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RESEARCH REPORT

Sustainability Science Education in Africa: Negotiating indigenous ways of living with nature in the third space

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In response to global climate change, loss of biodiversity, and the immense human impact on the carrying capacity of the earth systems, attention has been given to sustainable development worldwide. In this paper, we explore the emerging field of sustainability science within the context of the socio-cultural milieu of Malawi, a sub-Saharan African country. Through interviews in vernacular languages and observations in the field, our research explores how traditional agriculture practices of African elders may contribute to the sustainability of the environment and culture in Africa. Findings indicate that traditional farmers and food preservationists choose to practice indigenous ways of living with nature to live sustainably in a globalized economy. Further discussion elucidates how merging worldviews and hybridized knowledge and languages can be leveraged to create a third space for dialogue and curriculum development by connecting indigenous ways of living with Eurocentric science.

Keywords: *Environmental education; Sustainability; Indigenous knowledge*

The sustainability of ecosystems and cultural diversity in many developing African countries is in peril. Widespread poverty and deteriorating economic conditions have contributed to deforestation, malnutrition, unsafe drinking water, inadequate sanitation, and many preventable diseases (Kyle, 2006). Environmental educators are also concerned with the corresponding loss of cultural/linguistic diversity and intergenerational/indigenous knowledge that play an important role in maintaining biodiversity

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and ecological sustainability (Bowers, 2007). Although the reasons for ecological degradation and loss of cultural diversity are complex, researchers and theorists are now acknowledging the dominant role of globalization and neo-colonial forces in contributing to the sustainability problems worldwide (Bowers, 2007; Carter, 2007; Gough & Gough, 2004; Keane, 2008; Masuku Van Damme & Neluvhalani, 2004; Ryan, 2008). In this paper, we will explore the emerging field of sustainability science within the context of the socio-cultural milieu of Malawi, a sub-Saharan African country that was originally colonized by the British. Specifically, our research explores worldviews and perspectives of African elders for how indigenous ways of living may contribute to the sustainability of the environment and culture in Africa. Further discussion will elucidate how merging worldviews and hybridized knowledge and languages can be leveraged to create a third space (i.e. Bhabha, 1994) for dialogue and curriculum development in the field of sustainability science.

Sustainability Science

In response to global climate change, loss of biodiversity, and the immense human impact on the carrying capacity of the earth systems, attention has been given to sustainable development worldwide (e.g. International Council for Science, 2002; UNESCO, 2009; United Nations Commission of Sustainable Development, 2002; United Nations General Assembly, 1992). According to Kyle (2006), during the time period between the Earth Summit in Rio de Janeiro in 1992 and the World Summit on Sustainable Development in Johannesburg in 2002, progress with sustainable development has been disappointing. To address this urgent concern for sustainability, the United Nations General Assembly resolved that the years 2005–2014 be designated the "Decade of Education for Sustainable Development (DESD)" (UNESCO, 2005). According to this declaration: "Sustainability is not just about conserving the environment, but about learning to live in respectful relationships with each other and with our world" (UNESCO, 2005, p. 10).

From this new global attention on sustainability of humans and the environment, a new field of sustainability science has emerged that seeks to understand the interactions between nature and society (Kates et al., 2001). In a world divided by affluent, developed countries of the industrial North with the poverty stricken countries in the South, sustainability science spans such diverse phenomena as economic globalization and local traditional farming practices. Carter (2007, p. 166) defines sustainability science as a "transdisciplinary science that investigates the complex nature-society interactions, so as fundamental human needs can be met at the same time the earth's life support systems are conserved." As the impact of humans in the environment is substantial, sustainability science also extends the traditional field of environmental science by encompassing social science fields such as economics, political science, cultural studies, and anthropology.

From the UNESCO proclamations, many European countries have embraced the United Nations Decade of Education for Sustainable Development (DESD) as a framework for learning about human-society-environment interactions. According

to UNESCO (2005, p. 12): "Education for sustainable development is a vision of education that seeks to balance human and economic well-being with cultural traditions and respect for the Earth's natural resources." As the UNESCO initiatives are also perceived to have a strong connection to economic globalization, Gough and Gough (2004) are concerned that environmental education and local African cultural capital have received little attention, particularly in basic education. Masuku van Damme and Neluvhalani (2004, p. 356) also caution that globalized agendas for education may encourage "cultural homogenization and commodification of cultural differences" in which developed nations seek to reach milestones achieved by former colonial powers. From a neo-colonial perspective, for example, solutions to sustainability problems may involve Western agricultural practices such as the use of genetically engineered crops, fertilizers to increase crop yield, herbicides for pest control, or mechanized farming and irrigation practices. Such high cost inputs may be not be affordable or ecologically sustainable for indigenous cultures.

