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Introduction

Comprehending the social context of learning, as well as the effect of learners' socioeconomic and cultural backgrounds in the teaching of science is of primary importance if a firm foundation is to be laid for successful pupil achievement and positively affect outcomes of science teaching and learning process (Aikenhead & Huntley, 1999; Cobern, 1994; Driver, 1979; Jegede, 1995; Ogawa, 1986; Ogunniyi, 1988; Solomon, 1987). An IK responsive curriculum is likely to fulfill the millennium development goals which point towards 'education for all' and 'science for all.' These notions have to grapple with cultural diversity from one country to another as well as equality. There are other populations who by virtue of language, ethnicity, geographical location, and/or politico-economic status, which are under served by Eurocentric education systems. The increasing scholarship on cultural diversity in science education points towards an acknowledgement of an inherently Eurocentric and hegemonic universalistic Western science. An upsurge in the criticism of Western Science Epistemology (Williams & Muchena, 2004) has reinforced further the impetus of research into IK. The relevance of a Eurocentric science curriculum in an African nation is suspect (Adora-Hoppers, 1999). However, despite all these criticisms, not much has been done to reflect IK in the formal school curriculum and there is a general assumption that science teachers have the necessary knowledge or pedagogical skills to bring about the integration of the two systems of thought.

Integration of IK with school science is important in order to prevent a cultural clash whenever students attempt to learn meaningful school science (Aikenhead & Huntley, 1999). A science curriculum that is responsive to IK enables sustainable development, environmental responsibility, and cultural survival (Emeagwali, 2003). School science integrated with IK will facilitate the easiness with which students cross cultural boarders into school (western) science (Ogunniyi, 1988). Jegede (1995) refers to this as collateral learning, which according to Aikenhead (2002) encourages meaningful learning of science.

In Zimbabwe there is a wide gap between the culture of formal education and that of the majority of students (Shizha, 2005). The secondary school science in Zimbabwe is a legacy of the British colonial education system which tends to ignore or not adequately respect or acknowledge the contradictions between students' private or public lives (Shizha, 2005). Education policy and syllabi documents bear little to no resemblance to students' real cultures albeit the science syllabi goals stating the need for a student centered approach to the teaching and learning process. If a learner centered approach is to be taken seriously it should include students' traditional cultural knowledge which they bring into the science classes. A school science curriculum that integrates IK is yet to be designed in Zimbabwe. If such a curriculum reform is to be undertaken science curriculum will need to be aware of how science teachers perceive IK. This will provide information that will guide science teacher educators and supervisors to plan for effective curriculum reform in view that teachers are the key to any curriculum change endeavor; they can make or mar any of its curriculum no matter the quality of its design or content (Ogunniyi, 2005).

This case study explores secondary school teachers' conception of indigenous knowledge in science curriculum in the context of Mberengwa district, Zimbabwe. In pursuance of this goal answers were sought to the following questions:

· What are some views science teachers holds about the nature of IK? 3
· Why do these teachers have these views of IK?
· What are some views of science teachers on the role of IK in their teaching?

This study forms a backbone upon which future research into the formulation of IK responsive science curriculum for Zimbabwean schools may rest upon. The study challenges science teachers, teacher educators and science curriculum developers within the Educational Services Division of the Ministry of Education, Sports and Culture (MOESC) to start thinking about the formulation of an IK responsive science curriculum basing on the findings of this study and other related studies. The study reinforces the momentum that is gaining ground in the area of IK/School Science integration through refocusing it into the Zimbabwean situation with particular focus to a rural area.

Literature Review

According to Mosimege and Onwu (2004, p. 2), indigenous knowledge is an all-inclusive knowledge that covers technologies and practices that have been and are still used by indigenous and local people for existence, survival and adaptation in a variety of environments. Such knowledge is not static but evolves and changes as it develops, influences and is influenced by both internal and external circumstances and interaction with other knowledge systems. Such knowledge covers contents and contexts such as agriculture, architecture, engineering, mathematics, governance and other social systems and activities, medicinal and indigenous plant varieties, etc. Indigenous knowledge hence refers to the philosophies, indulgences and expertise developed by long resident societies in their interaction with their natural surroundings and other peoples.

For rural peoples, indigenous knowledge informs decision making about fundamental aspects of everyday life. Indigenous knowledge is vital to a cultural complex that also encompasses 4 education, language, systems of classification, resource use practices, and social interactions, highly is embedded within a metaphysical framework. The recognition that local and indigenous peoples have their own ecological understandings, conservation practices, resource management goals (Emeagwali, 2003), and ways of educating their siblings has important implications. It transforms the relationship between school science educators and local communities.

While education programs provide important tools for human development, they may also compromise the transmission of indigenous knowledge. With formal education, children spend more time learning passively in classroom settings, rather than engaged in hands-on learning on the land. Teachers replace parents and elders as the holders of knowledge and authority. National languages (European) become the medium of instruction, while vernacular languages (ChiShona and IsiNdebele) are side-lined. Formal education may therefore contribute to an erosion of cultural diversity, a loss of social cohesion and the alienation and disorientation of indigenous youth.

There is an urgent need to enhance the intergenerational transmission of indigenous knowledge, as a complement to mainstream education. In Zimbabwe very little effort have been made to bring indigenous language and knowledge into school curricula, and to move learning back into the community, thus reaffirming the status of elders as knowledge holders. Meanwhile, differences between scientific and indigenous world views continue to create barriers to meaningful collaboration, as does the widespread assumption that science is superior to other knowledge systems. These unique ways of knowing are important components of the world's cultural diversity, and provide a foundation for locally-appropriate sustainable development.

