

Engaging Indigenous Knowledge Holders in Teaching Preservice Teachers in IKS Food Production and Practices: Implications for Higher Education

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Abstract

This paper explores preservice science teachers' views and reflections of science, Indigenous Knowledge Systems (IKS) and their perspectives on the inclusion of Indigenous Knowledge holders as teachers in the academy, in the context of teaching Environmentally sustainable development practices. Forty-nine preservice teachers were engaged in a Science Education university module that prepared them for transformative pedagogy for the new South African school Curriculum Assessment Policy Statement (CAPS) curriculum. This module included the teaching and learning of IKS, scientific issues pertaining to IKS, and preparing students to establish gardens on campus and in their communities, using agriculturally sustainable practices. Two African *izinyanga* (medicinal knowledge holders) shared their knowledge and skills of agriculture and sustainable development during the teaching of the Science Education module. Data were collected from 49 preservice teachers about their views of science and IKS using open-ended questionnaires, and 29 reflections on the inclusion of IKS holders as indigenous knowledge teachers in the academy. The data were analysed for the emergence of major themes or issues. The findings indicate that preservice teachers' views of science, IKS and their relationships are complementary. The study has implications for planning responsive and innovative pedagogies in Higher Education curricula.

Keywords: Indigenous Knowledge Systems; preservice teachers; indigenous knowledge holders; pedagogies; higher education

Introduction

Indigenous Knowledge (IK) holders such as chiefs, *izangoma* (spiritual healers) and *izinyanga* (medicinal knowledge holders) are traditionally respected elders of African indigenous communities. As divine spiritualists, *izangoma* communicate with deceased ancestors and interpret their messages which are relayed to people who seek this information. In addition *izangoma* have intuitive knowledge of natural elements, such as the weather, and can predict rain (Krige 1965; Govender, Mudaly & James 2013). *Izinyanga* who are also herbalists play a crucial role in health provision for many communities (Govender *et al.* 2013). We argue that the ethno-botanical knowledge of the *izinyanga*, together with the knowledge of the natural elements of *izangoma*, can contribute to the establishment of sustainable environmental practices such as community gardens, adding credence to African Indigenous Knowledge Systems (AIKS). Their knowledge needs to be preserved, made accessible to the wider community and transmitted to future generations.

Problem Statement

There is a problem with competing paradigms of knowledge with indigenous knowledge being historically subjugated by Euro-western scientific knowledge in relation to environmentally sustainable development practices, global environmental issues and crises of poverty. Environmentally sustainable development involves participatory educational endeavours, public conscientization, and group efforts in learning to change in response to environmental and agricultural sustainability challenges. The recognition of the rights and knowledge of indigenous people has been endorsed through the establishment of the United Nations Inter-Agency Support Group (IASG) on Indigenous Issues (IASG 2014). Reports to the IASG reveal the importance of the role of customary and traditional practices in enhancing community resilience, particularly the promotion of Indigenous Knowledge through inter-generational transmission (IASG 2014).

The South African government adopted the Indigenous Knowledge Systems Policy in 2004 (Republic of South Africa 2004). This policy serves to strengthen collaboration among government departments, tertiary institutions, scientific councils and indigenous knowledge holders. In addition, it provides a framework for collaboration with other African countries with a view to recognising and addressing continental challenges, such as biopiracy (*ibid*). The University of KwaZulu-Natal (UKZN) is among the tertiary institutions which commissioned a feasibility study on researching African Indigenous Knowledge Systems (AIKS). The findings revealed that UKZN has an immense potential to contribute to this field and in 2014 the policy on African Indigenous Knowledge Systems became effective. One of purposes of the policy is to affirm the value of AIKS as a ‘legitimate’ knowledge domain (UKZN 2014). By embedding AIKS in activities related to research, teaching and community engagement, issues of poverty alleviation, food security and health management can be addressed in a more holistic fashion (UKZN 2014).

The argument for universities to create spaces which facilitate the construction and promotion of IKS is a cogent one, and policy formulation in this regard is evidence of the importance that universities attribute to it. This process, however, is not unproblematic, given the historical tension which permeates research and indigenous people (Kelly & Gili 2009). The reason for this tension is that universities are colonial institutions which operate according to distinct rules, procedures and conventions. The ‘languages of legitimation’ (Kelly & Gili 2009:1) enable the way of knowing of academics at universities to be predicated on superiority, regardless of whether these academics self-classify as indigenous or non-indigenous people. Indigenous Knowledge holders can make a valuable contribution regarding the intersection between IKS and Western Science. We are of the opinion that a scholarly encounter with IKS and IK holders can enrich the ways we engage in research and reconceptualise education. Within this context, we formulated the following problem statement: How should teacher educators and preservice teachers approach the problem of competing knowledge paradigms regarding the inclusion of indigenous knowledge of agricultural practices, including health and food security, in the context of planning and delivering responsive and innovative pedagogies in Higher Education? Furthermore, how are different IKS incorporated into other ways of knowing and systems of knowledge production? Can the Western paradigm of knowledge’s encounter with IK holders and IKS help bring about innovative perspectives and pedagogies with

regard to Science Education in order to build food security and sufficiency through sustainable use of known indigenous knowledges and practices? We respond to this by discussing three issues which are central to this question. Firstly, we focus on food security within the context of sustainable environmental practices. Secondly, we argue for preservice science teachers to be mentored to respond to these challenges. Thirdly, we examine the ‘social relation’ between the knower and knowledge (Kelly & Gili 2009: 2), and contend that the IK holder can and should serve as a pedagogue within the academic space.

