the Inkosi (Chief), she said we needed to be pragmatic. The curriculum designers must ensure that the curriculum was not inferior and that it provided access to more global participation.

The political tension between high and low status knowledge seemed not to concern the community. The dilemma for researchers and the school became a practical issue of curriculum design. (In a similarly way, the incorporation of traditional culture and the use of computers and technologies were left for the school to manage.) Unfortunately the political and practical tensions between high status and low status knowledge, and between conventional science syllabi and community-centered farming curriculum, remain unresolved at the school. In the meantime, the school has opted to stay with its conventional syllabus. Ideally, there could have been a balance and integration of the two, caused by a revision to the school's conventional status of knowledge to favor the position held by the community (and me).

The epistemological and ontological tensions between Western science and IK could also be applied to tensions between traditional and modern behavior within a community. For instance, differences in worldview are exacerbated through school science structures. The Mbumba committee Chairman identified school knowledge as being "different." Perhaps he was aware that it is not only the knowledge that is different, but that the knowledge is framed in a different paradigm. As our data showed, worldview is somewhat elusive to direct articulation, even for those immersed in a paradigm. Its familiarity makes its presence invisible.

I, too, was aware that the community's collective worldview was generally different from the worldview of science education, which is essentially mechanistic and competitive. IK has little chance of being appreciated or developed within this dominant Western perspective. Odora Hoppers (2002) recommends that we foster respect and co-operation rather than competitive frameworks, a recommendation that appears to present no problem for elders who see this as something that simply needs to be done. In the community of Chibini, learning is co-operative as part of ubuntu, and there is no distinction between the sacred and the secular (Biakolo 2002).

Designing the science curriculum consonant with this approach means taking science education out of the confines of the classroom. Moving from a learner-centered approach to a community-centered approach requires a type of learning that draws on, and integrates, cultural practices in the form of performative and factual knowledge. If a school science curriculum were designed to ensure that socio-cultural influences were a resource rather than a hindrance, the tensions between an African worldview and a scientific worldview could be largely resolved.

Conclusions

> We need to return to our roots – to cultivate the land –
> everything comes from the earth. (Elder, September 2002, C30c)

This quotation not only suggests a practical solution to life-threatening poverty in the Chibini community, it enunciates an ontological perspective. To return to one's roots is to look to one's culture, ancestors, and community. To cultivate the land certainly means to care for it, but even more, it means to recognize interconnections and to appreciate indigenous conceptions of time, water, and nature. These conceptions are not inferior to ideas axiomatic in science classrooms.

The Zulu community in Chibini has relevant Indigenous Knowledge to include in the science curriculum. This knowledge includes structures, processes, and pedagogies that preserve Chibini culture and increase performative knowledge (especially farming). These pedagogies also provide a balance with globally relevant knowledge and skills. Much factual IK about nature seems to have been lost. Skills for living in nature are declining. Elders want cultural preservation to go along with development.

Students were affirmed in their identities when they learned through culturally consonant activities. Students expressed their science learning through stories, dance, and place-based communal activities. Worldview shaped and nuanced these expressions of IK. A collective worldview is a heritage and key feature of identity for Chibini youth.

Several themes critical to acknowledging a collective Chibini worldview emerged from the research data. These were: history, food, medicine, nature, water, time, and ubuntu. Educators and curriculum designers in South Africa need to understand the role of worldview related to these themes. Some of these themes could be included in the science curriculum as was done in the Science Fortnight activity and the community Science Festival.

The issue of IK in the science classroom is not so much a problem to be solved as it is a resource to be used. Much research into worldview focuses on the difficulty that science students face when they embrace a non-Western worldview. This focus ignores the rich resource that such worldviews bring to the sciences and to education. We do not want just a curriculum that produces *more* African scientists. It would be good to focus curriculum efforts toward producing *better* scientists and human beings who have been enriched by deeper and broader understandings through drawing on both an Afrocentric and Western worldview. Such a curriculum should not aim to simply increase scientific literacy; it should strive to contribute to community well-being, to foster an aesthetic appreciation of nature, and to strengthen the interconnection of all things. The critical issue is not only improved access to Western science, but improved access to the community's own ways of understanding nature. Teachers and curriculum designers need to have a better understanding of Zulu students' identity and community culture. In the Chibini community, both students and elders were enthusiastic in support of a community-centered curriculum.

