INDIGENOUS KNOWLEDGE IN THE SCIENCE CLASSROOM: SCIENCE, PSEUDO-SCIENCE, OR A MISSING LINK?

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Abstract
Although the Life Sciences curriculum asks for the inclusion of indigenous knowledge systems in the classroom, it is either done very superficially by teachers by providing an example or two, or ignored completely. This mixed-methods study (with emphasis on the qualitative inquiry) into the status of indigenous knowledge in the life sciences classroom in Gauteng, once again echoed what Rogan and Grayston (2003) reported: in South Africa the curriculum process focuses too much on the *what* (the curriculum itself), at the expense of the *how* (the implementation of the curriculum). Although the progressive curriculum makes it clear that indigenous knowledge should be addressed, it provides very little guidance to teachers on how this should be done. This paper highlights the problem of teachers' lack of pedagogical content knowledge (PCK) in addressing indigenous knowledge systems.
Keywords: Life Sciences education, indigenous knowledge, teachers' pedagogical content knowledge

1. INTRODUCTION

Science education has undergone several waves of change over the past few decades. Wallace and Louden (1998) refer to three such waves of science curriculum reform in the international arena, namely (a) a focus on science as discipline knowledge in the 1950s and 1960s, (b) science as relevant knowledge in the 1970s (with an emphasis on scientific literacy and a science-technology-society approach), and (c) science as imperfect knowledge, with an epistemological shift towards cognitive science and more constructivist approaches in the 1980s and 1990s. The more constructivist approach to science education today asks of the Life Sciences teacher to acknowledge the indigenous knowledge (IK) that a learner might have. In a true constructivist fashion, the teacher should build on this pre-knowledge of learners. This poses a challenge to the Life Sciences teacher as it places high demands on a teacher's Pedagogical Content Knowledge (PCK).

1.1. Indigenous knowledge in the South African classroom: a golden opportunity

South Africa with its rich cultural diversity and rich biodiversity offers wonderful learning opportunities to Life Sciences learners. As an emerging economy, South Africa is faced with a number of challenges such as unemployment, a lack of scientists (which prevents us from becoming a global player in the world economy), poverty and issues regarding food security,

diseases and pandemics such as HIV and AIDS, and a lack of proper healthcare for many South Africans, especially those in rural areas. These obstacles pose a threat to economic growth. Scientists such as Van Wyk and De Beer (2012) are of the opinion that the inclusion of indigenous knowledge can help to address many of these issues.

The rich IK and cultural practices in many areas in the country provide learners with a good entry point into the scientific world. A true constructivist teacher will realise the importance of building new knowledge on learners' existing prior knowledge. This will show learners how relevant science is in our daily lives. It may even open future career opportunities and develop learners' entrepreneurial skills. An example of the application of IK: The local people in the Giyani district have been using the plant *Lippia javanica* as an insect repellent for decades. The CSIR, in conjunction with the local community in Giyani in Limpopo, has registered a patent on the use of *Lippia javanica* as insect repellent. Clinical tests on citronella oil as a mosquito repellent showed a success rate of 40% while the oils in *Lippia javanica* seems to be 95% effective. The commercialisation of this application is also benefiting the community by creating jobs (Mothwa, 2011).

These developments also offer the opportunity to reflect on biotechnology and modern pharmacology in the Life Sciences classroom. This provides teachers with golden opportunities to introduce learners to scientific processes and procedures that support IK claims- indigenous knowledge need not be pseudo-science: it can demonstrate rigorous scientific procedures. For example, botany can come alive if a teacher introduces simple chromatography techniques or organic chemistry. Simple chromatography can be done on a shoestring in the laboratory. As enrichment, teachers can also refer to modern techniques used in laboratories today, such as thin-layer chromatography (TLC), liquid chromatography coupled with mass spectrometry (LC-MS) or high-performance liquid chromatography (HPLC). These basic procedures are applied in most university laboratories, and they will give learners a better understanding of the nature of science, as well as future career opportunities.