Environmental sustainability issues include food production in the midst of dynamic global climatic changes (Harvey & Pilgrim 2011). The current crises of food insecurity and under-nutrition, which are associated with poverty (Altman, Hart & Jacobs 2009), require interventions from all sectors of the population to ensure increased production of food. Food security is a major global and national issue and gaining the knowledge and skills of how to adapt to climate change and ensure food security requires major interventions so as to transform current patterns and practices of food production, distribution and consumption (Beddington, Asaduzzaman, Clark, Bremauntz, Guillou, Jahn & Wakhungu 2012). Beddington *et al.* (2012) suggest that multidisciplinary investigations of regionally and nationally appropriate responses to climate change and food security challenges are necessary to tackle long term food security. In addition, it is important to ensure that sustainable agricultural practices are inculcated in order to manage climate change.

Science education preservice teachers engage with many learners during work integrated learning (referred to as Teaching Practice) in schools. We contend that these preservice teachers have a major role to play in developing learners for sustainable agricultural practices during Teaching Practice via projects, which should include integrating IK. However, they first need to be mentored at university on how to do this. One of the five key curriculum principles of the current school curriculum policy, the National Curriculum Statement (NCS), is: ‘Valuing indigenous knowledge systems: acknowledging the rich history and heritage of this country as important contributors to nurturing the values contained in the Constitution’ (Department of Basic Education [DBE] 2011: 5). A specific aim of this policy explores the link between indigenous knowledge and school science. Traditional medicines and sustainable use of the environment are among the topics which are specified (DBE 2011).

As practicing academics in science education, we sought to change from our continuous engagement with dominant Western and Eurocentric epistemologies and methodologies towards African-centred knowledge and practices. We developed an increased understanding of the value of IK and responded to the call for the inclusion of IKS in the university curriculum (Govender 2009; Mudaly & Ismail 2013; Valderrama-Pérez, Andrade & El-Hani 2015). We chose a novel way to do this by engaging IK holders as knowledge discussants and teachers in an academic setting. These knowledge holders conducted practical work on gardening for food-security and health, using indigenous practices and indigenous plants. This was related to the topic 'human nutrition', which we sought to teach in a holistic, authentic and relevant manner. We wanted to teach more than physiology and anatomy, so we transcended disciplinary boundaries by recognising the knower as the IKS knowledge holder, and IK as legitimate knowledge within the higher education landscape.

We argue that by creating a space for IK, and positioning the IK holder as a pedagogue within an academic place, we set the stage for transformative learning and transformative pedagogy. Transformative learning is a process whereby 'we transform our taken-for-granted frames of reference to make them more inclusive, discriminating, open [changeable], and reflective so that they may generate beliefs and opinions that will prove more true or justified to guide action' (Mezirow & Associates 2000: 214). Transformative pedagogy is a pedagogy which responds to changing socio-cultural, environmental, political and technological needs. Central to transformative pedagogy is the teacher's willingness to transcend traditional, familiar pedagogical boundaries, and to enable active participation in knowledge production. It marks a departure from parochial, transmissive models of teaching. It involves advocating for a socially-relevant curriculum which is sensitive and responsive to power relations between cultures (Senteni & Schneider 2007). This study was conducted to elicit the perspectives of our preservice teachers, in order to enrich our engagement with this type of pedagogy and we present the insights and implications for pedagogy which emerged from this study.

In an attempt to integrate IK holders in an academic setting and to formally recognise their knowledge and skills, two IKS guardians and knowledge holders were involved in sharing their knowledge of agricultural practices including health, food-security and sustainable development during a one day workshop as a way of integrating IK into an academic module. At the

time, forty-nine preservice teachers were engaged in a Science Education university course that prepared them for transformative pedagogy for the new South African school curriculum. This course included the teaching and learning of IKS, scientific issues pertaining to IKS, and preparing the teachers to establish gardens on campus and in their communities.

The research questions aimed at exploring preservice teachers' views of Science and IK, the inclusion of IKS holders' participation in the academy, their reflections regarding the IK holders contributions to knowledge regarding sustainable development, and their views on the implications for pedagogy in Higher Education.