In an effort to be inclusive of indigenous cultures, O'Donoghue and Russo (2004), proposed a model that describes education for sustainable development as a transdisciplinary enterprise that encompasses democracy and human rights, economics, and bio-physical life support systems. Similar to post-colonial interpretations within a sustainability science context, O'Donoghue and Russo view sustainability as a socio-political issue in which the voice of community elders is important for contributing knowledge about indigenous ways of living with nature. This model challenges neo-colonial paradigms where Eurocentric science dominates the school curriculum without input from the local community. Issues such as energy use, land distribution, and negotiating sustainable farming practices are important considerations by elders at the local level.

For the purpose of this research, we investigate how the emerging field of sustainability science might be inclusive of indigenous ways of living with nature in Africa. As discussed below, the inclusion of indigenous knowledge in the school science curriculum, necessitates dialogue and hybridized knowledge in dealing with the merging of worldviews concerning sustainability science issues.

Indigenous Ways of Living with Nature

Science educators have long recognized the importance of students' worldviews on the learning of science (Cobern, 1996; Kawagley, Norris-Tull, & Norris-Tull, 1998; Keane, 2008). In Africa and other traditional cultures, indigenous knowledge systems are embedded in philosophical thought and cultural practices that have evolved over many generations (Aikenhead, 1997, 2001; Aikenhead & Jegede, 1999; Jegede, 1997; Keane, 2008; Snively & Corsiglia, 2001; Thomson, 2003). Passed on through oral traditions, collective African worldviews are critical to community identity and the sustainability of cultural diversity and the local environment. Indigenous knowledge systems in Africa have evolved to provide a rich heritage of understandings about the interactions of humans with nature, thus providing foods, medicines, shelter, and other necessities for living. Indigenous knowledge systems are embedded

in human relationships and in the economic and governance system of a culture (Keane, 2008).

Aikenhead (2008) distinguishes between the epistemological frameworks of Eurocentric science and indigenous ways of living with nature by referring to the Greek terms *episteme* and *phronesis*. Eurocentric science, also known as Western Modern Science (WMS), is framed within the context of the *episteme*, or theoretical knowledge that is often construed as disconnected from the knower. Indigenous ways of living with nature focuses on *phronesis*, or practical wisdom and reasoning. From indigenous perspectives, the "knower is personally and intimately interconnected with one's ways of living" (Aikenhead, 2008, p. 582). Even though different epistemological frameworks of science may represent distinct ethno-sciences, Aikenhead and Ogawa (2007) provide a definition of science that encompasses both Eurocentric science and indigenous ways of living with nature: "Science is a rational, empirically based way of knowing nature that yields, in part, descriptions and explanations of nature" (p. 544). From the perspective of our research, we consider the borders and boundaries that distinguish Eurocentric science from indigenous ways of living with nature, but we also are guided by the cross-cultural definition of science of Aikenhead and Ogawa (2007) and by Carter's (2007) definition of sustainability science that encompasses a transdisciplinary approach for investigating nature–society interactions.

Hybridized Knowledge and Languages: Third Space Theory

In an effort to overcome the dichotomy between Eurocentric and indigenous knowledge systems, researchers are exploring Bhabha's "third space" theory (Bhabha, 1994) as a means to dissolve perceived cultural boundaries by embracing the metaphysics of multiple perspectives and languages (Taylor, 2006a, 2006b; Wallace, 2004). According to Wallace (2004), the third space "is an abstraction of a space/time location in which neither the speaker's meaning nor the listener's meaning is the 'correct' meaning, but in which the meaning of the utterance is hopeful for either co-construction of interpretation or new hybrid meanings" (p. 908). The purpose of negotiating meaning in the third space is to move away from privileged, authoritative discourse by providing indigenous cultures with improved access to Eurocentric science, while at the same time validating the local communities own ways of understanding nature. Within the application of Bhabha's theory, the local indigenous culture provides meaning and identity to community members in the first space, while Western ideas (e.g. Eurocentric science) provide a second space for learning in schools, often in European languages. However, students and community members must function in a third space to negotiate meanings and understandings for the intersections of knowledge, practices, and languages from merging cultures (see Figure 1). Third space theory eliminates the cultural hegemony in communication as multiple discourses are "woven together without sacrificing or dismissing the importance of their speaker's experiences and ways of knowing in the world" (Wallace, 2004, p. 908). Within the third space, stakeholders (e.g. students, teachers, curriculum developers, community