The National Curriculum Statement and CAPS for Life Sciences states clearly that indigenous knowledge should be incorporated in the Life Sciences classroom. However, this research shows that the incorporation of IK in the teaching of Life Sciences is easier said than done. One of the major obstacles in infusing IK in a sensible way into the Life Sciences curriculum is the lack of teachers' pedagogical content knowledge (PCK), which is a theoretical construct that was introduced by Shulman (1986) as a way to describe the particular form of content knowledge that embodies the aspects of content most germane to its teachability (Shulman, 1986: 9). Teachers need the knowledge and didactical skills to incorporate indigenous knowledge in the classroom in a sound way. Two additional factors make the introduction of indigenous knowledge difficult in the classroom: (a) the multicultural South African society (*whose* IK should be entertained?),

and (b) the nature of science, and many teachers' perception that the introduction of IK would constitute pseudo-science.

1.2. Indigenous knowledge: science, pseudo-science, or a missing link?

The question arises whether it is possible to introduce indigenous knowledge in a scientific way in the Life Sciences classroom. Is a focus on IK compliant with the syntactical nature of Life Sciences, namely an emphasis on inquiry-based approaches? A second question arises: are South African teachers able to teach IK in such a context? Many Life Sciences teachers find it difficult to follow heuristic approaches where learners engage with formulating hypotheses, developing experimental designs, collecting and interpreting data, and making conclusions (Horak & Frieke, 2004). Now, in addition to this challenge, teachers need to follow such a pedagogy to investigate indigenous knowledge claims. It is much easier for teachers to rely on chalk-and-talk approaches, as a study of Petersen (2010) reveals. The pleas of the new curriculum, namely emphasis on scientific processes and the incorporation of indigenous knowledge, are problematic for many South African teachers. As many teachers were trained in the "old method" of teaching and not in the pedagogy prescribed by the NCS/ CAPS, many of them do not have specific know-how about the indigenous knowledge that they need to impart to learners. Those who are fortunate enough to have sufficient know-how on indigenous knowledge systems (IKS), often lack the pedagogy. Why teachers find it so difficult to teach IK, is probably not only a question of a lack of training. In the apartheid era, it was a taboo to mention traditional medicine in the classroom. Under the Suppression of Witchcraft Act, indigenous belief systems were undermined, in most cases referred to as pagan (heathen) belief systems and viewed as something that derails the society (De Beer & Whitlock, 2008).

During the apartheid regime the education system was designed to suit the needs of the economy and to ensure African subordination. The education system at that time was never intended to provide all Africans with sufficient education in order to allow them to participate intelligently in conducting their lives (Nkabinde, 1997). The previous science curriculum was favouring "westernised" science, and the South African curriculum had a very British feel to it. This westernised focus on biology often comes at the expense of indigenous knowledge – a practice that Odora Hoppers (2004) calls knowledge apartheid.

Indigenous knowledge can be referred to as knowledge about the world around us which has been developed by local cultures and has been used to sustain their lives. Indigenous knowledge is the knowledge found among the indigenous people of the country. Such knowledge should be valued in the Life Sciences classroom since community, culture and school cannot be treated as separate entities. They need to work hand in hand in order to make the education of learners more meaningful.

2. RESEARCH METHODS

Explanatory and sequential mixed-method research, which involves both quantitative and qualitative data collection and analysis, has been undertaken (Creswell, 2009) to determine how teachers view the incorporation of IK in their lessons. The quantitative study was underpinned by a University of Johannesburg Science Education study that was commissioned by the Gauteng Department of Education (GDE). One of the sections in the questionnaire, which was sent to all the schools in Gauteng that offer Life Sciences, dealt with indigenous knowledge. A Likert scale was used, and STATKON, the statistical unit of UJ, analysed the data. More than 250 completed questionnaires have been returned to offer a wealth of information for this research. The data is provided in paragraph 3.4. Based on teachers' feedback, an interview protocol was compiled for the qualitative part of the research.

Phase 2 of the study entailed the generic qualitative inquiry (with elements of a phenomenological approach, since this research wanted to capture the "lived experiences" of the teachers). A number of eight teachers were individually interviewed and the interviews were recorded. Transcriptions were made and analysed to reveal a number of codes, categories, patterns and themes. These themes are discussed in paragraph 3.5.

3. INDIGENOUS KNOWLEDGE IN SOUTH AFRICAN LIFE SCIENCES CLASSROOMS

The views that teachers hold of IK, also reveal often how they view the nature of science.