The Role of Indigenous Knowledge and Education in Sustainable Agricultural Practices

Internationally, sustainable agricultural and environmental practices are gaining increased focus as evidenced from a seminal joint article by 53 international scholars who compiled the top 100 questions of importance to the future of global agriculture (Pretty *et al.* 2010). The first question in the study by Pretty *et al.* targeted the critical impact of climate change on agriculture yields and practices. It is generally accepted that organised agricultural production has been predominantly the domain of large-scale farmers, although small scale subsistence farmers, mainly from indigenous communities, also contribute to the global agricultural basket. While millions of people live in urban areas with limited land and farming space, urban agriculture (UA) is viewed as a valuable activity in developed countries, considering its capacity to alleviate food scarcity and its contribution to the economy, sustainable development, employment and optimal land usage (Pearson, Pearson & Pearson 2010). Evidence of the growth of UA lies in the value of food production in big cities that have an estimated UA production of between 15 and 20 per cent of the world's food requirements (Armar-Klimesu & Maxwell 2000).

Traditionally, agriculture in rural areas with rural communities far removed from urban areas has been the focus of research and interventions. However, with the migration of rural dwellers to towns and cities for employment opportunities and the resulting need for resources there, they can still continue with small-scale farming (Baiphethi & Jacobs 2009).

Unfortunately, they encounter many constraints such as small plots, cash expenses related to water, rates to be paid, and theft. Nevertheless, UA can be promoted and sustained as a valuable agricultural practice since most homes do have small plots and some households do already grow vegetables, herbal plants, and stock some animals, which are used to supplement food for the wider household, although very few engage in small-scale commercial activity. What is necessary is an exploration of the role that IK and IK holders can play in contributing to the development of urban agriculture in both developed and developing countries.

The need for increased initiatives in small scale subsistence gardens and farms, mini-co-operatives and the intervention of government and businesses is now more urgent than ever (Dorward, Kydd, Morrison & Urey 2004). With the HIV/AIDS and tuberculosis pandemics in Africa and other lifestyle diseases that affect many adults, large households often need to be managed by inexperienced and financially-strapped teenagers. There is therefore a dire need for schools and tertiary institutions in Southern Africa to promote sustainable agricultural education programmes (Chopra 2004), but this could be difficult as there is a lack of cohesive planning by the Departments of Education, municipalities, and communities to provide suitable education linked to the production of food (Kalaitzidis *et al.* 2011). We are aware of some local municipalities working on climate change community programmes with the focus on energy, food and environment (Aylett 2011) and also with schools on sustainable agricultural projects.

The latter has met with numerous challenges, where teachers' and learners' motivation rapidly dwindled as they encountered problems of theft, time constraints, and safe after-hours working periods. Nevertheless, we are aware from our preservice teachers and learners at schools that food-programmes organised by the government (Keller & Lang, 2008) as well as religious and charitable organisations in some communities do assist some learners and their families who have frugal economic means, to have healthy meals and so not attend classes hungry. The need for individuals and families, including university students, to provide their own food security has to take on a more practical form while integrating the theoretical concepts of science in agriculture.

Preservice teachers at a university come with agricultural and IK experiences from diverse settings, including urban areas and rural areas. They could share these skills with others. We maintain that spaces at homes, schools,

community areas and institutions could be maximised and used for extensive agricultural means thereby contributing to sustainable food security. We contend that these efforts which integrate science education and IKS food production practices within a collaborative and mentored work-setting have the potential to create a regular supply of fresh organic fruits and vegetables, which could also be used to sustain the family and to generate additional income. This could enhance the nutritional balance of healthy food in the urban diet thereby reducing the incidence of adverse health conditions among students and the wider community.

The Role of IK Holders in Agricultural Practices and IKS

During the past few decades there has been a flurry of activity relating to the value of IKS especially in developing and previously colonised countries, where substantial loss of culture, land, agricultural practices and IKS have demoralised and decimated indigenous communities (Hammersmith 2009). Many highly respected IK holders in indigenous communities are subsistence farmers with indepth knowledge of the weather, seasons, agriculture, environment including droughts and floods, identification of soils and nutrients, seeds, plants and animal diversity and maintain intricate relationships with their environment (Alcock 2010, 2014). But, sadly, much of this knowledge and skill has been lost, primarily through deliberate subjugation of the indigenous way of community life.

In South Africa, after the demise of 300 years of colonial rule and apartheid, the democratic government in 1994 set about rejuvenating and establishing systems to restore and preserve IKS. In this regard, IK policy was drafted to be implemented in all aspects of South African society including the agriculture and education sectors (Department of Science and Technology 2004). The policy underscored the protection of intellectual property of IK holders (Department of Trade and Industry 2008).