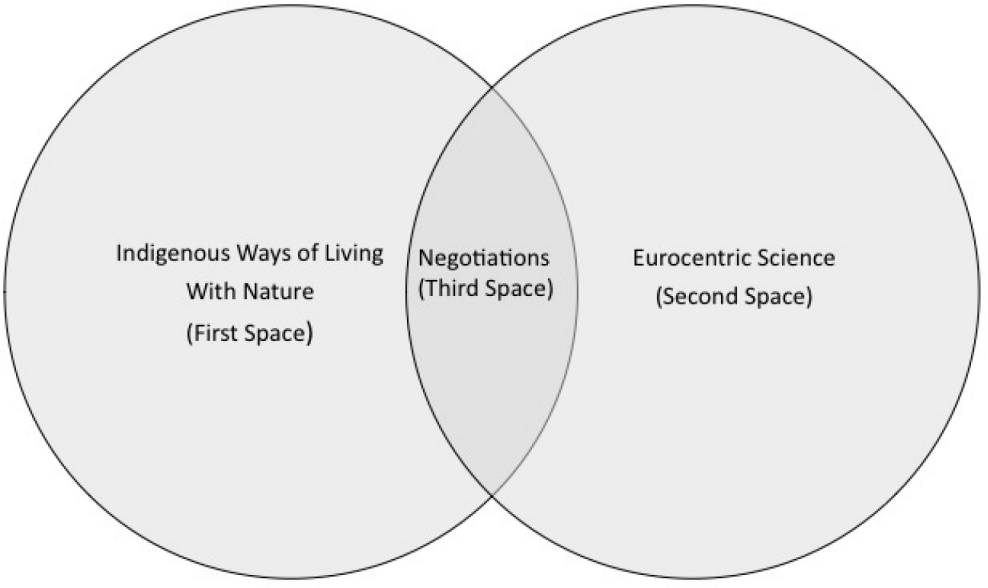

Figure 1. Negotiations in the third space

elders) collaborate together in the co-construction of new hybrid meanings and interpretations of science. Rather than focusing on the reproducible knowledge of Eurocentric science, the goal of learning in the third space is to facilitate the reconstruction of the learner's everyday beliefs and experiences about the natural world to develop a more robust scientific worldview.

Dialogue in the third space is supported by Gough and Gough's (2004) advocacy of developing a reflexive research community that is engaged in inter-epistemological dialogue. By learning in a third space, crossing cultural borders is a two-way versus a one-way journey (Taylor, 2006b). Taylor explains the important ramifications and benefits of negotiating in the third space when working with indigenous cultures:

> Of major importance is the positive recognition and growth of local cultural capital, including traditional knowledge systems and languages, recognition of the non-essentialist and mutable nature of all cultures and worldviews (including WMS), and the need to develop multicultural identities which harbour a strong sense of shared humanity with the culturally different "other." (2006a, p. 191)

The codified Eurocentric science curriculum found in many African countries is almost exclusively taught in European languages and is unresponsive to sustainability issues and twenty-first century globalization issues (Glasson, Frykholm, Mhango, & Phiri, 2006). To move toward a more culturally inclusive classroom, deconstructing the homogeneity and authority of so-called "universal" Eurocentric science will help to transcend the discord among different worldviews. As we can

only know nature through the lens of culturally framed epistemological frameworks, understanding how indigenous people negotiate the impact of globalization and the domination of Eurocentric science is essential for planning culturally relevant curriculum.

In response to the pressures of globalization and neo-colonialism, Bowers (2007) has called for the revitalization of the commons, which is the shared biological, physical, and cultural space that all life depends upon. According to Bowers, revitalizing the commons:

> Involves local communities taking democratic responsibility for the quality of the air, water, soil, plants, animals, and every other aspect of the bioregion they share and depend upon. It also involves renewing the intergeneration knowledge of healing, agricultural practices, mentoring in the arts and building skills, use of locally adapted technologies, growing and preparing food, ceremonies, and so forth. (2007, p. 50)

Because Eurocentric science has been construed as dominant and repressive of indigenous ways of living with nature in non-Western countries, Bowers (2007, p. 53) advocates an eco-justice pedagogy that addresses "the need to understand the ideological, economic, and technological forces that lead to the domination of the South by the North—and recognize how the revitalization of the commons represents an alternative to the history of Western economic colonization." Recognizing that scientific knowledge is a product of culture (Aikenhead & Ogawa, 2007; McKinley, 2005, 2007), researchers worldwide are engaging in dialogue with elders in traditional cultures to learn about indigenous ways of living with nature as a means to understand sustainability science. This dialogue is necessary to revitalize the commons as researchers create a third space to explore multiple discourses and languages, hybridized knowledge, and issues that are important to the sustainability and survival of indigenous cultures.