Since the 1980s there has been redevelopment of the science curriculum in many of the world's developed nations in line with the ideology 'science for all' (Michie, 2005). 'Science for all' typically focuses on scientific literacy for all citizens as well as promoting Science and Technology as a way for national advancement.

Curriculum development in some developing countries is being undertaken as a global project rather than inclusive of the needs, policies and cultures of the host nation (Ryan, 2003). Ryan (2003) described how expatriate education consultants in Papua New Guinea have developed and are now implementing a science curriculum which bears the footmarks of a globalized curriculum with little acknowledgement of government policies or of the needs of indigenous population.

In some industrialized nations with minority indigenous populations such as Australia, New Zealand, Canada, United States of America (USA), indigenous knowledge has been recognized as a valuable teaching resource (Michie 2005). This is unlike the trend observed by

Ryan (2003) in the developing world. However, Bell (2003), observed that even though initiatives in the developed world such as the Maori Science curriculum in Aotearoa New Zealand have been initiated, their uptake by students, teachers and schools has still been eclipsed by the western curriculum.

In North America there have been inputs from several indigenous people (e.g. in Alaska: Kawagley, 1995; Kawagley, Norris–Tull & Norris–Tull, 1998; USA: Cajete, 1999; Canada: Maclvor, 1995), trying to resolve the tensions between the need to understand science in a developed world with their own cultural ancestry. Similar efforts have been made in Aotearoa New Zealand (McKinley, 1996; McKinley Waiti and Bell, 1992), the Islamic world (Haidar, 1997, 2002; Loo, 1996) and South Africa (Naidoo, 2005).

However, despite all these developments, voices have been heard retrogressing to a universal science (school science). Such a voice is that of Abdus Salam, one of the leading physicists of the Arab World who according to Alvares (2005) expressed:

There truly is no inconsonance between Islam and modern science…What gives one hope is that there are Muslim scientists working principally (though not exclusively) in developed countries who have registered the highest attainments in science. This implies that it is basically environmental factors in our societies which need to be corrected.

This, however, could be true for those students who by nature are destined to be scientists and not for the majority of indigenous students (Fakudze, 2004; Ogunniyi, 2010). Science trained teachers in non-western countries generally, ascribe to concept of the universality of Science (Michie, 2005). A study by Ogunniyi, Jegede, Ogawa, Yandila and Oladele (1995), showed that science teachers in non-western countries share a similar worldview towards western science with minor variations from one culture to another.

The UNESCO (1999), sponsored Science for the Twenty-First Century conference held in Budapest came up with two statements; the 'Declaration of Science and the use of scientific knowledge' and 'Science agenda: Framework for action'. In the Declaration of science and the use of scientific knowledge it states, …traditional and local knowledge systems are dynamic expressions of perceiving and understanding the world, can make and historically have made, a valuable contribution to science and technology, and that there is need to preserve, protect, research and promote this cultural heritage and empirical knowledge. science curricula should include ethics, as well as training in the history and philosophy of science and its cultural impact.

The Science agenda: Framework for action (UNESCO, 1999) focuses on actions that promote the use values of indigenous knowledge, rather than the worldview aspect of other systems of knowledge and suggests that: 83: Governments are called upon to formulate national policies that allow a wider use of the applications of traditional forms of learning and knowledge, while at the same time ensuring that its commercialization is properly rewarded.

Countries should promote better understanding and use of traditional knowledge systems, instead of focusing only on extracting elements for their perceived utility to the S &T system. Knowledge should flow simultaneously to and from rural communities.

Responding to the UNESCO (1999) call, a number of indigenous writers have argued for the importance of connecting school science education to the students' cultural background (Cajete, 1995; Kawagley, 1995; Kawagley and Barnhardt, 1999; McKinley, 1997). McKinley (2005) divided this argument into two strategies. The first being making science 'relevant' to the student, which usually involves teaching cultural relevant context or everyday science. This direction is what Naidoo (2005), referred to as integration of IK into school Science, which is unidirectional, reflecting IK as small, less useful, grounded and is tantamount to assimilation. The second strategy directs towards improving indigenous students learning through what Bishop & Glynn (1994) and Ladson–Billings (1995), called more appropriate teaching approaches and models, that is culturally responsive teaching or culturally based pedagogy. The Contiguity Argumentation Theory (CAT), rooted in the Contiguity Theory, is a learning theory traceable the Aristotelian Contiguity Theory. CAT asserts that two distinct coexisting thought systems such as science and IKS, tend to readily couple with, or recall each other to create an optimum cognitive state (Ogunniyi & Hewson, 2008). This type of association has sometimes been considered the basic type to which all others are reducible. Associationism is therefore a theory of the structure and organization of the mind which asserts that every mental state is resolvable into simple, discrete components. In addition, mental life is explicable by the combination and recombination of these simple, discrete components in conformity with the laws of association of ideas (Runes, 1975 as cited by Ogunniyi, 2008). CAT regards such elemental ideas as dynamic organizing conditionals or "frames of reference" that galvanize the process of association or learning in general depending on the context in question. CAT holds that claims and counter-claims on science and IKS can only be justified if neither thought system is 8 dominant (Ogunniyi, 2008). There must also be valid grounds for juxtaposing the two distinctive world views within a given dialogical space. The dialogical space facilitates the process of rearticulation, appropriation, and/or negotiation of meanings of the different world views.