In education, research on practicing and preservice teachers' views of IKS and pedagogy of IKS in classrooms is evident (Vhurumuku & Mokeleche 2009), but a focus on authentic IK holders' participation in the academy (Mpofu, Mushayikwa & Otulaja 2014) is minimal. As they are often interviewed in the field, they are generally not considered on equal terms as tutors or lecturers in the academy. Several reasons for this have been suggested:

flexible access to IK holders, a complicated process of monetary payment, current policies of appointment of ‘legitimate staff’ in terms of formal academic qualifications, perception of the status of IKS in relation to Western and Eurocentric knowledge, amongst others (Ntuli 1999). Kaya (2013: 148) adds that the ‘recruitment of appropriate AIKS teaching staff’ into the academia is problematic as ‘the availability of appropriate and qualified staff is one of the major challenges of integrating IKS into teaching and learning’. Some researchers are convinced that indigenous agricultural knowledge (IAK) if harnessed, taught and practiced in a community-supportive manner in communities and in student-driven projects on university campuses could encourage and grow the knowledge, interest and action for sustainable agricultural practices. Parrish (1999) maintains that an understanding of IAK may be a necessary ingredient in any successful contemporary effort to feed the world and thus reduce extreme poverty. Successful outputs of this work may be observed in studies of Native Americans, First Nations (Canadians) and Maori (New Zealanders) (Masemula 2013), which indicate how indigenous knowledge lessons in academic operations can be directly linked to economic, political and community action.

As IK activists in academia, it is incumbent upon us to seek knowledge and utilise the lessons from pioneering initiatives and efforts for greater development. In Southern Africa, there are only a few published studies based on preservice teachers’ and teachers’ interactions with IKS holders in the formal sector or who are exposed to the struggles of the indigene (Mudaly & Ismail 2013; Vhurumuku & Mokeleche 2009). For preservice teachers and in-service teachers to critique IKS and science they need knowledge of science, IKS and Nature of Science (NOS) and Nature of Indigenous Knowledge Systems (NOIKS) (Vhurumuku & Mokeleche 2009), insight into politics, hegemony and colonisation (Kincheloe & Steinberg 2008), and how to integrate these into the school/tertiary curriculum (Govender 2014; Hewson & Ogunniyi 2011; Mpfu *et al.* 2014). It is, of course, extremely important to consider the types of questions we ask about the relationship between indigenous knowledge, western science and education as presented in the problem statement.

Theoretical Framework

Preservice teachers need to understand the historical and power relationships of societies and how some groups of people are prioritised at the expense of

others, who are marginalised. In order for these preservice teachers to appreciate a wide variety of insights, they also need to better understand and engage with the issue of indigenous knowledge in the academy. The main weapons used to conquer human societies in Africa were guns, germs and steel (Diamond 1997). Nowadays, the conquerer has taken to literature in the guise of neoliberalism where numerous individuals engaged in scientific research come from dominant Western/Eurocentric cultural backgrounds, and they continue to belittle the importance of cultural and indigenous knowledge in academic work and pedagogy (Huygens 2006). The Western scientific worldview generally regards alternate knowledge systems as outdated, lacking in evidence, superstitious and archaic (Tamdigi 2012; Kho 2014).

In framing the study in terms of the educational and epistemological value of indigenous knowledge and to counteract the claims which position IKS as subaltern, critical multilogicality (CM) as espoused by Kincheloe and Steinberg (2008) is relevant and appropriate. Critical multilogicality is:

an effort to act educationally and politically on the calls for diversity and justice that have echoed through the halls of academia over the last several decades. Such an effort seeks an intercultural/interracial effort to question the hegemonic and oppressive aspects of Western education and to work for justice and self-direction for indigenous peoples around the world (Kincheloe & Steinberg 2008: 135).

In the CM perspective, the purpose and inclusion of indigenous education in academia and in communities, and the viable economic production of indigenous knowledge must help to construct environments that facilitate indigenous self-sufficiency. Indigenous knowledge systems are complex and are a vast reservoir of practical and theoretical indigenous resources that can provide substantial insights into multiple domains of human endeavor. Such a complexity of IKS is discussed by IKS scholars (Bredlid 2009; Govender 2012; Ogunniyi 2011). Critical multilogicality is based on the notion of the transformative power of IK and of IK as an alternate way of knowing. It can be used to nurture empowerment, justice and sustainability in a variety of social, cultural and political contexts. Transformative IK involves having self-confidence in one's experiences, knowledge and skills, and knowing and understanding the 'other' through an exploration of '*ubuntu* (humanness)' (Waghid 2014: 57). Reflecting and being aware of the way we interact with