Essential to dialogue in the third space, McKinley (2005) advocates the teaching of science in local languages as a means for providing an authentic context for promoting community identity and learning of indigenous students. In his work in Kenya, Thomson (2003) worked with elders to identify and categorize local knowledge of snakes in the indigenous Keiyo language. Thomas further recommended inviting elders and leaders into the classroom and to participate in curriculum development. Dlodlo (1999) proposed creating a vocabulary in the indigenous Nguni language (spoken in South Africa, Swaziland, and Zimbabwe) to provide meaning for physical science concepts that are embedded in the local culture. In this research, we investigated the indigenous ways of living with nature of Malawian elders that may contribute to understanding sustainable agriculture in Africa. Through observations and interviews in indigenous languages that were transcribed into English, we documented the knowledge and language of elders as they engaged in sustainable agriculture practices that have been passed down through oral traditions. We looked for hybridized intersections of knowledge, languages, and practices in the third space by exploring sustainability science connections between Eurocentric science and indigenous ways of living with nature.

Method

A team consisting of two US science educators and two Malawian educators in science and social studies education, respectively, collaborated together in Malawi to explore the potential of including indigenous ways of living with nature in the school science curriculum. Two research questions were addressed:

1. What are examples of indigenous agricultural practices of elders that contribute to the sustainability of the environment in Malawi?
2. How did the elders negotiate their traditional practices within the discourse of a third space that is influenced by Western agricultural methods?

In this qualitative research project, we report on two examples of indigenous ways of living with nature of African elders that result in sustainable agricultural practices. Site visits and video-recorded observations in the field were conducted to better understand the agricultural practices of a traditional farmer and food preservationist. Audio and video recorded interviews were also conducted to learn more about how the elders understand their own practices. For these non-English speaking elders, the interviews were conducted by the Malawian researchers on the team in the tribal languages of Chichewa and Chiyao, respectively, and subsequently transcribed into English. Conducting interviews in indigenous languages was an important methodological consideration in giving voice to the elders within the context of their own culture on sustainability issues. Field notes, video-recorded observations, and the transcripts of elder interviews were carefully reviewed to identify emerging themes (Ely, Ansul, Friedman, Garner, & Steinmetz, 1991) that were related to the subjects' perspectives of sustainable agriculture and education. The research further reviewed the data to look for confirming and disconfirming evidence that supports our interpretations of the elder's perspectives (Erickson, 1986). Our interpretations were enhanced by the multiple and hybridized viewpoints and analysis from researchers from the USA and Africa.

From a post-colonial theoretical lens (Carter, 2007; McKinley, 2007), we were interested in understanding the cross hybridization of ideas from Eurocentric and indigenous science perspectives in the third space as we explored sustainable agricultural issues in Malawi. For example, we were interested in how the elders negotiated their farming practices within the context of Western agricultural practices. What choices did the elders make that influenced their farming practices and indigenous ways of living with nature? How might the elder knowledge be connected to the science curriculum in Malawi?

Results

The interviews with Malawian elders were transcribed and arranged as vignettes in which each elder discusses indigenous farming practices and connections with Western agricultural practices. For each interview, conducted in traditional languages and transcribed into English, we identified words or phrases in the vernacular that have corresponding meanings that are related to sustainability science in English.

Footnotes are employed to clarify the root meanings of the indigenous terms. In these interviews, the elders discuss indigenous farming agricultural practices that have been passed down for generations.

Traditional Farmer: Mr Leyi Witinesi (Interview Conducted in Chiyao)

Mr Witinesi practices traditional farming along the Shire river in Malawi (see Figure 2). According to Mr Witinesi, the practice of growing crops under the msangu trees (*acasia* species) increases soil fertility. Below is Mr Witnesi's description of this practice.