According to Ogunniyi (2008), students must therefore be able to negotiate the meanings across the two distinct thought systems in order to integrate them. CAT recognizes five categories that describe the movement of conceptions among students involved in dialogues warranting the mobilization of scientific and/or IKS-based conceptions which are: dominant conceptions, suppressed conceptions, assimilated conceptions, emergent conceptions, and equipollent conceptions (Ogunniyi, 2008). Ogunniyi (2008; 162) goes on to refine the conceptions as:

A conception becomes dominant when it is the most adaptable to a given context. However, in another context the same dominant conception can become suppressed by, or assimilated into another more adaptable metal state. An emergent conception arises when an individual has no previous knowledge of a given phenomenon as would be the case with many scientific concepts *and theories e.g., atoms, gene, entropy, theory of relativity etc. An equipollent conception occurs when two competing ideas or world views exert comparably equal intellectual force on an individual. In that case, the ideas or world views tend to co-exist in his/her mind without necessarily resulting in a conflict e.g., creation theory and evolution theory. The context of a given discourse plays an important role in the amount or intensity of emotional arousal experienced by the participants in such a discourse.*

The multicultural debates are connected to other prominent debates in science education aimed at inclusion, such as, the constructivism, 'science for all' and Science, Technology and Society (STS), that concern ways pedagogical change can improve learning and achievement in science of a wider range of students (McKinley, 2005).

Methodology

The study is located within the broad category of qualitative research. The qualitative research's exploratory study was premised on a socio-cultural constructivist epistemology that construes learning as a socio-cultural activity in which learners and teachers play specific roles and negotiate meanings from mutual interaction.

The research was carried out in one rural educational district of Mberengwa which is located in south-eastern tip of the Midlands Province of Zimbabwe. The District is mostly habited by the Indigenous Shona speaking people of the Karanga dialect. The Karanga are a group of Shona speaking people in the southern part of Zimbabwe. The Shona dialectical groups comprise the Zezuru, in the central part of the country, the Korekore in the North, the Karanga in the south, Manyika in the east, the Ndau in the south-east and the Kalanga in the south-west (Bourdillon, 1976). Most of the Karangas live in the Mberengwa district in the Midlands Province. But there are several other groups in the neighbouring Zvishavane and Shurugwi districts in the Midlands Provinces and Chivi and Zaka districts in the Masvingo Province. There are, however, a few isiNdebele speaking people in some few villages. The IsiNdebele are descendants of migrants from South Africa during the Chaka, Zulu wars. The paper makes a special focus on the Karanga of Mberengwa for special reasons. Not much has been produced on Mberengwa in the arena of science education and indigenous knowledge. Apart from missionary records of von Sicard (1930) Soderstrom (1984); historical references by Ranger (1967), Bhebe (1979), Beach (1980); there is definitely scarcity of material which relates to Mberengwa. Mberengwa covers an area of about 7,800 km2 between the 20th and 21st parallel. The altitude is about 1,000 feet (330 m) above sea level in the southern part and 5,377 feet (1639 m) at the peak of Mount Mberengwa. Geographical features portray Mberengwa as a 'hot and dry' area, a 'natural veld suitable for ranching.' Mberengwa is also marked by erratic rainfall and droughts.

Administratively the area is divided into sixteen chiefdoms under the leadership of a chief and headman who report to the district administrator (Bourdillon, 1976). The economy comprises agriculture and small scale mining (gold, chrome, emeralds, and asbestos). As documented in the Portuguese records, the term ‘Karanga’ was used to refer to the ancestors of the present Shona people. The meaning of the term ‘Shona’ is very controversial. It derives from the designation ‘Svina,’ which means ‘dirty,’ introduced by the Ndebele to scold the Shona captives. The Shona were also called derogatorily ‘Holis,’ which means ‘captives,’ ‘bush draggers,’ and ‘Shabi,’ ‘peddlars.’ Initially the Shona did not like the use of this term, but the Europeans adopted it and applied it to all dialectical groups. Researchers concur that not much has been published that links directly with Mberengwa. All this confirms that the Karanga offer a viable case for study. Besides, the principal author was born and attended Primary school up to High school in Mberengwa. He speaks Karanga and is at home with traditional beliefs and practices in the district. So the paper tapes on an 'internal perspective.' But the authors are also conscious of the fact that an 'insider' may not free himself of certain prejudices and thus may not be as 'objective' as anticipated.

Two schools in Mberengwa District were purposively selected as per the researchers’ convenience and because of their situation in the same rural area. Both schools implement a national science curriculum provided by the government's Zimbabwe School Examination Council (ZIMSEC).

Participants

A comprehensive sampling of science teachers in the purposively selected schools was done which resulted in the inclusion of five qualified science teachers from the two secondary schools. The research participants have been recruited and employed by the Ministry of Education, Sports and Culture (MOESC) officials on behalf of the schools and have been 11 exposed to scientific and traditional world views through their interaction with the community and through the science lessons they received from primary schooling through tertiary education.

The science teachers are indigenous Zimbabweans which made them likely to have been exposed to similar politico-socio and economic conditions, and were likely to be familiar with the traditional practices found in this particular socio-economic cultural environment.

Data Collection

Permission was sought from and granted by the Head teachers to apply the research instruments. In order not to bias results, the researchers informed research participants that he was conducting ‘…a case study on science teachers' personal experiences, feelings, thoughts, and opinions on students' culture and school science’. This wording was used because it was considered vague but at the same time indicative of the general area of study. Participation was voluntary.