others and how similar we are in many respects involves an ‘engagement with cultural difference’ (Kincheloe & Steinberg 2008: 136). In South Africa in particular, most of the economic power and skills still lie in the hands of wealthy previously advantaged communities, mine owners, property-owners and large-scale agriculturalists. While IK is a rich social resource for any justice-related attempt to bring about social change, its economic value also needs to be elevated. In this context indigenous ways of knowing about agriculture and unique farming skills for sustainable living can become an important area for research, development and transformation. It is imperative then to examine pedagogical ways of how IK activities affect the reality in local agricultural contexts and how these activities can be included in the academic curricula. The IK ways of knowing and inclusion can contribute to the educational experiences of preservice teachers because it challenges the ‘rules of evidence and the dominant epistemologies of Western knowledge production’ (Kincheloe & Steinberg 2008: 136). The hope is that preservice teachers’ newly acquired experiences and knowledge of IK will provide a platform for them to further challenge the academy on Western and Eurocentric universalism of knowledge with the questions that IK raises about the centrality of ‘*ubuntu* (humanness)’ (Waghid 2014: 57), the relevance of our technological and scientific knowledge production (for instance the negative effects of armaments for warfare, wastage of food, amongst others), and about environmentally sustainable development. Leveling the power balance through personal and community transformation via agricultural and other services is what we anticipate as the product of engaging in the theoretical frame of CM. Preservice teachers, academics and IK holders will then be viewed as being on the same academic platform albeit contributing differently to the human dialogue and endeavours. In focusing the lens for this study, we adopt Kincheloe and Steinberg’s (2008: 147-150) five principles which shed light on the theoretical framework of CM. These are that critical multilogicality: (i) *Promotes rethinking our purposes as educators* - An understanding of indigenous ways of seeing as a subjugated knowledge alerts us to the fact that multilogicality exists and that there are multiple perspectives of human and physical phenomena. (ii) *Focuses attention on the ways knowledge is produced and legitimated* - The study of indigenous knowledges we are advocating is concerned with the process of knowledge production for sustainable agricultural practices. Such an awareness is too often absent in Western education. We are often taught to believe that the knowledge we consider

official and valid such as in textbooks and in research journals has been produced in a neutral and philanthropic manner. However, such a view dismisses the cultural and power-related dimensions of knowledge production and structures that propagate such practices. (iii) *Encourages the construction of a just and inclusive academic sphere where IK is not seen as merely a curricular appendage that provides a little diversity to Western academic institutions* - Curricular transformation based on our analysis of indigenous knowledge requires that educators become critical scholars. In addition, teachers who organise their work and teaching around an effort to help others to make critical sense of the world and who expose their learners to how knowledge came to be validated and included in mainstream pedagogies, is crucial. Educators who adopt this CM approach may bring a new dimension to the academy, in reconceptualising and making explicit the hidden, often implicit and unjustified practices, such as notions of superiority of the academy. (iv) *Produces new levels of insight* - Indigenous ways of knowing help communities to cope with their sociological, political and agricultural environments and are passed down from generation to generation. A curriculum that incorporates and implements IK supports the notion that indigenous knowledge is important not only for the culture that produces it but also for people from different cultures. (v) *Demands that educators at all academic levels become researchers* - In positivist Westernised-Eurocentric education teachers often say 'Give me the truth and I will pass it along to students in the most efficient manner possible' (Kincheloe & Steinberg 2008: 149). In the indigenously transformed curricula, preservice teachers are encouraged to understand a variety of subjugated knowledges and to assert their independence from Eurocentric experts.

In order to apply constructs from CM, critical ontological reflection is required. Our view is that who you know, what you know and how you come to know determines your identity. We are of the view that there is an inextricable connectedness between ontology, epistemology, methodology and axiology. Therefore, we invited IK holders to participate in the official educational programme as a way of bringing those individuals into the 'who you know' and their knowledge into the 'what you know' and we did so by means of a workshop on indigenous agricultural practices as the means of 'how you come to know'.

Methodology

This study was located in the critical paradigm. We positioned ourselves as critical pedagogues (Burbules & Berk 1999), and we created opportunities for our preservice teachers to critically reflect on ‘legitimate’ knowers and ‘legitimate’ knowledge within academic settings. Our study was also informed by the ‘three ways of knowing’ postulated by Habermas (Walker & Lovat 2015: 123). Habermas contends that knowing oneself (self-reflective or critical knowing) is a pre-requisite for empirical-analytic knowing (which focuses on technical data about what is known) and historical hermeneutic knowing (which focuses on understanding of meanings and is interpretive). According to Habermas, through self-reflection, social action for change and emancipation is possible (Walker & Lovat 2015). In our study we reflected on ourselves as knowers, and on the knowledge we wished to construct. We also encouraged our preservice teachers to reflect on the knower-knowledge dialect, by positioning the IK holder as the knower, and IK as part of the mainstream knowledge, within the academic curriculum.

A qualitative, case study approach was adopted in this study. Forty-nine preservice science education teachers (who represented both the population and sample) were purposively selected to participate in this study. The criteria for selection was that they should have been registered students in the Science Education module, had agreed to participate voluntarily in the study, and had attended the practical demonstration conducted by the IK holders. The Science module for which preservice teachers were registered included food gardening as part of the topic ‘human nutrition’ in the module outline. These participants were asked to complete open-ended questionnaires and record their reflections in the form of essays. Forty-nine questionnaires and 29 reflections were submitted by the participants. The questionnaires were used to elicit preservice science teachers’ views of the nature of science and of indigenous knowledge and possible links between the two seemingly disparate bodies of knowledge. The questionnaires were completed after the participants’ exposure to the teaching sessions by IK holders. Questionnaires were useful because they provided a private setting in which the preservice teachers could write about their views without fear or ridicule from peers.