Mr Witinesi. We learned this from our parents, who also learned this knowledge from their parents. The older generations started growing crops under these msangu trees long before the use of synthetic fertilizers (*fetelesa*[1]) were known in this country. As a result, the older generations began to conserve (*kuteteya*[2]) these trees. This is why you see that some of the trees are quite huge and old. The trees could have been deforested (*kumasya chiteteke*[3]) just like the other species had it not been for their valuable way of replenishing the soil fertility (*chajila*). People whose gardens have no such trees harvest very little.

Some fishermen come to buy the old big trees for making dug out canoes. Some people also come to buy the trees for curing tobacco (*kuchisa sona*[4]) or burning bricks (*kocha njelwa*[5]) in kilns. This is why you see some gardens around here don't have these trees because the owners sold the trees because of poverty. But most of us

Figure 2. Traditional farmer growing crops under msangu trees

plant more of these trees if we happen to sell the old trees. The advantage is that these are fast growing trees.

We grow our crops along this river but without the use of synthetic fertilizers (*fetelesa*), and yet, the crops grow very well and yields are always high. We grow our crops along this river because these trees grow in abundance along rivers. These trees shed down their leaves (*kulakatisya masamba*), which enrich the soils just like what synthetic fertilizers do. We don't apply synthetic fertilizers (*fetelesa*) in our gardens because such chemicals cause soil fertility to deteriorate (*kumasya chajila*) after a few years of continuous use.[6] We grow our crops here and sell the produce along this main road for people passing by to buy from us. Sometimes we transport our farm produce by bicycles to markets in urban markets.

These trees begin to shed down their leaves in October just before the rainy season. We bury the leaves to quicken their decomposition (*kuwola*). However, the leaves decompose fast anyway. The trees remain bare during the entire rainy season (October to March). Thus, when we plant our crops on the onset of the rainy season, our crops grow very well from the decomposed leaves (*masamba gewole*). The shedding down of leaves (*kulakatika kwa masamba*) during the rainy season means our crops are not shaded (*kuchijila*) from direct sunlight (*kuwala kwa lyuwa*). In all these gardens we plant maize,[7] which assists us quite a lot as our staple food. The trees begin to blossom (*kusipuka masamba*) from March or April, at the end of rainy season. The trees also produce long seed-pods which we use to feed our goats.

After the rains, we begin to grow vegetables, especially tomatoes and leafy vegetables as well as winter maize. But we grow these along the river so that we can irrigate our crops. This river was small but it is now widening because of erosion (*kololoka kwa litaka*). This has a disadvantage that some of the trees that grow along it are easily uprooted by running water during the rainy season.

The soils in this area are of a clay type (*makande*) that promotes the growth of the msangu trees. The other types of trees do not grow very well in this area. We know the importance of passing down this knowledge from elders (*kusunga misyungu ja achinangolo*) of the msangu tree to our children. We teach them to plant a lot of these trees. We also tell our children not to cut down these trees so that their future remains bright. After all, we tell them that synthetic fertilizers are very expensive to buy. When we go to the garden the children know these trees even after they have just germinated (*kumela*). They know the importance of conserving (*kuteteya*) these trees, and they don't cut or uproot the young trees when we are weeding our crops. We tell them that God is great because He gave us land with the msangu trees. We don't ask for support from the government to give us synthetic fertilizers. We already have natural fertilizer (*chajila cha chilengedwe*), which we must promote and conserve. Most of the trees grow by their own, but we also plant them where we want them to grow. We also protect the young trees from goats. Thus, our children know the importance of the msangu tree from the early age. This knowledge should be taught in schools in addition to what the children get from their parents.

Traditional Food Preserver: Juliet Zuza (Interview Conducted in Chichewa)

Mrs Zuza is an elder in the community who practices traditional ways for preserving vegetables (see Figure 3). Mrs Zuza describes her practice below and the important advantages of preserving vegetables by boiling and drying.

Mrs Zuza. What you see in these baskets are dried vegetables, which we preserve (*posunga*) in a traditional way (*njira ya makolo*). The dried vegetables (*mfutso*) in these baskets include pumpkin leaves (*mkwani*[8]), cowpea leaves (*kwanya*), and both fruit and leaf okra (*thelele*). To preserve the pumpkin leaves, we cut into small pieces the leaves we harvest from the garden, and then boil (*kwaphika*[9]) it for a short period. After this process, we spread the boiled vegetables (*masamba ofutsa*) on a mat for sun drying (*kuyanika*). We do this because most vegetables are seasonal and they grow in abundance only during the rainy season. We therefore preserve the vegetables (*timasunga masamba*) during the times when we have these vegetables in abundance so that we sell them during the dry season when vegetables are generally scarce. However, it is not every other vegetable that we can preserve in this way. For example, cassava leaves do not taste nice if they are preserved in this way. Otherwise, the other types of vegetables are preserved using the same process of boiling for a short period and then sun dried. But the okra leaves are just sun dried without boiling to maintain its flavor (*kakomedwe*).