3.1. Nature of science

Life Sciences education in school should focus on scientific knowledge (the facts, principles and laws of science) and also emphasise scientific processes. Learners should be assisted to state hypotheses, test predictions, do experiments and analyse data. In this way, students will get a better understanding and a "feel" for the true nature of science. Our understanding of the Nature of Science (NOS) can be described as the ideas and assumptions we hold in terms of scientific knowledge and the science process (Vhurumuku, 2010). The NOS can be described as the way of knowing and the characteristics of scientific knowledge which are intrinsic or internal ideas guiding all scientific investigations. One of the greatest ideas regarding the nature of science is that scientific knowledge is not stable or cast in stone and can change at any given time. Learners' understanding of the nature of science can influence how learners attend to evidence in support of or in conflict with their own belief systems regarding social issues (De Beer & Whitlock, 2008). The two authors further suggest that all science is embedded in cultural assumptions and historical processes, which are deterministic to the ways knowledge is apprehended and encouraged. The question arises whether the inclusion of IK in the Life Sciences classroom can assist students in obtaining a better understanding of the NOS. If a person's perception of indigenous knowledge includes metaphysical views on traditional healers

making contact with ancestors, the answer is probably no. However, if IK is introduced in the classroom in a rigorous scientific way, students will get a better understanding of the nature of science. De Beer and Whitlock (2008) and De Beer and Van Wyk (2011) propose teaching strategies that could be followed when introducing indigenous knowledge in the classroom, based on observation, hypotheses formulation, data collection and data analysis. Such an approach in the Life Sciences classroom will give learners a more nuanced understanding of the NOS.

3.2. Introducing ethnobotany with scientific rigour in the Life Sciences classroom

South Africa is one of the global hotspots of both biological and ethnic diversity. Southern Africa is rich in angiosperm species (21,817), and Van Wyk and Gericke (2005) estimate that about 3,000 medicinal plants are regularly used in South Africa. De Beer and Whitlock (2009) and De Beer and Van Wyk (2011) show that ethnobotanical perspectives can be brought into the Life Sciences classroom with rigour, and without introducing pseudo-science. By using ethnobotanical approaches, students can engage with the true Nature of Science, as well as with the so-called scientific method. These authors indicate how learners can do ethnobotanical surveys, tapping into the IK of cultural groups, using the rapid appraisal methodology. Learners can prepare herbarium voucher specimens of the plants used by people, identify these plants, and also consult literature and websites, like the website of the South African National Biodiversity Institute (SANBI), for clinical tests carried out on these plants in order to identify active ingredients with anti-microbial activity. The authors also suggest methodologies, based on the scientific method, where learners can isolate active substances from plant material (using simple chromatography techniques) and test for anti-microbial activity. The question is whether teachers have the PCK to effectively guide learners in rather sophisticated procedures.

Also, an ethnobotanical approach can introduce ethical aspects, such as intellectual property rights, in the classroom. An interesting South African example that can be used to illustrate the ethical minefield we find ourselves in, is the *ghaap* or *ghoba* (*Hoodia gordonii*) which is a popular food item used locally to suppress hunger and thirst and also to treat stomach pain. The appetite-suppressant properties of the plant have been studied scientifically and are ascribed to a chemical compound in the plant known as P57 (Van Heerden, 2004). This plant has become internationally famous as potential anti-obesity drug. The economic implications are huge as the current market potential for dietary control of obesity is billions of US Dollars per annum in the USA. *Hoodia gordonii* provides an interesting example of some of the ethical issues encountered in science . The earliest people in South Africa, the Khoi and San, used it as an edible plant, and the fleshy stem provided the necessary water in a very dry part of South Africa. Research undertaken by the Council for Scientific and Industrial Research (CSIR) in South Africa shows that this plant, with an active ingredient named P57, is an effective appetite suppressant. In the late 1990s, the American firm Pfizer was given the rights to develop *Hoodia* tablets as a commercial undertaking. However, questions were asked about the intellectual property rights of

the indigenous (San) people, who have used this plant for many decades or perhaps even centuries. The CSIR therefore signed an agreement with a particular San group in the Kalahari, whereby this San group received royalties from the sales of this plant product. However, this created problems as only one San community was acknowledged and the plant is widespread in the dry areas of South Africa. This might be one of the reasons why Pfizer announced that it will no longer develop the commercial use of Hoodia, although restructuring of the company was given as official reason for withdrawal from the project. However, illegal trade in *Hoodia* has led to the plant becoming a threatened species. These issues should be addressed in the Life Sciences classroom.