The two indigenous knowledge holders who interacted with the participants were not academics and were schooled in Zulu culture, traditions and agricultural indigenous knowledge. We decided to bring the IK holders,

who typically might be positioned as ‘intellectual fringe dwellers’ (Dudgeon & Fielder 2006), to the centre of knowledge production and dissemination. The engagement of these ‘unconventional sources’ was intended to transcend preservice teachers’ ‘epistemological and pedagogical’ horizons (Mudaly & Ismail 2013: 193). We sought to disrupt ‘classical epistemological regimes’ (Pohl *et al.* 2010: 269) which positions academics who are schooled in Western scientific epistemologies and methodologies as the sole legitimate knowledge holders in tertiary education settings, by creating spaces for our preservice teachers to interact with other knowledge holders (Nakata, Nakata, Keech & Bolt 2012). We contend that IK holders are legitimate producers and disseminators of valuable knowledge, and should engage with aspiring future teachers in academic settings. The indigenous knowledge holders conducted a day-long workshop and taught the participants about indigenous plants, indigenous methods of planting, and the control of pests.

The workshop was interactive and the participants asked many questions. Most of the participants wrote a reflective essay after the workshop, where they recorded their learning from the indigenous knowledge holders about indigenous agricultural practices. We used reflexive inquiry (Cole & Knowles 2000) as a process of generating data from these participants, in order to plan effective, inclusive teaching strategies. We agree with Abbott, Brown and Wilson (2007: 187) that ‘reflections potentially form the basis of transformations in learning’. We propose that through reflecting on the nature of science and IK, the preservice teachers would have engaged in more than mere knowledge packaging and information-receiving and would produce rich data. Data from the questionnaires and reflective essays were analysed and content analysis was used to categorise major themes or issues.

Findings

1) Analysis of Questionnaires Regarding IKS and Science

Evidence from the open-ended questionnaires confirm that preservice teachers defined science using science content concepts such as natural selection, the use of science in life, and living in a context without science (see Table 1). The results were not surprising because preservice teachers have had deep and consistent exposure to the content and values of Western orientated science both at school and university.

Table 1: Preservice teachers' conceptualisation and views of science

What is science?	Give an example of a concept in science	Give an example of the practical application of science in your daily life	Can you live without science? Explain
It is a body of knowledge that uses an investigative process to gain knowledge and understanding of the world.	Photosynthesis	In boiling liquids, I can use science to know what chemical processes occur for making products, how it does so and understand what happens at high temperatures?	No, I can't. Science can be used to explain how things occur and this information is used with regard to everyday applications.
Science is the study of all things that are part of life sciences and to determine why and how things happen.	The theory of evolution by means of natural selection.	Rooibos tea is known to reduce allergies and improve sleep. I drink one cup a day because of its benefits which is now verified by science.	No, science surrounds all aspects of life and can be used to improve and understand various aspects of life.
Science is how nature relates to us and how we connect with	The process of photosynthesis and food production in plants.	Making a cup of tea requires the application of science such as boiling points,	No. Science and experimentation allows us to enjoy life and get the best out of it in

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our surroundings .		infusion and evaporation, temperature and safety.	terms of food, resources, travel, water supply etc.
Science is concerned with how humans understand the history of the natural world around us on the basis of physical evidence.	Photosynthesis – plants make their own food through the use of sunlight, air and water.	Boiling water is used to make an infusion (of tea/coffee). When water boils, you see steam and water vapour rising and then condensation takes place. This is the same concept as the water cycle to explain the formation of rain.	No, because through scientific forensic evidence of a murder case suspects can be found. Forensic evidence helps to catch out the criminals.

The format and the content of the questions asked represent the Western manner of interrogation and the lack of space for narratives. The responses to the first question revealed the ‘textbook’ meaning of science where the content and process is presented. Since science is about learning concepts, it was expected that the preservice teachers would respond in this way, and not surprising that they refer to photosynthesis as an example of a science concept. The application concerned the use of water (in a liquid mixture) for consumption and life purposes. All participants indicated that they could not live without science and provided evidence in general or related it to its importance in their personal daily life.