I learned how to preserve vegetables (*kasungidwe kamasamba*) in this way from my own mother and grandmother. The main reason why my parents were preserving vegetables was to have ample vegetables during the scarcity period of the dry season.

Figure 3. Traditional food preservation

This was the only traditional way passed on through generations (*mnjira ya makolo*) to preserve vegetables. It looks like this knowledge of preserving vegetables is still very important considering the way people come to buy the dried vegetables in this market. Some people from surrounding countries like Zimbabwe also come to buy these dried vegetables. Most people who buy these vegetables say they taste nice just like the actual green fresh vegetables. Even the children in our homes like these vegetables, but it also depends on the way the final dish is prepared. Children like the vegetables if they are used to eat them often. Any dislike of such dishes would threaten our traditional knowledge (*nzeru za makolo*) of preserving vegetables.

During colonization, European settlers came with other types of exotic vegetables (*mitundu ya masamba a kunja*) such as cabbages and rape. Modern day people like both the traditional vegetables (*masamba a makolo*) and the other exotic vegetables, but most modern African families do not know how to preserve these traditional vegetables. It is these families that come here in the produce market to buy from us. There is very high demand for dried vegetables in dry season because that time the readily available vegetables are of exotic types. The advantage of dried vegetables (*mfutso*) is that they can be kept up to six months and still taste with its original flavor. What is important is to thoroughly dry the vegetables after they have been boiled. Some people today eat frozen vegetables (*masamba osungidwa mu fuliji*[10]). Since they have refrigerators (*mafuliji*), but they still come here to buy the vegetables preserved in a traditional way. The best way to promote this knowledge is for every parent to teach their children the skills of preserving vegetables (*kusunga masamba*). If this was taught in schools, students, especially girls, could learn this skill of vegetable preservation.

Discussion

Practicing Sustainability Science in the Third Space

The interviews revealed that the two Malawian elders practiced sustainability science so that "human needs can be met at the same time the earth's life support systems are conserved" (Carter, 2007, p. 166). For Mr Witinesi and Mrs Zuza, indigenous ways of living with nature that are embedded in cultural traditions and traditional languages are essential for living sustainably (see Table 1). Sustainability science practices such as burying leaves from the msangu trees as a natural fertilizer (*chajila cha chilengedwe*) or preserving vegetables (*posumga mfutso*) were practiced for generations long before colonization. In the cases of these two elders, the agricultural practices were perfected through years of observation, collecting data, experimentation, and interpretation. However, because Malawi is not a country with widespread electricity, energy resources, or economic infrastructure that might be conducive to the successful implementation of Western agricultural methods (Dzama & Osborne, 1999; Ministry of Natural Resources & Environmental Affairs, 2002), the elders must operate in a third space to make choices that are better for sustainability and food sovereignty. Mr Witinesi and Mrs Zuza were aware of Western agricultural practices such as using

Table 1. Analysis of elders' indigenous ways of living with nature and negotiations in the third space

Elders' indigenous ways of living with nature	Elders' negotiations about sustainable agriculture in the third space
Traditional farmers conserve (*kuteteya*) msangu trees. The shedding of tree leaves (*kulakatika kwa masamba*) replenishes soil fertility (*chajila*). The leaves are buried to quicken decomposition (*kuwola*). Using msangu leaves as a natural fertilizer (*chajila cha chilengedwe*) improves crop yield. Passing down of knowledge of elders (*kusunga misyungu ja achinangolo*) to children is very important.	Synthetic fertilizers (*fetelesa*) make soil fertility deteriorate (*kumasya chajila*). Synthetic fertilizers (*fetelesa*) are very expensive to buy. Knowledge of conserving (*kuteteya*) msangu trees should be taught in schools.
The traditional food preservers cut harvest crops into small pieces of leaves. The leaves are then boiled (*kwaphika*) for a short period. After this process, the boiled vegetables (*masamba ofutsa*) are spread on a mat for sun drying (*kuyanika*). Food preservation (*posumga*) in the traditional way (*njira ya makolo*) improves accessibility to vegetables during the dry season.	Most rural Malawians cannot afford electricity or a refrigerator (*mafuliji*) to preserve food. Children should be taught in schools about indigenous ways (*njira za makolo*) for preserving vegetables.

synthetic fertilizers or preserving vegetables by freezing, however, they chose more traditional agricultural practices for achieving more sustainable yields or cost-efficient means for preserving vegetables. Hence, after considering Western agricultural methods[11] in the third space, Mr Witinesi and Mrs Zuza rejected these practices and chose to continue operating in their first space by practicing indigenous ways of living with nature. Many other Malawian farmers, dependent on government subsidies for synthetic fertilizers, accept Western agricultural practices that may not be sustainable economically or environmentally.