Tensions between traditional and modern practices and between local culture and education policy need an open discussion. "Science is generated by discussion and thrives on it. If we want science in Africa, we must create in the continent a human environment in which and by which the most diverse problems can be freely debated" (Hountondji 2002, p. 132). South Africa can make important contributions to the recognition of Indigenous Knowledge and its integration into science education in schools. Rural schools are in a particularly strong position to explore Indigenous Knowledge and traditional culture. The climate for debate within the rural community we found to be remarkably open. These communities also have ways of knowing and being that could contribute to the enrichment of science education.

References

Achebe (2003). Talk given at the University of the Witwatersrand, 16th September 2003.

Armah, A. K. (2005, February 25). *African identity* (public talk). Human Science Research Council, Pretoria.

Biakolo, E. (2002). Categories of cross-cultural cognition and the African condition. In P. H. Coetzee & A. P. J. Roux (Eds.), *Philosophy from Africa* (2nd ed., pp. 9–19). Oxford: Oxford University Press.

Biko, S. B. (2002). Black consciousness and the quest for true humanity. In P. H. Coetzee & A. P. J. Roux (Eds.), *Philosophy from Africa* (2nd ed., pp. 19–85). Oxford: Oxford University Press.

Cobern, W. W. (1996). Change in science education. *Science Education, 80*, 579–610.

Dekkers, P. (2005). *Integrating indigenous knowledge and technology in science teaching – how do exemplary teachers engage with the challenge?* A paper presented at the 13th Annual Southern African Association for Research in Mathematics, Science and Technology Education Conference, Windhoek, Namibia.

Department of Education (2002). *Revised National Curriculum Statement Grade R-9.* Gazette No.:23406, Vol. 443, pp. 1–36.

Department of Education (2003). *National curriculum statement grades 10–12. (General) Physical Sciences*. Pretoria, South Africa: Government Printer.

Ellis, J. (1978). The child in West African society. In J. Ellis (Ed.), *West African families in Britain* (pp. 34–47). London: Routledge and Keagan Paul.

Fox, M. (1983). *Original blessing: A primer in creation spirituality*. Sante Fe, NM: Bear.

Gee, J. P. (2001). Identity as an analytic lens for research in education. *Review of Research in Education*, *25*, 99–125.

George, J. (1999). World view analysis of knowledge in a rural village: Implications for science education. *Science Education, 83*, 77–95.

Gyekye, K. (2002). Person and community in African thought. In P. H. Coetzee & A. P. J. Roux (Eds.), *Philosophy from Africa* (2nd ed., pp. 297–312). Oxford: Oxford University Press.

Hess, D. (1995). *Science and technology in a multicultural world: The cultural politics of facts and artefacts*. New York: Colombia University Press.

Higgs, P., Higgs, L. G., & Venter, E. (2003). Indigenous African knowledge systems and innovation in higher education in South Africa. *South African Journal of Higher Education, 17*(2), 40–45.

Horton, R. (1967). African traditional thought and Western science. *Africa*, *37*, 50–71.

Horton, R. (1971). African traditional thought and Western science. In M. F. D. Young (Ed.), *Knowledge and control* (pp. 208–266). Johannesburg, South Africa: Collier Macmillan.

Hountondji, P. J. (2002). Producing knowledge in Africa today. In P. H. Coetzee & A. P. J. Roux (Eds.), *Philosophy from Africa* (2nd ed., pp. 501–507). Oxford: Oxford University Press.

HSRC (2005). *Emerging voices: A report on education in South African rural communities*. Houghton, South Africa: Nelson Mandela Foundation.

Kaomea, J. (2003). Reading erasures and making the familiar strange: Defamiliarising methods for research in formerly colonized and historically oppressed communities. *Educational Researcher, 32*(2), 14–25.

Keane, M. (2006). *Understanding science curriculum and research in rural Kwa-Zulu Natal.* Unpublished PhD Thesis. University of the Witwatersrand, Johannesburg, South Africa.

Kruger, J. S. (1995). *Along edges: Religion in South Africa: Bushman, Christian, Buddhist.* Goodwood, Western Cape: University of South Africa, National Book Printers.