At each targeted school two interviews were applied per individual. The interviews were carried out in the teachers’ offices and a notice was placed on the outside of a closed door reading 'OUT OF OFFICE' to prevent disturbances. A preliminary interview session lasted about 40 minutes. The preliminary interview elicited secondary science teachers' professional qualifications and years of teaching experience after training. The preliminary interview also helped in building trust and rapport with respondents, thus making it possible to obtain information that the individual probably would not reveal by any other data collection method (Gall, et al, 1996). This was followed after two weeks by an in-depth interview which triangulated on earlier gathered information as well as probing further.

The in-depth interviews were lasting around one hour thirty five minutes. The science teachers' conceptualisation of IK was probed by the in-depth interviews. A standard interview guide derived from an adaptation of Ogunniyi and Hewson (2008)'s NOS-IKS questionnaire was 12 used for the in-depth interview. Participants were asked to frame their responses around specific instances of action to better exemplify their inclination towards IK or Western science in their teaching. All participant identifiers were removed from materials and analytic notes were taken throughout the interviews to assist in the process of identifying themes from the data (Maxwell, 1996). Transcriptions from the ten interviews were coded using an open coding, constant comparison process (Creswell, 2007). Category saturation was obtained after a thorough review of the transcripts by the researchers (Strauss and Corbin, 1998). A matrix was developed to assist in visualizing the various themes (Creswell, 2007) which emerged and to identify any connectedness, and therefore aiding in collapsing/merging themes. Responses were recorded by the researchers through hand written notes and also in short memory (Wiersma, 1991) which was later recorded by the researchers.

The researchers finally sampled homework and test exercise books as well as teachers' schemes of work to find out how the science teachers comment on the students who reveal incidents of cultural border crossing into IK. The researchers requested for students' homework and test exercise books and randomly selected fourteen books per class of forty five students taught by each research participant making up a total of two hundred and eighty student books.

Data Analysis

The researchers sought permission and analyzed the teachers' schemes of work. A content analysis of these documents was carried out in order to gain some insights on how the teacher responds to students who showed cultural border crossing into IK (Aikenhead and Huntley, 1999; Fakudze, 2004; Ogunniyi, 2005). The content analysis of document findings was written down by the researchers. Data analysis A constant comparative technique was used to analyze data during collection. This guided subsequent collection of data to ensure satisfactory triangulation. The content analysis technique was employed for post field data analysis. Content analysis involved category development and refinement, coding content of text according to categories, aggregating the coded text into categories, and describing and interpreting the meaning of the categorised data to arrive at substantive conclusions (Tesch, 1990).

The findings are reported in the following categories: Teachers' biographical data, Science teachers' understanding of IK and ways in which science teachers make use of IK in science instruction. These categories are further subdivided according to emerging themes. Individual or less popular viewpoints that are not easily fitted into the main sub themes are reported in the text that follows each table.

Teachers' Biographical Data

Table 1. below presents biographical data from preliminary interview of teachers who participated in this research.

Teachers' professional qualifications and years of experience in the teaching services after training.

Teachers' identification code
Professional qualification Experience after training (in years)
T1 Certificate in Education Diploma in Special Education Over 15
T2 Licentiate Degree in Education(Biology) 6-10
T3 Licentiate Degree in Education(Physics) 6-10
T4 Licentiate Degree in Education(Chemistry) 11-15
T5 Diploma in Education Bachelor in Education Over 15 Table 1.

The respondent's identification code becomes important because in the sections below these participants are extensively quoted. The reader may wish to interpret those quotations in light of the teachers' biographical data. While Table 1. provides objective biographical data, the reader may want to know each participant more subjectively. This information was gleaned from the interviews by paying attention to key incidents, defining metaphors, or pervasive themes, supplied by the interviewees themselves.

All the science teachers who participated in the case study are senior teachers who have been in the teaching field for over five years. The teachers can be said to have accrued enough experience to be able to reflect on their work experience. Most teachers (80%) are degreed except for one who holds a three year certificate in education and a diploma in special education.15

Statement Agree Disagree Left out 1 (i).
Nature is real, observable and testable T3, T5 T1, T2, T4 (ii).
Nature is real, partly observable and testable T1, T2, T4 T3, T5 2 (i).
Space is real and has definite dimensions T1, T2, T4, T5 T3 (ii).
Space is real and has definite dimensions but ultimately incommensurable T1, T2, T4, T5 3 (i).

Time is real, continuous and cyclic T5 T1, T2, T3,T4 (ii).
Time is real and has continuous, irreversible series of duration T1, T2, T3,T4 T5 4 (i).
Matter is real and exist within time and space T1,T3,T4 T5 T2 (ii). Matter is real and exist within time, space and ethereal realm T5 T1,T3,T4 5 (i).
Events have both natural and unnatural causes T1, T2, T3,T5 T4 (ii).
All events have natural causes T4 T1, T2, T3,T5 6 (i).
The universe is orderly, metaphysical, partly predictable and unpredictable T1, T2, T3,T5 T4 (ii).
The universe is orderly and predictable-that is nature is not capricious T4 T1, T2, T3,T5 7 (i).
Scientific laws (generalizations) are causal, logical, rational, impersonal and universal T4, T2, T3,T5 T1 (ii).
Scientific generalizations have causal, logical, rational, impersonal and universal T1 T4, T2, T3,T5 8 (i).
Language is important to workings of the natural world T3,T4 T1, T2,T5 (ii). Language is important as a creative force in the workings of both the natural and unnatural worlds. T1, T2,T5 T2, T4 9 (i).
Science is culture free T1, T5 T2, T3,T4 (ii). Science is a critical part of culture T2, T3,T4 T1,T5 10 (i).
IK is concerned with 'what' not 'what ought be' T4,T5 T1, T2, T3 (ii) IK is concerned with 'what' not 'what ought be', and 'why' T1, T2, T3 T4, T5 11 (i). IK is based on a dualistic worldview T1, T2, T3,T5 (ii).
IK is based on monistic worldview T4 T1, T2, T3,T5 12 (i).
Generalisations within IK are relative statements which do not purport to have universal applications T4 T1, T2, T3 T5 (ii).
IK generalisations (laws & theories) are declarative statements with universal application T1, T2, T3 13 (i).
Humans are capable of understanding only part of nature T2 T1, T4, T3,T5 (ii).
Humans are capable of understanding nature T1, T4, T3,T5 T2