Within the context of the third space, however, it is clear from our interviews that the development of indigenous sustainability scientific practices in Malawi would be best characterized as hybridized throughout the history of colonization. With the introduction of exotic vegetables in the fifteenth century by the Portuguese, followed by the colonization of British, many indigenous farming practices were adapted for localized participation in the global economy. For example, maize, originally an exotic crop, is now considered the staple food in Malawi that is also exported to neighboring African countries. Burning bricks or curing tobacco was adapted from the indigenous technologies of burning pottery in kilns or curing seeds, respectively. As these farmers continue to interact in the global economy and are exposed to Western agricultural methods, hybridized practices and knowledge will continue to emerge.

Nevertheless, even though purely indigenous practices may gradually change, the revitalization of the commons continues to be an important issue for these two elders. For example, through their practices of indigenous ways of living with nature, both Mr Witinesi and Mrs Zuza demonstrated the importance of conserving indigenous

ways of living with nature and understandings of the natural environment. The traditional knowledge and practice of growing crops under msangu trees and preserving vegetables are both examples for revitalizing the commons. Both elders also spoke of the importance of indigenous ways of living with nature being passed on through generations and the importance of sharing this knowledge with children in the villages and the schools. From the perspective of negotiating in the third space, the inclusion of indigenous ways of living with nature in the school curriculum gives voice to the relevance and importance of elder knowledge in teaching about sustainability science in the community.

Sustainable Science Curriculum Development in the Third Space

As the elders were explicit in their view that indigenous knowledge about sustainable agriculture should be part of the school curriculum, curriculum developers and educators need to collaborate with community elders in a third space to negotiate the inclusion of indigenous ways of living when teaching about Eurocentric science. Although the examples of indigenous ways of living are commonly practiced in Malawi, the connections to Eurocentric science concepts are not well known or explicitly taught in the school curriculum (Phiri, 2008). However, drawing on Aikenhead's (2008) distinction between indigenous ways with living with nature (phronesis) and theoretical Eurocentric science (episteme), connections can be made by curriculum developers, educators, and elders negotiating in the third space. For example, the indigenous practice of growing crops under msangu trees to improve soil fertility (phronesis) provides a context for teaching about importance of natural fertilizers as a source of nitrogen for growing maize (episteme). Similarly, preserving vegetables by boiling and drying (phrenomis) can provide an opportunity to teach about how boiling, following by drying, retards metabolic activity and decomposition of the plants (episteme). Such collaboration could yield information that is useful for teachers in understanding the importance of indigenous ways of living with nature and the connections to Eurocentric science.

Attempts to teach about indigenous ways of living in the school curriculum is problematic, however, because many Malawian teachers have negative attitudes toward indigenous knowledge and are frustrated by the lack of scientific explanations for "why" things work (Phiri, 2008). These negative attitudes may be rooted in the marginalization of indigenous ways of living with nature throughout the history of colonization within the school curriculum (Keane, 2008). Additionally, the educational policy in Malawi is designed to primarily instruct children in the nation's official language of Chichewa from first through fourth grade, with a daily 45-minute lesson to learn English. Beginning in the fifth grade where science is taught, there is an abrupt shift to teaching children exclusively in English. Therefore, in the curriculum, there is little effort to teach science within the context of indigenous practices or connect these practices with local languages. Teachers struggle to explain Eurocentric science concepts exclusively in English and they are not aware of pedagogies that will help them connect science with the local culture.

Although didactic instruction in the context of Eurocentric science is the predominant pedagogy currently practiced in Malawi (Glasson et al., 2006), examples of curriculum development in sustainability science practices are now beginning to be explored (Nordin, 2005). In this project, many community stakeholders in Malawi were consulted to develop a manual for practicing permaculture using sustainable agricultural practices such as composting, water recycling, gravity-fed irrigation, organic pest control, and low-cost, locally available resources.