Lemke, J. L. (2001). Articulating communities: Socio-cultural perspectives on science education. *Journal of Research in Science Teaching, 38*, 296–316.

Lewis-Williams, J. D., & Pearce, D. G. (2004). *San spirituality: Roots, expressions and social consequences.* Cape Town, South Africa: Juta.

Mabuza, E. (1982). The African and wilderness, in wilderness. In V. Martin (Ed.), *Wilderness* (pp. 42–47). Moray, Scotland: Findhorn.

Malcolm, C. (2002). Science for all: Learner-centred science. In R. Cross, R. (Ed.), *A vision for science education: Responding to the work of Peter Fensham* (pp. 17–37). London: Routledge Falmer.

Malcolm, C. (2003). Science, science education and war. *Labtalk, 47*(1), 38–43.

Markus, H. R., & Kitayama, S. (1991). Culture and the self: Implications for cognition, emotion and motivation. *Psychology Review, 98*, 224–253.

Mboya, M. M. (1999). African adolescents' self-concepts: Rural-urban and gender comparisons. In M. M. Mboya (Ed.), *Culture and self from an African perspective* (pp. 83–96). Pretoria, South Africa: Ilitha.

McFarlane, T. J. (Ed.). (2002). *Einstein and Buddha: The parallel sayings.* Berkely, CA: Seastone.

Moodie, P., & Thomas, B. (2002). *Science and technology for all: Grade 6 learner's book.* Manzini, Boleswa: Macmillan Boleswa.

Morris, C. (1984). Black philosophy of education. *Perspectives in Education, 8*(1), 57–60.

Nakashima, D., & Roue, M. (2002). Social and economic dimensions of global environment change. In P. Tinmerman (Ed.), *Encyclopedia of global environment change* (pp. 314–324). Chichester, UK: John Wiley.

Nisbett, R. E. (2003). *The geography of thought: How Asians and Westerners think differently and why.* New York: Free Press.

Nsamenang, B. A. (1999). An image of the self in African social thought. In M. M. Mboya (Ed.), *Culture and self from an African perspective* (pp. 19–42). Pretoria: South Aftric: Ilitha.

Obenga, T. (2004). *African philosophy, the Pharaonic period: 2780–330 BC.* Theophile Obenga and PER ANKH s.a.r.l. the African Publishing Cooperative. http://www.perankhbooks.info. Access date: 10/3/2005.

Odora Hoppers, C. A. (Ed.). (2002). *Indigenous knowledge and the integration of knowledge systems.* Claremont, South Africa: New Africa Books.

Ogawa, M. (1998). A cultural history of science education in Japan: An epic description. In W. W. Cobern (Ed.), *Socio-cultural perspectives on science education* (pp. 139–161). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Ogunniyi, M. B. (2002). *Border crossing and the contiguity learning hypothesis.* A paper presented at the 10th annual meeting of the South African Association for Research in Mathematics, Science and Technology Education, University of Natal, Durban, South Africa.

Ortiz, O. (1999). Understanding interactions between indigenous knowledge and scientific information, *Indigenous Knowledge Monitor*, Nov. http://www.nuffic.nl/ciran/ikdm/7-3/ortiz.html, accessed 7/9/02.

Oruka, H. O. (2002a). Four trends in current African philosophy. In P. H. Coetzee & A. P. J. Roux (Eds.), *Philosophy from Africa* (2nd ed., pp. 120–124). Oxford: Oxford University Press.

Oruka, H. O. (2002b). Ideology and culture: The African experience. In P. H. Coetzee & A. P. J. Roux (Eds.), *Philosophy from Africa* (2nd ed., pp. 58–63). Oxford: Oxford University Press.

Reason, P. (1993). Reflections on sacred experience and sacred science. *Journal of Management Inquiry, 2*, 273–283.

Reason, P., & Bradbury, H. (2001). Inquiry and participation in search of a world worthy of human aspiration. In P. Reason & H. Bradbury (Eds.), *Handbook of action research: Participative inquiry and practice.* Sage Publications.

Rogers, C. (1977). *Rogers on personal power.* New York: Delacorte.