Science Teachers' Understanding of IK

The in-depth structured interview probed science teachers' understanding of IK basing on pairs of statements. Of each pair of statement only one corresponded to underlying assumptions of IK (which will be in bold in the table) and the other one to a Western scientific assumption. The results obtained are reported in Table 2.

Table 2. Science teachers' understanding of IK.

Table 3. shows the statements corresponding to IK to which each science teacher is agreeable and this is expressed as a percentage of the statements which were given.

Teacher IK assumption statement # % agreement to the 13 statements

T1 1(i); 2(ii); 5(i); 6(i); 7(ii); 8(i); 10(ii) 54
T2 1(i); 2(ii); 5(i); 6(i); 8(i); 9(ii); 10ii; 13(i) 67
T3 5(i); 6(i); 9(ii); 10(ii) 33
T4 1(i); 2(ii); 9(ii); 11(ii); 12(i) 38
T5 2(ii); 3(i); 4(ii); 5(i); 6(i); 8(ii) 50 Table 3.

Science teachers' percentage agreement to IK assumption statements From the structured interview T1, T2 and T5 managed to identify above half (50%) of the statements which correspond to some assumptions underlying IK. The most identified as inherent to IK are 2(ii), 5(i) and 6(i) which were identified by four teachers and the least identified which were identified by a single teacher are statement 3(i), 4(i), 7(i), 11(ii), 12(i) and 13(i). The in-depth interview data produced in-depth results about the science teachers' understanding of IK. The unstructured interview data is presented in table 4. according to subthemes which emerged upon analysis of the scripts from the interviews.

Sub-themes: Teachers' understanding of IK Representation (phrases, words) Mentioned by Culture Traditional; Local; Home-based knowledge; Related to the environment in which one grew up in; African T1, T2, T3, T4, T5 Metaphysical African beliefs; We consult traditional healers who throw bones in order to diagnose illness; We have knowledge of zvipfira {a small reptile} whose tail is used by wives to bewitch their husbands T3, T4, T5 Innovation, adaptation and experimentation Affected by our surroundings; Different herbs tried when one is ill; Helps in the cure of many diseases. T1, T2, T3 Dynamic Changes in line with culture T1

Table 4. Science teachers' understanding of IK

As can be noted in Table 4., the sub-theme culture as a conception of IK is identified by all five teachers. This cultural view of IK stems from the fact that IK is generated within communities of long residents, it is location specific (Michie, 1999; MOST & CIRAN, 2005), it is the way how local people perceives their relationship with the environment. However, in the structured in-depth interview only T2, T3 and T4 identified science as a critical part of culture which means that they might as well be agreeable to taking IK as science as well, since they have also indicated to it as dependent on culture or they might be talking of both science and IK as part of culture. T2 clarifies this enigma as follows, Science is universal, IK is a local agreement. It is not science; we talk of *Ngozi and Midzimu* {Spirits of vengeance and Ancestral spirits} there is no proof for the existence of these things, we just agree that they are there.

The metaphysical dimension of IK was directly identified by T4 and T5 although the examples of IK given by the teachers in one way or the other pointed to the fact that IK is intricately associated with the ethereal realm. IK does not make any distinction between the mind and matter. It is based on an anthropomorphic and monistic view of the world (Ogunniyi, 1988).

T5 gave the following example which demonstrates that IK is metaphysical, Our knowledge of an owl is that it is a bird of evil and is used at night by witches; we know that it is active at night and sleeps during the day. This knowledge is different from that of a westerner who will only identify an owl as just a bird with particular feeding habits.

The 'evil' part is metaphysical and it is intricately associated with darkness. T4 indicated, 'an African believes in something which has not been proven scientifically'. What T4 fails to realize is that IK may provide explanations that serve an entirely different aspect of reality than mechanical and material one. T5 disagree with T1,T2 and T3 and goes on to reflect, 18 There is no experimentation in IK. What is evident is a lot of imagination, for example, it is said that you can rid a maize field of maize stalk borer pests through taking one such pest and piercing it with a Mopani stick and placing it on the edge of the field. The rest of the stalk borer pests in the field will die. T1, T3 and T4 indicated that IK is problem solving and thus experimental in that the 'types of medicine prescribed by traditional healers have been tried over centuries and have been verified to cure particular disease'. Upon reflection T2 said, 'the herbs have not been verified in terms of dosage to be given and whether the medication present side effects or not'. He preferred to say, 'IK partially is problem solving'.