3.3. Teachers' Pedagogical Content Knowledge (PCK)

Shulman's (1986) notion of PCK focuses on the knowledge of what method or teaching strategy would be most useful to ensure student understanding of a particular topic. Contextual knowledge is also necessary. Teachers should know the students, and the environment they come from. This will enable teachers to understand and anticipate misconceptions that learners might encounter on specific topics (Shulman, 1986; Sanders, 2007). Shulman (1986) introduced PCK in 1985 after America revealed that there was a poor correlation between learners' needs, teaching methodology and the content to be taught. According to Shulman (1986: 9), PCK includes "the most useful forms of representation of topics, the most powerful analogies, illustrations, examples and demonstrations – in a word the ways of representing and formulating the subject that make it comprehensible to others".

3.4. The quantitative data collected during this research

The quantitative study draws on the GDE-commissioned research that was done by the Department of Science and Technology Education, Faculty of Education, University of Johannesburg. Questionnaires were sent out to Life Sciences teachers in all the schools in Gauteng and 255 completed questionnaires were returned to the University. Table 1 gives an overview of some of the data obtained on IK in the Life Sciences classroom.

Table 1: The GDE research data on Indigenous knowledge in the Life Sciences classroom

		Strongly disagree	**Disagree**	**Agree**	**Strongly agree**
By referring to indigenous knowledge, science becomes more relevant to my learners	N %	4 1.7%	27 11.7%	140 60.9%	59 25.7%
Learners do not understand science concepts because they want to cling to their	N %	21 9.4%	150 67.3%	39 17.5%	13 5.8%

indigenous knowledge					
Science explains all natural phenomena completely	N %	17 7.6%	115 51.3%	75 33.5%	17 7.6%
The importance of indigenous knowledge is exaggerated	N %	10 4.5%	143 64.1%	57 25.6%	13 5.8%
There is little connection between indigenous knowledge and Western science	N %	21 9.4%	142 63.4%	51 22.8%	10 4.5%
I understand what is meant by indigenous knowledge	N %		2 0.9%	133 58.1%	94 41.0%
Indigenous knowledge is often in conflict with Western science	N %	1 . 0.5%	82 38.0%	111 51.4%	22 10.2%

From the data it is clear that most Life Sciences teachers see the value of IK in the Life Sciences classroom. Of the 230 teachers whose answers were used, 86.6% indicated that the incorporation of IK in the classroom makes science more relevant to the learners. A high percentage of teachers (76.7%) indicated that IK is not limiting the acquisition of scientific knowledge by learners. These teachers are of the opinion that learners, despite being taught IK, are open to explore and embrace scientific investigations.

The majority of teachers (67.3%) disagreed with the statement that learners might cling to their IK (IK is not a barrier in the understanding of science), which might negatively impact on the learning and understanding of science. Some teachers did feel that IK has a negative influence on learners' understanding of science. A total of 17.5% of teachers agreed with the statement, and 5.8% strongly agreed. A large percentage of teachers (86, 6%) felt that by referring to IK, science might become more relevant to learners.

The question on whether science adequately explains all natural phenomena led to a split in opinions. A total of 58.9% of teachers felt that science alone cannot adequately explain natural phenomena, while 41.1% felt that it does. In the survey, 31.4% of teachers are of the opinion that IK is overrated and over-emphasised in the curriculum (25.6% agreed, while 5.8% strongly agreed). On whether the importance of IK is exaggerated, 64.1% of teachers disagreed and 4.5% strongly disagreed.

A cause for concern is that 61.6% of teachers are of the opinion that there is conflict between "IK" and "Western science". In response to the item whether indigenous knowledge is in conflict with Western science, 38% of teachers disagreed, and 0.5% strongly disagreed. A worrying 51.4% agreed, while 10.2% of teachers strongly agreed.

3.5. The qualitative data: what we learned from the interviews

Following the quantitative study, interviews were conducted with eight teachers. The following section discusses the themes that emerged when the transcriptions of the interviews were analysed.

Theme 1: The challenges experienced with the infusion of IK in teaching Life Sciences mostly centres around a lack of teacher PCK

The data revealed that the participants experienced several challenges in relation to the infusion of IK in teaching Life Sciences, which mainly points to the lack of teacher PCK.