Table 2: Preservice teachers’ conceptualisation of IKS

What is IKS?	Give an example of a concept in IKS	Give an example of IKS experienced in your daily life	Can you live without IKS? Explain
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<p>IKS is knowledge that is generated and passed on by people of various communities.</p>	<p>IKS utilises plants for medicinal purposes as a natural remedy for a variety of ailments.</p>	<p>My mother always told me to drink crushed ginger and tumeric when I had the flu. It does help to relieve the symptoms of a flu.</p>	<p>No, IKS is embedded in our past and everyday lives.</p>
<p>IKS is knowing the traditional knowledge that is passed down from elders or ancestors about how to live, to farm and hunt etc.</p>	<p>Drying of meat – meat from animals slaughtered have to be cut up into pieces and stored in the sun so that the meat is cured.</p>	<p>There is a plant called ‘Mother-in-laws tongue’ that my granny used. When one is having an earache, the leaf is squeezed and the juice is warmed and poured gently into the infected ear.</p>	<p>No, because to an extent IKS is of vital importance as information is being passed from one generation to the next. It is mostly in oral form.</p>
<p>Indigenous knowledge is knowledge of a particular group that is passed on from generation to generation.</p>	<p>Plants are used as treatments for bites, stomach ailments, flu etc.</p>	<p>Use ginger and tumeric powder and boiled with milk to help with colds and flu.</p>	<p>No, it is just as important as Western science and we can use IKS in our everyday lives. The IK is applicable and sustainable.</p>
<p>Knowledge that is learned from indigenous people within a community and passed on from generation to generation.</p>	<p>IKS farming utilises rotational cropping where different species of vegetation are grown at different times.</p>	<p>Tumeric powder and syringa crushed leaves are used to treat chicken pox or measles by applying on one’s body.</p>	<p>No. IKS has direct relevance for our current society as it can be utilised in combination with modern Western methods to enhance the quality of life.</p>

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Students were able to explain the concept of IKS, give examples of IKS as experienced in daily life, many of which were examples of natural remedies used at home that have been passed down from generation to generation. Their answers indicate that they perceived IKS to have historical value and to still have value nowadays as well (see Table 2). The IKS expressed is linked to how participants used the resources available to them for healing and health related purposes.

Preservice teachers reported the relationship between science and IKS as follows: Science was developed through IKS experiences acquired generations ago and had an early influence on the development of Western knowledge, mainly through oral tradition. They cited examples of medicinal plants that have been known to cure ailments, the healing properties of which have now been confirmed by scientific experiments providing scientific evidence of the value of some treatments used in IKS. As examples, participants mentioned the use of rooibos tea for stomach cramps which has now been shown scientifically to have antispasmodic properties and to have antioxidants and flavonoids which are beneficial in treating dermatitis (Bramati, Minoggio, Gardana, Simonetti, Mauri & Pietta 2002). In addition, participants mentioned curcumin (tumeric) which has now been shown to have valuable antioxidant and anti-inflammatory properties (Tilak, Banerjee, Mohan & Devasagayam 2004) and as an antiseptic for cuts and as a facial wash (Prasad & Aggarwal 2011). These examples cited were used and continue to be used by different communities in South Africa.

Preservice teachers also responded to the following questions: ‘What is your understanding of the relationship between IKS and Natural Science? Explain with examples.’ Here are a sample of the participant’s responses:

P1 - The relationship is dependent on each other and should be taught alongside. The one cannot be taught without the other. Without IKS experience, science is ‘foreign’ and not relateable at times. For example, when teaching about ‘heartburn’, it will be useful to teach a western science perspective of how to treat it as well an indigenous medicinal plant that is also used to treat it and alleviate the problem.

P2 - Natural Science is a Westernised compilation and development of ideas that arose through various IKS. IKS provides the ground work for many of the topics in science or scientific approaches used to

explore these topics. The ideas of inquiry in science was also brought about through IKS. For example, elders long ago used rooibos tea as it was beneficial and assisted in alleviating stomach cramps and heartburn but now through scientific investigation scientists discovered that rooibos hold antispasmodic properties supporting IKS practices.

P3 - IKS and natural science are directly connected as they share a common object 'nature'. Previously, communities have made use of tumeric and syringa leaves to treat chicken pox and measles. Science can use this knowledge to extract the medicinal properties of the tumeric and syringa leaves to produce medicine for chicken pox or measles. In this way science and IKS can co-exist without one being more dominant than the other.

Table 3: Categories of science, IKS and their perceptions of relationship between science and IKS

Science	IKS	Relationship between science and IKS
Science is based on experiments.	IK is based on experiential knowledge and shared historical knowledge.	Science originated from IKS.
Science has largely Western influence.	IKS is used for daily survival as it comprises knowledge from plants, animals, materials and spirituality.	IKS supports science. Both are linked to nature and should be taught alongside each other.
Science explains natural events.	IKS still has valuable medicinal uses.	Science can confirm the validity of some IK medicinal substances through laboratory testing.

Table 3 shows the categories which emerged from the questionnaire data regarding the participants views of science, IKS and their perceptions of the relationship between the two.

2) Reflections on the Workshop

Preservice teachers shared their reflections on their learning from the workshop experience. Sample statements are presented below:

The visit helped me a lot in terms of understanding how the traditional healers know which herbs to grow and use.

I did not know that we can plant Blackjack, since they grow quickly and rapidly. Blackjack is a weed that helps! It is not good for other plants but our health. The visit helped a lot because I learnt so many things about common plants that grow on their own in our gardens.