Although participants were not able to identify all key assumptions associated with IK in the structured in-depth interview, some of the key assumptions not identified in the questionnaire we identified by the teachers during the unstructured interviews, for example, only T4 identified generalizations in IK as relative statements which do not purport to have universal applications, but in the unstructured interview T1 argued that IK 'changes in line with culture, it is relative, it is not international'. T4 also reflects that 'IK is about African situations, experiences'. Maybe the reason why the teachers fail to identify this in the structured interview is the more technical language in it.

Science Teachers' View on How IK Influences Success in Learning School Science

In order to have an insight into how science teachers view the influence of IK on success in learning School science two questions were asked in the unstructured interviews. One question was directed towards whether the teachers identified IK as presenting students with difficulties or advantages in their learning of science and the other one was on whether the teachers noted any evidence of IK presence during their science lessons. One major and consistent finding in science 19 education research over the past 20 years is the recognition that students' preconceptions (their everyday common knowledge) often inhibits their learning of science because their preconceptions make more sense to them than many of the counter-intuitive concepts found in science. Consequently, students resist re-conceptualizing (or rejecting) their prior knowledge (Driver, Asoko, Leach, Mortimer & Scott, 1994). This is evident in the interview findings when for example T5 says, *Pupils are afraid of frogs, cockroaches, climbing mountains and even eating mango fruits from a mango tree growing on a grave. There are some taboos associated with these things and pupils will not listen to you if you try to say for example, a fruit is just a fruit it does not matter where it is found and even so the cadaver is deep down where roots will not reach.*

These cosmological issues inherent in IK as observed by T5 will retard success in learning school science if the syllabus requires the carrying out of experiments which involve manipulation of a frog for example, or the climbing of a mountain. T5 put it more coherently by saying, If you want students to study about sewages even if you provide them with gloves and gas masks, the pupils will still feel uncomfortable with handling and studying human refuse. In our culture one who handles feces is referred to as a mental challenged person, ibenzi (mad).

Table 5. reports on some emerging categories from the unstructured interviews. These emerging themes are triangulated through analysis of schemes of work of the teachers in order to verify whether science teachers reflect IK as influencing learning of science through the comments which they give students. 20

Influence of IK on Success in Learning School Science Representation (Phrases, Words)

Mentioned by Antecedent concepts Pupils in our area are disadvantaged in such topics as fossil fuels, pollution from industries but they perform better in for example, topics on interactions between organisms. They perform badly because things they learn are not there at home. They have no background information. They have no contact with scientific reality. Lack of exposure to the scientific modern world. Not exposed to technology. T2, T3, T4, T5

Language No mastery of English Language. Difficulties in explaining scientific concepts in English. T1, T3, T4

Creation of Misconceptions

Some ideas from home influence acquisition of scientific concepts, e.g., for pupils salt will remain Sodium Chloride, the one which is consumable (NaCl) and not any other salts. Pupils have a high mastery of unscientific methods of contraception from their homes, e.g., they will tell you that jumping over a certain plant will prevent conception. Children have a different conception of lightning from the scientific one which we teach. No matter how we teach the home belief remains and the child might forget the scientific explanations but not the home ones. Observations in pupils is synonymous with seeing and not the use of other senses and if I request them to observe they will concern themselves with what they can see with their eyes. Ideas from home are a big problem. Sexual issues in our community are taboo, so, when teaching sexual reproduction boys tend to become excited and girls shy. Girls will not participate in the lesson and hence perform badly. T1, T2, T3, T4, T5

Table 5. Influence of IK on Success in Learning School Science

T2 was the only one who recognised that IK can have some positive effects on the successful learning of school science. He argued, 'our pupils perform better in topics like ecology and natural resources….they are aware of these things from home'.

On answering the question, 'which difficulties are presented by your learners when learning school science?' most were articulate and persuasive in denying (or marginalizing) any cultural conflict between the scientific ways of knowing (T2, T3, T4 and T5). The teachers' explanations on learners' difficulties in the scientific way of knowing pointed realistically to a variety of students' inadequacies, for example, inadequacies in 'their talents to learn school science' (T2), 'language' (T1, T3 and T4), 'mathematical skills' (T1 and T4), 'academic orientation' (T3 and T4), 'motor skills development which enable the carrying out of experiments' (T1, T2,T4 and T5) and 'the exposure to positive scientific applications'. Not even a single teacher broke through this wall of excuses to see a more fundamental issue of cultural 21 conflict for his students in learning school science. What these teachers failed to coin down is the fact that language is part and parcel of their indigenous knowledge and that perhaps even if 'positive scientific applications' are presented as put forward in the experiments which the students carry out weekly, this might not even impact on the students as they refuse acculturation (Jegede, 1995), cultural imperialism (Battiste, 2002) through the 'arrogance of ethnocentricity' (Maddock, 1981, p. 13).

How Science Teachers Make Use of IK in School Science Instruction

Table 6. is derived from the unstructured interview when teachers were asked to reflect on how they make use of IK in their science lessons, if they do.

As motivation I start my lesson from the things my pupils know, e.g., when teaching food chains, I start by asking what is eaten by what.

They might end up with something like; Grass→ Cattle→ Humans, and I then move on to teach about the Producers→ Primary Consumers→ Secondary Consumers. I drive my lessons' motivation from the knowledge my pupils bring from home which is wrong (misconceptions)

T1,T2

Use of Shona Language as a vehicle for learning school science

It is important to clarify scientific concepts in Shona. If we teach in English language throughout the pass rate in science will reach a bottom low level, I tell you.