Implications

Eurocentric science that is taught in primary and secondary schools can make valuable contributions to the knowledge and economic development of a community. For example, knowledge of biological and physical science theories and concepts are important for explaining sustainability science issues such as global warming, watershed pollution, or the recycling of nutrients. However, this research is based on the premise that rural communities in Africa can make unique contributions to science education. By drawing on the indigenous knowledge of elders, many environmental problems connected to sustainability science can be identified and the sustainable practices, passed down through generations, can be included in the curriculum to provide an essential context for learning science. Further, understanding indigenous ways of living helps to promote self-esteem, community identity, human rights, and democracy in indigenous cultures (Keane, 2008). Unfortunately, the validation of indigenous knowledge has been marginalized through the imposition of European science curriculum that is based on a deficit model of learning that rewards success on standardized tests that assess understanding of Eurocentric science concepts. These Eurocentric scientific concepts that are taught in schools are often decontextualized from the local culture.

Presently, Eurocentric science has the power and influence in the school science curriculum but is largely irrelevant to most Malawian villagers. Indigenous ideas should be explicitly identified and addressed in the curriculum as important funds of knowledge that are essential to the sustainability of the environment and culture (e.g. Gonzalez, Moll, & Amanti, 2005). As culture and worldviews are critical to establishing community identity, it is important to create a third space to consider students' worldviews and lifestyles when connecting with Eurocentric science. Cultural practices within the community should contribute to curriculum development and, in return, the curriculum should affirm cultural practices (Keane, 2008).

Moving to a community-centered approach to developing sustainability science curriculum requires the integration of Eurocentric science with the knowledge of indigenous ways of living with nature in African countries. By connecting indigenous practices to Eurocentric science concepts, teachers and children will learn to value knowledge and practices that are part of their everyday lives. Legitimizing traditional methods for farming or preserving food by connecting with Eurocentric scientific knowledge is essential for learning about sustainability science. This hybridized approach for integrating Western and indigenous science is also important for

curriculum development that is necessary for providing a meaningful context for learning science. As we focus on accountability and standards-based instruction in Western countries, we should not lose sight of our responsibility as science educators to address issues of sustainability science that remain so vitally important on a global scale.

Notes

1. *Fetelesa* in Chiyao or *feteleza* in Chichewa are words for "fertilizer" that were adapted from English but were not originally used in the traditional languages.
2. *Kuteteya* is the Chiyao word for traditional conservation practices but can refer to similar practices that were brought from other parts of the world.
3. Most of the Chiyao words identified in this interview refer to natural processes that were understood and part of the language of indigenous people in pre-colonial times, e.g. deforested (*kumasya chiteteke*), soil fertility (*chajila*), shedding down of leaves (*kulakatika kwa masamba*), decomposed leaves (*masamba gewole*), or erosion (*kololoka kwa litaka*).
4. Although curing tobacco (*kuchisa sona*) was introduced by the Europeans, the practice of "curing" grains like millet and sorghum was done traditionally in local kitchens using firewood. The curing of grains was done to preserve the seeds for the following growing season.
5. The British missionaries first introduced brick making in the nineteenth century; however, the technology for burning bricks (*kocha njelwa*) in kilns using firewood as an energy source was adapted from indigenous practices. In pre-colonial times, Africans molded kilns using wet clay that were then used for firing pottery or smelting iron.
6. In addition to shunning synthetic fertilizers, Mr Witinesi did not use the traditional "slash and burn" practice for clearing land and growing crops. As not all indigenous practices were sustainable, slash and burn is not commonly used today because of unavailability of land. Many farmers, however, still clear fields by burning and this practice contributes to soil depletion and air pollution.
7. The Portuguese introduced maize (corn), the staple crop in sub-Saharan African countries, during the fifteenth century.
8. Pumpkin leaves (*mkwani*), cowpeas leaves (*kwanya*), and okra (*thelele*) were all crops introduced by the Portuguese in the fifteenth century, but now considered indigenous by many Africans.
9. Boiling (*kwaphika*) is an example of a scientific concept that is taught exclusively in English in Malawian schools today.
10. *Fuliji* (fridge) or mafuliji (refrigerators) are words adapted from English.
11. Although the elders in this study rejected the use of synthetic fertilizers or unaffordable methods of preserving vegetables, it must be noted that many Western farmers, particularly at the smaller scale, also make use of practices that could be considered to be indigenous such as composting to enrich the soil or preserve foods through salting, pickling, or canning.

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