Semali, L. M., & Kincheloe, J. L. (1999). Introduction: What is indigenous knowledge and why should we study it? In L. M. Semali & J. L. Kincheloe (Eds.), *What is indigenous knowledge? Voices from the academy* (pp. 1–57). New York: Falmer.

Soudien, C. A., & Nekwheva, F. (2004). Indigenous culture and resistance: Africancentred responses to education in South Africa. *Journal of Postcolonial Education, 3*(1), 25–45.

Thomson, N. (2003). Science education researchers as orthographers: Documenting Keiyo (Kenya) knowledge, learning and narratives about snakes. *International Journal of Science Education, 25*, 89–115.

Wiredu, K. (2002). The moral foundations of an African culture. In P. H. Coetzee & A. P. J. Roux (Eds.), *Philosophy from Africa* (2nd ed., pp. 287–296). Oxford: Oxford University Press.

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Forum: Teaching IK in school science: depths of understanding, nuances, and just do it

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Abstract   The Indigenous Knowledge (IK) discussed in this forum is the traditional community's knowing and way of being as might be included in the school science curriculum (but not necessarily in the science *classroom*.) We consider the problematic terminology of a "body of knowledge" or appropriate "pieces of knowledge." Dawn offers alternative notions of "coming to knowing" through community participation—drawing on work in Northern Canada. Cliff raises the question: "What would effective dialogue between two knowledge systems look like?" In both the Canadian and South African examples, dialogue certainly results in a respect for culture, it enhances confidence and affirms identity. It is the dialogue that is more important than specified "content." We can philosophise about the nature of worldview and the differences in knowledge systems but ultimately the message to teachers is: "Just do it."

Dawn: How do we know if knowledge is lost? In Moyra Keane's article, "Science Education and Worldview," one point that she made was that Indigenous knowledge was lost from Chibini. This statement really had me thinking about the point at which we, as outsiders to the Chibini community, can truly say that Indigenous knowledge has been lost. I think about Pam Colorado's (1988) description of "coming to know" and the idea that Indigenous knowledge (IK) needs to experienced and earned. This is one of the fundamental differences between Western and Indigenous approaches to learning.

Moyra: Just to clarify "knowledge was lost:" this statement came from the school principals in our project (who are Zulu) as well as from the community elders and the Chief (Inkosi). Additional data simply confirmed this. Otherwise I agree; the assumption could be far off.

Dawn: Thank you, Moyra. Another issue about knowledge comes to mind. In school we are taught to pursue knowledge, and that if we are diligent enough we will find answers to our questions. Any knowledge in the Western system is "up for grabs." This is not the same as the local knowledge of many First Nations communities in Canada, and Moyra highlights this finding in Chibini when she compares knowledge systems. The community's local Indigenous knowledge may be a "body of knowledge" but not one that can just be taken; it is a body of knowledge that must be earned. The Mbumba committee chairman also identified the difference between school knowledge and Indigenous knowledge, but this was framed by Moyra in terms of a different paradigm.

Moyra: Yes, IK (Indigenous knowledge) is not there "for taking," I agree. In our project we were not concerned with esoteric/sacred knowledge or knowledge of initiates (and neither was the community). We were looking at Indigenous knowledge that might be

included or shared in the school curriculum—knowledge that the community wished to share. The researchers and the school were able to mediate with the community to make integration possible where it might not have been. For example, we asked students to ask elders about traditional farming practices, and to ask chicken farmers for some statistics on production. At first the farmers said they don't accept being questioned by young people. After the issue was discussed in a community meeting, they agreed that this would benefit everyone and so they participated. Later when students displayed the data they had collected, the whole community was celebrated and affirmed. This is perhaps an example of culture being flexible and changing. The essence here for the adults was respect, and the respect was being preserved.

The concept of "a body of knowledge" comes up repeatedly in our discussions. Perhaps a different metaphor is helpful. Indigenous knowledge appears more as an interaction of knowing, a relationship of understanding with people and nature.