T4

For illustrating school science concepts

I give examples from their homes, e.g., when teaching about insulators, I ask people to reflect on types of materials making up pots' handles. Use examples from their homes, e.g., we sit around the fire during winter, how heat pass to us from the fire can be used to explain radiation.

T1, T2

Use of IK resource material in science instruction

Use of pots made of dagga, pfuko, when teaching heat transfer.

T1

Table 6. How Science teachers make use of IK in School science instruction.

T4 indicated that he rarely made use of IK in his teaching of science. T4 thinks Ideas from home are a big problem. They most often counter the acquisition of scientific concepts….Pupils need to practice with a number of examples in science lessons and this, maybe, might help them to abandon these ideas from home.

T4 sees his role in science instruction as that of eliminating the ideas which his students bring from their homes. On the other hand T4 acknowledges to using Shona language to facilitate mastery of scientific concepts. Some teachers however, acknowledge that trying to employ IK in school science brings about a number of challenges such as: the teachers' beliefs that their role was to teach scientific concepts and theories as required by the syllabus, their fears about how to manage the diversity of ideas, their religious fears. T1 exposed his cosmological fears saying 'if you talk about lightning carelessly to your students they will inform their parents and you will be stricken, unokiriya rakacheka nyika (you die in broad daylight), you will surely die in broad daylight'. From the responses given by the teachers during the interviews it can be noted that they think IK/School science integration is essential and beneficial to students' learning, but at a practical level it does not seem that these beliefs are translated into action. Although teachers gave varied examples on the integration of some IK content and school science, upon analysing their schemes of work which are the documents guiding their teaching, not a single inference was made in these about IK and its possible role in the teaching and learning process. The activities which appear in their Schemes of work ranged from experimental work, teacher expositions, written tests and teacher demonstrations. This indicates that if the teachers integrated any IK in their teaching it would have been incidental. Maybe the reason why IK is not evident in the Schemes of work is that the teachers are bound by examinations syllabuses from ZIMSEC and the success of students in learning science is measured in terms of learning outcomes which are evaluated at the end of a four year period through a final (terminal) examination from ZIMSEC. It is possible that since Schemes of work are official documents and for example English language is the official language through a government policy directive, it would be out of line to 23 indicate in the Schemes of work that 'I had to explain this concept in Shona because the students failed to understand it in English language'.

In the students' exercise books what was more evident was English language spelling errors, use of wrong words and grammatical errors. In some selected books, flask was spelt 'lack', sources as 'sourses' and medicine as 'medisene'. One form one student expressed himself this way, "One apparatus use in the lab is flax it is used to putting medisene or chemicals". T1 marked the student wrong by placing a red line below the words medisene and chemicals. Besides having problems expressing himself in English language the student's IK might be aiding this difficulty because from his home knowledge the words medicine and chemicals are synonymous and are referred to as mushonga, so to the student there might be nothing wrong to co-opt medicine for chemicals. Spelling errors are also evident in the above statement. The statement might also provide proof for the teachers' assertion that they teach in Shona in order for students to understand but it seems they are not doing enough to reinforce the 'English language mastery' as these students will be expected to answer questions in English and not in their mother tongue which had helped them to master the scientific concepts. A Form four Physical science student also expressed herself this way, 'The coil is moved in and out of the magnet the current is produced because when the coil move in the field lines is cutting and when moves out there is also present cutted so the current is produced'. Language expression problems were also evident among form three Biology students. One student wrote, 'when experimenting with plant leaves water is not remove because when we remove water the plant become dead'. T3 marked this student correct and did not indicate on the language expression problems evident here. This might be due to the fact that T3 recognises that there are problems in 'English language mastery' and hence resort to deciphering to get through to any slight approximation to the expected answer. On the other hand T4 commented in some exercise books giving such comments as, 'language not clear; what?'

In the Physical science subject what was more pronounced were mathematical calculation problems in students' exercise books. These might be due to no collateral learning occurring because what students learn in Physical science is mostly based on formulae which cannot be easily linked to the students' IK and hence there will be impossible border crossing, resulting in rejection of incoming information. If IK resources would have been used in the teachers' work as exemplified by T1 when he said 'when teaching about separation of substances the use of rusero, a flat winnowing basket, is a good start point' then two of T2 students as indicated in their exercise books would have given a better answer than saying, 'solids are separated from liquids by winnowing' or as the other student said, 'liquids with different densities can be separated by winnowing dense liquid float on top of the more dense liquid'. These students were marked wrong and no comment was written by the teachers in the students' exercise books. However, upon carrying out a retrogressive interview with T2 he indicated, discussions were carried out in the classroom after marking in order for students to correct where they went wrong. There are too many students to teach and there are too many books I have to mark, so it becomes impossible to comment on every exercise book. IK was evident in the students' exercise books and the teachers marked these students' answers as incorrect. One student at this level expressed herself this way, ' we want to kill the leaf', referring to the process of placing the leaf in hot water in order to stop metabolic reactions in the leaf through the denaturation of enzymes in the leaf as well as the removal of the cuticle. Another student expressed himself this way, 'to soften the leaf because after boiled in boiling water, it will be hard'. The first student is aware through her IK that the stoppage or breaking down of anything is killing. An example of this 'common knowledge' is to refer to a car which has broken down as being dead, yafa (dead). To an indigenous pupil there is therefore no reason of not referring to the leaf as being 'dead'. Four out of twelve students' exercise books selected, referred to the 'boiling of the leaf', instead of 'place a leaf in boiling water'. This might be valid if translated literal into Shona, but in science only liquids boil when the partial pressure of their vapours equal the atmospheric pressure. The teacher did not comment in the exercise books. A form three Integrated Science student of T3 wrote, 'people slip on polished floor because he want to avoid dirty' and another one also wrote, 'fertilization is the fusion of male and female garment'. In both cases T3 did not award the student any marks but only underlined the statements inferring that they were not correct. From the first statement it can be noted that the student is aware from his IK background that one must avoid getting dirt and for one to avoid stepping on dirty things in the house one might jump but in so doing if the floor is polished then the person might fall because there is less friction. The student could not easily identify the concept of friction. The second statement seem at surface value to be a spelling problem but upon closer inspection it can be noted that the student is more familiar with garments used in sewing and he then uses his intuitive schema (Fakudze, 2004) to write garment instead of connecting his thinking with the concept of gametes because the border crossing had not been managed. All these are examples of impossible to hazardous border crossing experienced by the students (Fakudze, 2004).