Category 1.1: Insufficient training and professional development for the implementation of the NCS (CAPS)

The participants acknowledged that the infusion of IK in Life Sciences posed challenges. The narratives also revealed that the teachers were concerned with the extent to which Life Sciences educators are trained to infuse their teaching with IK. Teachers acknowledged that they lack knowledge related to the contemporary curriculum and infusing IK in their teaching:

> *"My main problem is that of the lack of teaching methodology and it is difficult to teach the learners. I think this is teachers' greatest concern. Learners are adapted to western life and mostly their belief system makes them loose interest in their indigenous knowledge. This makes them relate IK to evil spirits (Satanism). The practical application of the indigenous knowledge in class is also difficult. As a teacher I am challenged to develop some practices that can convince them to be at least gravitated towards science."*

Teachers need relevant pedagogical content knowledge in order to infuse their teaching with IK. A Life Sciences teacher needs *content knowledge*, i.e. know-how of the indigenous knowledge claims of different cultural groups, e.g. plants used for medicinal reasons; *pedagogical knowledge*, i.e. how to effectively structure learning opportunities for learners when exploring IK claims, and *contextual knowledge*, i.e. what the cultural background of the learners are.

Category 1.2: Lack of IK-related material resources in school

The transcriptions of interviews revealed that it was difficult to include IK because of a lack of material resources. The participants indicated that it was difficult to obtain further information about indigenous knowledge. One participant mentioned that:

> "*We have the problem of not having enough material concerning IK. Teachers do not have places of reference or at times do not get necessary material to use in class. As I have already said that this type of knowledge is verbally transmitted, there is nowhere one can get the proof of its existence in the first place. Everybody comes up with his or*

her own statement. This leads us to the misconceptions and misrepresentations about indigenous knowledge."

Category 1.3: Cultural diversity and differences

Teachers might be knowledgeable in terms of their own culture, but do not necessarily know much about IK in other cultures. This leads to a confusion of whose culture to consider as they do not match.

> *"Eish,… teaching Life Sciences is very challenging, especially that you teach learners from different cultures and communities. As a teacher you cannot cover all their cultures, some of which you do not know. When you emphasise knowledge from one cultural group, others feel belittled while others feel excluded. At times you do not get the necessary or enough information or material you want to teach learners. Learners are from different cultures and environments and it is difficult to know and cater for their different cultural backgrounds in class. Our policy states clearly that we must include their indigenous knowledge in class, but it is difficult because as an educator I did not know them all. It is only a few that I am acquainted with."*

Category 1.4: Lack of support systems from the Department of Education

The participants indicated that there is lack of support from the Department of Education. As such, they try to work on their own by organising Saturday schools and inviting knowledgeable people from the community to come and share lessons on IK. The only available support comes from colleagues, educators from surrounding areas, parents and community elders. The participants mentioned that:

> *"We are not supported by anybody, instead we run around seeking help from others. We are just like a train moving without the head. You as a teacher will see how to come up or to solve problem."*

The Department needs to organise in-service education and training for the teachers in order to upgrade their skills and the knowledge they impart to learners.

Category 1.5: Lack of pedagogical content knowledge (PCK)

All of the above imply that teachers' lack of PCK seem to prevent the effective teaching of IK in the Life Sciences classroom.

Theme 2: The emotional experience of the participants (teachers) in relation to teaching IK in Life Sciences

The findings of the narratives indicate that the participants experienced negative emotions because of the perceived risk of not being able to convey the correct IK content to learners. The

curriculum changes, without thorough professional development support, also create stress among teachers. Some participants indicated the following:

> *"There are changes in our education system that leads to the confusion and frustration on us. For instance, we are trained in an old method of teaching and they brought us OBE which was followed by NCS. It is difficult for us to apply them in class. When doing the NCS there are some outcomes that we need to accomplish with the inclusion or infusion of indigenous knowledge, but it is difficult because of the lack of material, different cultures from different communities and our own experiences as educators."*

> "*Indigenous knowledge brought fear to us as educators because we don't know how to approach it as we were never given courses or trained about it. We are just striving to understand it and feel that it is a challenge to us as we are having different belief systems. As teachers we are divided where some of us just brush it aside and continue with the other part of the syllabus."*

Category 2.1: Feeling of a lack of control over own practice (e.g. changes in the education system and curriculum, and the inclusion of IK in the LS syllabus)