Dawn: In my own experiences in northern Canada there is another side to coming to know; it is the knowledge gained while trying to create something new out of a collective process that includes community, teachers, and students. It is the value of having community members, teachers, and students try to incorporate their own local experiences and knowledge while learning a Western science curriculum. For the most part, community members are unaware of what is in the science curriculum and how science may be taught in school. However, while developing a community-based local science curriculum in northern Manitoba, the community members began to see how their personal and traditional stories fit into the school science content and could see where they could contribute to science learning. One fond memory of mine is a brainstorming session that took place among the elders, teachers, and Grade 5 students (as well as me) on what would be a traditional meal that met the Canada Food Guide. We developed the menu and then collected (not bought) most of the food. Afterwards we all sat down for a great feast.

There have been offshoots to this community-based project. For example, a school created a secondary science course "Indigenous Knowledge and the Environment." I see this experience as being similar to what Ermine (1995) explains as *mamatowisowin*, a Cree word for the capacity to be or do anything, to be creative. "For the Cree, the phenomenon of *mamatowisowin* refers not just to the self but to the being in connection with happenings" (p. 104). I am wondering if Moyra experienced this type of change in the community—the increased confidence to identify elements of the science curriculum (and perhaps other areas of the curriculum) that could incorporate the local knowledge. It seems as though the community felt more capable of doing this after the program. This impact may have longer lasting results than many of the other impacts of the program.

Moyra: In terms of IK being, in part, a relationship of understanding with people and nature, it seems an indictment of the schooling system that "community members are unaware of what is in the science curriculum." The curriculum project that Dawn mentions in northern Manitoba seems very similar to how our curriculum intervention worked. Up until now, only school learning was affirmed. Indeed, the result of including the community and its knowledge increases the confidence of students and elders. Young people spoke about a new respect for culture and elders.

Cliff: Moyra's article, encompassing as it does issues of philosophy, politics, curriculum, research methods, and ethics, offers much for further discussion (and I see that Dawn's reflections similarly work across many issues and just as naturally). I want to try to choose just a few ideas that seem to me to be especially true to Moyra's argument (which is nicely summarized in her abstract), and stay fairly close to her data and approach.

Dawn, the idea of knowledge lost and knowledge gained is the pivotal issue from which we can build into practical issues of curriculum design, theoretical issues of worldview and research framework, and ethical issues of educational purpose.

There is unquestionably a sense in which IK is a "body of knowledge" with large or small bits that change over time, or slip in and out of use; that their movement applies to many different kinds of knowledge at many levels, and that movement happens for a variety of socio-political, practical-utilitarian and philosophical reasons. As Joni Mitchell sang in *Both Sides Now*, "Something's lost and something's gained from living every day."

Moyra: Yes, the acknowledgement of change makes culture and IK more than a museum curiosity, and one is less likely to become precious or sentimental about it. The example of farmers waiving the questioning taboo is an example.

Cliff: Two issues here are especially interesting to me: first, the loss of IK where we think of IK as a *symbol* (not just "substance"); and second, the very idea of knowledge as body or substance that can be lost and found.

The importance of IK as symbol is everywhere in Moyra's data: IK symbolizes traditional culture and structures, with all of sangomas (healers), indunas (headmen), inkosi (chiefs), cattle (social status), indaba (conferences and meetings), ubuntu (African humanism), and more. In a particular situation, the loss of a particular piece of IK might be appropriate in terms of changing needs and information, but that loss can chip away at the status of a sangoma, the relationships between villagers and the work they do, even the life and death of the village itself. In Moyra's data, there is little acclaim from the community for "something's gained" from recent changes in local knowledge and possibilities in South Africa—not in the practical realms of electricity and health care in the village, nor in the political freedoms of movement, language, and association. Indeed, the community's reports of IK tend to reach beyond the day to day, even the struggles of apartheid, or the more recent struggles of social and economic transformation, to the myths, stories and practices of traditional Zulu life. So, for example, the community celebrates its history of crafts, dances, and ceremonies, but also the prospect of buying from local shops rather than making or growing what they need.

With "knowledge lost" from the village, it is possible to identify lost pieces, count them, explain why they disappeared, explore criteria for their replacement, and speculate on knock-on effects. But as Moyra's article keeps reminding us, there are nuances and depths of IK, alluded to in the idea of worldview, that are at the heart of the issue, and which we risk missing if we consider IK as pieces of knowledge or even a body of knowledge. The loss of IK is largely about roots, history, identity, and ubuntu; with IK both a medium for and the substance of IK. This makes the discussion of "loss of IK" difficult. For example, Moyra is left to talk about the plants that students can't name. Yet the importance for the community of deep notions of nature-aesthetic, collective-self, interdependence, connectivity remains. (I shall return to this later.)