Analysis of the reflection notes indicate that participants were able to identify indigenous plants that they have at home and recollect their historical and current uses as taught to them by their elders, and to prepare these plants for medicinal uses. A significant observation is that Zulu names of plants were provided and foods prepared from them were named. In particular, the Blackjack (*Uqadolo*) and the Amarathus (*Imbuya - umfino*) leaves were mentioned, both being used as a herb source for meals as they are nutritious, contain Vitamin C and have a fibre content which is beneficial for the digestive system.

Preservice teachers recognised the value of the integration of IKS knowledge into mainstream science, especially the practical integration of such knowledge. Participants expressed positive attitudinal and emotional feelings towards the inclusion of IK holders as teachers in higher education settings. Bongzi expressed her joy as follows: *The visit from the traditional healers was extremely exciting as it was the first time I was exposed to one. It was learning something simple as planting in a new and innovative way. I will definitely pass on the knowledge of indigenous crops to my own learners because I think it will greatly benefit them.* The participants also expressed a desire to share and teach their learners this type of knowledge, when they begin their science teaching career.

Discussion and Implications for Responsive and Innovative Pedagogies in Higher Education

Our goal as educators and researchers operating in Western academia is to

create the space for practical, relevant, indigenously informed science that is dedicated to the social needs of communities and is driven by humane concerns rather than only political ideology. Often Western science via its education curricula plays a significant role in perpetuating the hegemony of the Western-European worldview and thereby the subjugation of indigenous experience, knowledge and worldview.

Based on classroom questionnaires and reflections during our first implementation of the inclusion of IKS holders in the academy, the voices emanating from the data, our interpretations of preservice teachers' narratives and our analysis, we propose that the participation of IKS holders should be explicitly included in the curriculum on a regular basis. This would assist preservice teachers by involving them in dialogues on different ways of knowing and, also, in promoting awareness and recognition of different knowledge systems and knowledge holders, through agricultural projects in their communities. This inclusion may encourage more political and community participation for enriching sustainable environmental programmes. We propose that a scholarly encounter with indigenous knowledge holders can enrich the ways we engage in research and conceptualise education while promoting dignity and respect, stimulating dialogue on an equal footing, and contributing to the survival strategies of marginalised communities and modern urban communities. We contend that exposure of preservice teachers to these arguments is critical, which is why we brought the voices of preservice teachers to the centre in this article. The critical debate between indigenous knowledge and science should now embark on a more practical and integrative phase to deal with the many questions posed regarding sustainable agricultural development.

Relationship between Theory and Findings

This study has produced new levels of insight along the lines of Kincheloe and Steinberg's five principles of critical multilogicality (CM). Our study has *promoted rethinking of our purposes as educators*, as a result of seeing the need for integration of IKS in science education curricula and creating the spaces for preservice teachers to re-think their roles. This study has *focussed attention on the ways knowledge is produced and legitimated*, by engaging IK holders as teachers in science education, and thereby legitimising and valuing their knowledge and status. In doing this, we contend that this study has

encouraged the construction of a just and inclusive academic sphere where IK is not seen merely as a curricular appendage that provides a little diversity to Western academic institutions. Finally, we argue that preservice teachers have been enabled to *produce new levels of insight* from the opportunities created for them to think and reflect deeply about the value of IKS and science, and the role of indigenous knowledge holders as teachers in academia. By researching how ontology, methodology and epistemology interact, and how these can be used as tools of control, power and subjugation, we meet the fifth principle of CM which *demand that educators at all academic levels become researchers.* We anticipate that some preservice teachers will be leaders in IKS programmes and enrol for post-graduate courses in Higher Education where IKS is further explored and researched.

There is evidence of preservice teachers' new experiences and changed attitudes towards IK holders and a confirmation of their intention to co-construct IK with their learners. They valued the aspect of the Science Education curriculum that incorporated and implemented IK because it supports the notion that indigenous knowledge is important, not only for people from the culture that produced it, but also for people from different cultures. Preservice teachers revealed that they were cognisant of the implications of science-IKS research in relation to agriculturally and environmentally sustainable development.

Conclusion

The questionnaires and reflections enabled the preservice teachers to voice their positive experiences of an IKS learning experience, and the findings show that in particular they valued the medicinal uses of plants embedded in IKS. In addition, they were inspired to preserve their IKS through trans-generational knowledge transfer to their learners and communities. They also supported IKS inclusion and indigenous knowledge (IK) holders into the academia but were not explicit about how this should occur. They have come to recognise that Western science is not the only legitimate knowledge producer, through conversations about how different forms of research and knowledge are produced based on issues of locality, cultural values, and social justice. The findings indicate that preservice teachers did not take the binary position of western epistemology/indigenous epistemology. Instead they sought to create a hybrid space where ideas rooted in different epistemologies complement each other.

Implications for Further Studies

While preservice teachers were eager to engage in IKS inclusion, the study suggests that they also need to be challenged further to express their critical voices on the status of IKS and science and take on a more cohesive and practical role in their communities, given their scientific and IKS experiences on garden projects. This can be the basis for further studies.

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