The narratives indicated that the participants felt they have no control over their teaching because of the changes in the education system and curriculum, and the inclusion of IK in the syllabus for Life Sciences. The following quote from Rogan and Aldous (2009) also applies to the inclusion of IK in Life Sciences:

> *Teachers are at times described as being reluctant to changes, of being bound to tradition, or even active saboteurs of the intended curriculum. In our case studies, the low level of implementation, for the most part, cannot be described to 'foot dragging or lack of effort'. The interview revealed an overwhelming desire to faithfully implement the new curriculum, but tinged with an enormous perplexity about how to do so, and an uncertainty as to whether their efforts in the classroom were 'the right way'.*

Category 2.2: Teachers' own negative perceptions of IK

Some teachers are negative about IK, and feel that IK cannot be scientifically proven and that it constitutes "pseudo-science". Many teachers do not have the know-how to incorporate PCK in a scientific and rigorous way.

> *"Eish, … some of the things cannot be scientifically proven and do not have a living evidence. Some cannot be brought to class so that they can be done practically or even show to learners when the teacher needs to give an explanation."*

"Most of the learners have a negative attitude towards IK as they take it to be outdated and barbaric. Maybe it is because of their religion. To some people, anything that is not European is not just worth their time."

Theme 3: The meaning of IK in the teaching of Life Sciences

The transcripts indicated that the participants have an understanding of the meaning of IK. The participants verbalised their inner satisfaction of knowing what IK is, its importance and relevance to teaching LS, and the impact that IK has on the involvement of parents in learners' education.

Category 3.1: Having an understanding of IK

The findings of this research indicated that the participants understood the definition and meaning of IK even though they put it in different words. Beliefs, values, customs, traditions, family, culture and norms, communities and societies, generations and the environment were among the common terms used in the definition of IK.

Category 3.2: The relationship between IK and Western science

According to the findings, there is a difference between IK and "Western science" in that indigenous knowledge is acquired from home while Western science is acquired from school. IK is gathered from the communities in different cultures and is learned through experiences. Western science, on the other hand, is said to be normally scientifically proven and is also positivist and materialist in contrast with indigenous knowledge which is normally spiritual. Some participants indicated that:

"The two cannot be separated because the knowledge that one has can be linked with the knowledge that can be acquired in everyday life. Western science favours analytic and reductive method as opposed to the mere intuitive and holistic view often found in traditional knowledge. It is based on academic and literature while indigenous knowledge is passed on orally from generations."

"Indigenous knowledge is home based and does not require one to make experiments or to prove the findings. It is just what you have learned from home and the surrounding area in which you live and from the community. This knowledge is subjective. Western science is based on lab work and literature. It is normally not influenced by your own feeling or opinions (objective) and analytic, i.e. using methods that help you examine your facts or assumptions carefully."

Category 3.3: The importance of IK in Life Sciences

Many teachers are of the opinion that there are positive changes that can be brought about by the infusion of indigenous knowledge in the teaching of Life Sciences. It was indicated that learners need to connect the knowledge from home with the knowledge from school. One participant indicated that:

> "*I think the infusion can make learners love and be interested in Life Sciences although some do not like indigenous knowledge".*

> "*Because, ... mmm… it will connect learners' traditional knowledge with curriculum knowledge science at school. This will make learners feel proud of their culture and tradition*."

It was indicated by some teachers that learners are given a new dimension from which to view life, leadership and community, and to realise that IK may be different to Western knowledge. However, the two may lead to the same outcome or objective. Some participants mentioned the following:

> "*Okay, I think it helps to make learners aware of the scientific methods and ideas that were used in the past and that they don't differ from the ones they learn in science class. The aim here should not be misconstrued to be that of aligning our science to the European science. The two will remain somewhat parallel, i.e. going in the same direction but not necessary being the same."*

Category 3.4: The effect of IK on parents' involvement in learners' education

The findings indicate that IK was important as it led to positive involvement of the parents in their children's education. It surfaced that, as parents are members of the community, they have a wealth of IK. It is easy for them to involve themselves in learners' education by imparting their IK-related information, especially when learners have been given projects and research to perform at home. Parents as source of information are also able to identify the relevant people in the community who are knowledgeable about the subject at hand. Some participants indicated the following:

> "*I think parents will have access in the education of their children because they will be participating by giving them information. The indigenous knowledge will serve as a link between the school and home. Teachers will be able to communicate with parents and this will also form a link between the home and the school".*

Theme 4: Religious beliefs

The narrative revealed that most participants are bound by their religious beliefs in their infusion of IK. Belief systems discouraged some teachers to involve themselves in IK. Many Christian teachers thought that visiting a sangoma and making contact with their ancestral spirits is against their religious belief system.