Moyra: Cliff refers to "deep notions," and along with Dawn he queries the term "body of knowledge." Another way to see what is present (i.e., the collective-self; interdependence, …) is to say that the essence is still existent but the form is eroded. Maybe there is a need to affirm or reinvent the form through which the essence is carried. This essence is closer to what I referred to as "worldview."

Cliff: Certainly, a discussion of knowledge gained in IK needs to attend to worldview insights as well as to specific pieces of knowledge; and this was important for the community. It is also important in government emphases on African Scholarship and African Ways of Knowing, not only for the contributions IK can make to local communities, but to scholarship and quality of life worldwide. Gain and loss arise not only for the locals.

My second issue is knowledge as entity and/or relationship. Changes in knowledge occur in all cultures. A focus on threats to African and other "Indigenous" knowledges are important not from the occurrence of change, but from the particular changes that occur, and the socio-political, epistemological and methodological assumptions that operate. For example, many Westerners are prepared to reject an entire African knowledge system because it incorporates spirit forces. This is a major issue. The very act of *talking about* a knowledge system involves choice of a theoretical framework, and that framework itself shapes the discussion. So, a "body of knowledge" is a metaphor that fits easily with a Western-Aristotelian framework, where pieces of knowledge exist like pieces of matter or objects that can be discovered, uncovered, manipulated, and sorted. The knower, the known, and the process of knowing can be thought of separately. African commitments to collective-self, ubuntu, relationships, harmony, and context see knowledge quite differently: more as process than discovery, more as relationship than entity, and more as verb than noun. At the same time, those commitments do not require us to reject the idea of knowledge as entity; rather we need to take account of context and purpose, and the ways these are also shaped by worldview.

Aristotelian logic and Enlightenment ideas of objectivity/subjectivity are deeply embedded in our conceptions of science and research and in the language we use to talk about them. Notwithstanding the critiques of logical positivism and universalist conceptions of "reality," nor the rise of alternatives through constructivism and relativist conceptions of reality, the basic position remains intact: the universalist position has the knowledge object real through its correspondence with the real world, the relativist position has knowledge objects as social constructs, accepted as real objects for the sake of discussion and theory building. The issue then becomes: How can this Western position be enriched and adapted through interaction with African thinking and in the context of African life?

Moyra: Both positions can be enriched, I would think.

Cliff: Yes, but let me attempt to address this question by moving the discussion away from epistemology. Helen Verran (2001) argues that, whether one starts from a universalist position or a relativist one, African and Western systems of mathematical thinking are different and incompatible with each other, as has been widely established in the science education literature. This has ramifications for curriculum policy. In particular, if the two systems are different, it can be argued that they need to be taught as such, preserving the integrity of each. Second, both systems need to be taught (especially in African settings): the African system because it is so important locally, the Western one because it is so important globally. How would an African government justify teaching one system but not the other? And if they are both to be taught, should they be taught at different times or both together in dialogue?

The entire issue is clouded by suspicion that it has arisen too much as an outcome of method and theoretical framework (Aristotelian logic and notions of objectification of knowledge) that closed off other options. For example, the villagers and children in Moyra's study wanted both African and Western ideas, working together, and saw no difficulty with that. The idea of teaching one system or the other, or pitting systems against one another, simply wasn't raised. And when differences between the systems emerged, those differences were generally viewed as points of real interest and educational possibility.

Thus, the issue moves: The point of interest/action is not so much the differences in the two systems that our analyses toss up, but what to do. In other words, what would an effective dialogue/conversation between the different systems look like in the curriculum,

and what would be an appropriate theoretical framework to allow this conversation to flower? Moyra and Dawn have made some suggestions, drawing from ideas of: knowledge as process, self as continuous, participative epistemologies, and knowledge in context. Helen Verran (2001) takes up similar ideas in her "emerging worlds" approach, where reality emerges from reutilized action and is carried in experience.