Conclusions

The Science teachers who participated in this case study view IK as cultural knowledge, home-based knowledge, or simple as local knowledge. However teachers put more emphasis on the metaphysical dimension of IK than giving equal weight to those aspects of IK which have been developed through experimentation as is the case with Western scientific epistemology. The science teachers' understanding of IK lacks the methodological part of IK. It lacks on explaining 26 how IK is generated and how it is transferred from one generation to the next. The teachers however observed that the way in which IK is propagated meant that the 'students' ideas from home are difficult to change'. Indigenous Knowledge as reflected upon by T1 'changes in line with culture', so the teachers noted that IK is dynamic both in situ and from one culture to the next. What all the teachers failed to note was that IK exists in levels like the ones provided by IIRR (1996) and that not all forms of IK is or should be available to everybody. The participants grappled with this last point indirectly when they were suggesting what content of IK should not be included in the classroom. Most of the examples given by the teachers of IK belong to the first level of IK which is 'common knowledge' (IIRR, 1996). Teachers stereotype IK as of lesser value as compared to School science because they feel that IK cannot be subjected to proof testing. What they fail to understand about IK is that it provides some similar and some different theories about the material world, derived from the processes which parallel Western scientific thought but operates within a different framework and therefore it sometimes comes to different conclusions. From the research it emerged that the research participants felt that, IK retards success in learning school science through fostering the creation of misconceptions, through making it difficult for students to understand science which is being taught in English language and through the blocking of some students to successful learn some topics like Sexual reproduction in Human beings, because these students regard these concepts as taboo in their community. The teachers however acknowledge that using IK in lessons motivates the students and help in dispelling some myths which are counter the acquisition of scientific concepts.

Science teachers acknowledge that although they were supposed to teach in English language they, however, blend it with Shona. To the science teachers, teaching in the mother tongue which is part to IK, enable better understanding of science concepts.

The science teachers start most of their lessons basing on the students' IK as prior knowledge. This, they say, motivates their students and prepares them for acquisition of scientific concepts. The science teachers claim that in some instances they use IK resources to clarify scientific concepts or as illustrations of how scientific events happen. These claims were neither evident in their students' exercise books nor their schemes of work.

The exercise books revealed, if anything, that science teachers marked the students wrong for any incident which shows some form of border crossing into IK world view. The teachers were more comfortable with their roles of 'correcting the beliefs' and the inculcation of the right 'scientific' thinking and attitudes to their students, hence they considered IK as 'motivational' because the students will 'recognise how wrong they had been' and hence become more inspired to learn the new scientific concept.

The research participants were not teaching IK at the same level as School science, even when they said that they were aware that some IK was worthwhile as teaching material, like, for example, the different herbs which are in use in the treatment of different ailments. These teachers, like any others in Zimbabwean school system are guided by an examinations syllabus which does not explicitly recognise IK as a worthwhile subject matter, as T4 indicated, 'I stick to the syllabuses'.

Upon carrying out an analysis of the Science teachers’ Schemes of work it was observed that science teachers did not use the methodologies inherent in IK in their teaching of school science which include but not limited to; folk stories, riddles, music and song (Kroma, 2000) or the inclusion of a consultation of IK specialist like the old people from the surrounding community when teaching for example a topic on conservation of natural resources. Their schemes of work made it evident that all learning was taking place indoors and in such a situation the incorporation of IK is hindered as IK is best transmitted in an environment without artificial boundaries (Michie, 1999).

The findings from this study have major implications for science curriculum development. Firstly, there seem to be a need for a science curriculum that would require a science educational perspective that views Science as a process of crossing the border between the students’ worldview and the scientific worldview (Fakudze, 2004; George, 1999; Ogunniyi, 1988), as has been demonstrated in this study. Secondly, this type of curriculum approach requires teachers to understand students’ fundamental IK so as to teach a kind of science that coincide with their intellectual interest and socio-economic and cultural setting of such students. Science teachers should become aware of the impact of cultural variables such as traditional beliefs and religious affiliations in their teaching efforts (Jegede & Okebukola, 1991). Further considerations are warranted in such questions as; Do science teachers in other rural districts of Zimbabwe hold viewpoints similar to these identified here?, What potential does IK in Mberengwa District have on restructuring of the content of science instruction? and; will efforts directed towards the development of instruments that are concerned with other increments of the de-codification of IK in Mberengwa District contribute to a better understanding and achievement in science education in the district? Needless to say, a lot of research is still needed to investigate the learning process taking place within a science classroom in a rural setting. 29

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