> *"Most of the learners really give me a very negative attitude towards IK by saying it is against their religious beliefs. It is only few who seem to be interested in it. This makes some learners also to lose interest and become reluctant in doing the work."*

4. CONCLUSION

This research highlighted the following problems in incorporating indigenous knowledge in the classroom.

4.1. Perception of being disempowered

The constant curriculum changes (first NATED 550, then the NCS, then the RNCS, followed by CAPS in 2012) are challenging teachers. Many teachers show great dedication to incorporate IK in the Life Sciences classroom despite a lack of skills, methodology and resources. They are confused about the methods to use in the implementation of the CAPS and also IK.

4.2. Lack of resources

The findings revealed that teachers are facing difficulties in incorporating IK in their teaching, amongst others, because of the lack of resources. Life Sciences teachers are unsure of what they need to teach, while some of the evidence cannot be easily be brought to class. Textbooks used in class give little or even no proper information about indigenous knowledge. While some textbooks still provide information on IK in the form of examples, hardly any attention is given to teaching strategies and practical work that can be done in the classroom. As most of the IK is transmitted verbally, some people regard it as a myth because it cannot be tested scientifically.

4.3. Insufficient pedagogical content knowledge (PCK) to teach IK

Many South African teachers have insufficient PCK to address indigenous knowledge in Life Sciences. What's more, IK and ethnobotany are gaining in complexity as rigorous chemical and pharmacological procedures are applied to test IK claims. Teachers' lack of knowledge of the techniques used by scientists in modern ethnobotany, such as thin-layer chromatography (TLC), liquid chromatography coupled with mass spectrometry (LC-MS) or high-performance liquid chromatography (HPLC), robs learners of the opportunity to learn about career options in ethnobotany.

4.4. Lack of support by the Department of Education

The curriculum changes posed challenges to Life Sciences teachers as the *how* of curriculum implementation should have received more attention. From the interviews, it is clear that many teachers feel that there was not sufficient support from the Department of Education. This causes stress among teachers. Subject facilitators need to assist teachers with the implementation of IK, and many teachers felt that they do not receive sufficient guidance from subject advisors.

4.5. Belief systems

Fundamentalist religious beliefs can have a negative influence on the teaching of IK in the classroom. Some people are sceptic about traditional healing because they equate traditional healing with communication with the ancestors. Christians, for example, may find this offensive. During teacher training, it should be emphasized that the inclusion of IK does not call for the promotion of pseudo-science or medical quackery. IK should encompass so-called scientific methods, and should assist learners to develop critical thinking skills. By including IK in their lessons, teachers will encourage learners to consider how science-based issues affect their own lives and to reflect on the moral principles that underpin science.

4.6. Recommendations

From this research, the following recommendations emerge:

4.6.1. Developing resource materials addressing IK (e.g. textbooks should address IK- not just a few examples, but also practical work that could be done, that includes the scientific method). The Department of Education needs to provide centres in every district or circuit where teachers will find the resources they need.

4.6.2. The Department of Education should provide better support. Subject advisors need to be in touch with teachers, motivate teachers, and be willing to help at all times. Scaffolding is necessary, and teachers' PCK development should be a primary aim of the DoE.

4.6.3. Teachers' pedagogical content knowledge (PCK) should be developed. Teachers need to up skill their pedagogical content, subject knowledge and contextual knowledge. Professional development best proceeds within communities of practice. This research highlighted that there are very few top-level teachers who know how to infuse IK in the Life Sciences classroom. These "keystone species" (Petersen, 2011) must interact with teachers who have PCK developmental needs. Cluster meetings, which are called every now and then for moderation of assessment, should be turned into fruitful and educative gatherings where PCK development is emphasised.

4.6.4. The curriculum must provide detailed IK content and skills. In order to assist teachers in their professional growth and PCK development, we need a curriculum that clearly

states the envisaged outcomes or specific aims when dealing with IK. Unfortunately, many science educators have a naïve understanding of IK in Life Sciences. Hence, it is time for a knowledgeable task team to develop guidelines in this regard.

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