The effects of seeking these alternatives is, first, to confront the impasse that arises from focusing on differences between Western and African thinking, and second, to employ and develop a theoretical framework more attuned to African experience; hence making a bold new contribution to thinking about science education. The critical political and episte-mological dimension is to break away from ideas of African thought as primitive or inferior, and to look instead to it as a resource to be judged on grounds other than its fit with current Western thinking.

What to teach? Perhaps in this philosophical reaching, I am losing track of the issue most frustrating teachers and curriculum designers: What to actually *teach* in the name of IK in South Africa? Browsing through copies of the journal *South African Association for Research in Mathematics, Science and Technology Education* (SAARMSTE) over the last decade, I see a range of unsatisfactory suggestions, under headings of IK systems, African knowledge, and Nature of Science. Some, as Moyra points out, have followed logics similar to George's described in Moyra's article, with authors identifying bits of IK that fit readily with science, bits that might, bits that don't, and then using the bits variously to make points about science (more than IK). Other researchers, working more from the Nature of Science, have begun from general propositions about science—propositions that in some cases seek the nuances of worldview that Moyra acknowledges as more important than the bits of IK, even though they do not pull together easily as bases of curriculum design.

The issue then is to move towards more complex conceptions of curriculum and teaching, such as have been developed in place-based education, project-based learning, curriculum as story, and so on.

Central to South African curriculum policy are two planks: outcomes-based education and learner-centered education. Clearly, both of these slogans have currency in the inter-national literature in science education. The idea of learner-centered education is readily "adapted" to African thinking through the notion of self that underpins ubuntu: the self is not the free-standing autonomous self of Western thought, but the collective community self. However, I hear in Moyra's article a strong suggestion: shifts in the words and language can help. For example, in her project, the integration of the science curriculum into community development goes well beyond common conceptions of learner-centered education, calling for reconceptualization of school-community, reconceptualization of science, and who teaches it and how.

The deepest issue that emerges for me from Moyra's work is the depth and yet subtlety of worldview in science education and in research, and the degree to which the Western position—whether universalist or relativist—permeates our thinking. As I write, I hear the voices of participants at conference where Moyra has presented her project, complaining, "That's not science" and "That's not research." We need alternatives to these theoretical frameworks.

Like Helen Verran and Moyra, I am troubled by the ramifications of deciding that Western and African ways of thinking are so separate that choices must be made between them, especially if the differences arise in large part anyway from the process of analysis. Alternative frameworks and more appropriate processes of analysis are required. These alternatives need to be more attuned to the Indigenous cultures themselves; drawing on them in creative ways, looking for emerging worlds.

Dawn: I want to focus on the practicalities of IK in the classroom, what Cliff referred to as "What to actually *teach* in the name of IK." Specifically I shall focus on the most effective domains for the dialogue about IK to take place in the classroom. Within the academic community where individuals discuss IK, there is much more analysis of the epistemological premise and worldview commensurability of IK and Western science (WS), and dialogue is often focused on the overlap of epistemologies. Although this dialogue has its value to work through some of the more subtle differences between these worldviews, there is a time where you need to stop philosophizing and try implementing an aspect of IK in the classroom. The reason I argue "just do it" is that the dialogue that will be most valuable in the development and implementation of local IK into the classroom will be the dialogue that takes place at level of the Indigenous community. Moyra's article demonstrates this; her involvement and dialogue with the community initiated some internal discussion among community members, teachers, and students about science and IK: what they are, and how they relate to the lives of students and community members. This bridge between community knowledge and science knowledge that Moyra has created will be there long after she has left the community, and hopefully it will initiate some community-developed programming as it did in northern Manitoba.

As you might see, I do not whole-heartedly agree with Cliff. I see some value in the creation of curriculum that uses some parts of community knowledge or IK in order to teach science content. In this framework or approach, IK is stripped of its worldview and treated similarly to the way WS content is often treated in school. True, we have learned that teaching WS without including a dialogue on the nature of science often leaves students feeling disenfranchised from the content of science. But we had to find that out by first teaching science in a decontextualized way in order to start the dialogue. IK is different in that it could never be taught in a decontextualized format; it must be tied to the land and the community. However, by incorporating snippets of the local IK into the science classroom, a dialogue is initiated between the student, teacher, parents, and community. The dialogue itself is actually much more valuable than the content taught because dialogue will be community-based and it could begin community-driven programming in school science.

I argue this point because it is my own experience. I worked with teachers in a small northern community in Canada and brainstormed how community members and community knowledge could be incorporated into the science curriculum at the middle years level (grades 6–8). The teachers came up with their own ideas and we developed lessons and then taught them. The lessons were not developed with a sophisticated view of worldview or the epistemology of IK or WS, but they were developed with an intimate knowledge of the community and Cree culture. The resulting lessons were engaging and students did make connections between community knowledge and science knowledge. However, the most valuable component to this project was the conversations that occurred between the teachers who reflected on the lessons and the brainstormed modifications that were more representative of their local IK. It has led the teachers to create additional teaching experiences for their students that include the community. Teachers are now beginning to include aspects of worldview at the senior years. So perhaps initially it may seem that early programming efforts appear very superficial in teachers' representation of IK, but teachers may move to a more sophisticated representation of IK once they are given the chance to implement something.

Cliff and Moyra both raise the issue concerning the challenge that IK brings to curriculum developers. Perhaps it is not a challenge at all, in a sense. Perhaps IK cannot fit within the confines of a curriculum that outlines "end-result" learning outcomes. IK is not

transferable in the conventional sense of classroom learning, and consequently, all individuals do not reach the same outcome. This quality of IK conflicts with outcome-based curriculum development. In terms of real practicalities and IK in the classroom, we cannot appropriately represent IK in the current classroom, I would suggest, because the whole notion of how knowledge is transferred from one individual to another differs between IK and Western knowledge in general and institutionalized schooling specifically.

For IK, students must earn knowledge and demonstrate they are capable of using any IK responsibly. The Knowledge Giver decides on the extent to which the IK will be revealed to a Knowledge Receiver; not all Knowledge Receivers will be given the same knowledge. How can we incorporate this process of knowledge transmission into the current institutionalized educational system? I don't think it is possible and yet what would an educational system look like that instituted a coming-to-know process of knowledge transmission? Or is there a possibility of a combined approach to knowledge transmission? Many Canadian schools that have taken a combined approach, I would say, accomplish a transfer of IK during "culture camps" and outings that take place away from the school and are taught by elders. This approach to bringing IK to the school not only values the content of IK and WS, but also the ways in which these two knowledge systems are transmitted.

Moyra: I think it important that both systems (if we think of them as separate knowledges or worldviews) need to be discussed together within the same projects. Conflict is likely to arise in a science lesson; and saying that concerns will be dealt with in another class is to duck the issue. By analogy, we don't need an "apartheid" system of knowledge segregation, with IK removed to its own "homeland."

Cliff mentions place-based education, project-based learning, and curriculum as story. These new creative pedagogies are especially suited to IK and to science integration in teaching. Furthermore, in materially poor communities it is ideal for the projects to be linked to subsistence, entrepreneurship, health, etc., all of which are supported by community-based organizations, for practical reasons. But practicality is also part of a worldview. Integration needs to be across and with knowledges, cultures, communities, and needs. In this we are challenged to look "… for emerging worlds."

Canada seems ahead of South Africa in the IK projects and this is encouraging for us. Some projects in Africa have reported that youth are not interested in learning IK. There is a perception that IK is "so last-century" as some teenagers say. Youth here look to the global players to see what is valued. At the same time, our South African youth experience a conflict between the two (Cameron 2007).

I think Dawn has a good point: "Just do it." In the same way we advocate students learning IK, we should learn how to design curricula and interventions—by working in and with community. This will widen our worldview.

References

Cameron, A. K. (2007). Cultural and religious barriers to learning in basic astronomy: A South African study. Unpublished PhD thesis, University of the Witwatersrand, Johannesburg, South Africa.

Colorado, P. (1988). Bridging Native and Western science. *Convergence, 21*(213), 49–68.

Ermine, W. J. (1995). Aboriginal epistemology. In M. Battiste & J. Barman (Eds.), *First Nations education in Canada: The circle unfolds* (pp. 101–112). Vancouver, Canada: University of British Columbia Press.

Verran, H. (2001). *Science and an African logic*. Chicago: University of Chicago Press.

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