

# PRE-SERVICE TEACHERS' ANALYSIS OF THE MEANINGFULNESS AND RELEVANCE OF THE LIFE SCIENCES CURRICULUM TO SOUTH AFRICAN LEARNERS

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**ABSTRACT**-Contextually-relevant science education aims to provide learners with knowledge, skills and values applicable to their lives. Accordingly, the South African Department of Education has striven to respond to the needs of a democratic nation while, simultaneously, embracing the dictates of global challenges. This is encapsulated in the first general aim which states that the curriculum should ensure that learners acquire and apply knowledge, skills and values in ways that are meaningful to their own lives. In order to assist pre-service Life Sciences teachers to interpret and implement the Life Sciences curriculum before their final school experience (work-integrated learning), all 77 pre-service life sciences methodology teachers in one university were tasked to evaluate how well the first general aim is realised in the Life Sciences curriculum (Grades 10–12) in terms of content and activities. In a qualitative research design, data, in the form of student teachers' responses, were collected through essays and were coded manually then subjected to content analysis. Findings showed that the pre-service Life Sciences teachers had mixed views regarding the realisation of the first general aim in the content and activities. They did identify relevant and meaningful aspects in the content. However, they argued that the curriculum lacked clarity and provided inadequate guidelines on how to develop such knowledge, skills and values in learners. These results provide important implications for teacher professional development, which include specifically engaging teachers in reform-oriented practices.

**Keywords:** Relevant, meaningfulness, Life Sciences curriculum, South African learners, pre-service teachers.

## 1. INTRODUCTION

Most policy-makers, curriculum developers, science education researchers and science teachers use the term 'relevance' in relation to teaching and learning reforms in science (Stuckey, Hofstein, Mamlok-Naaman & Eilks, 2013). Literature suggests that what the learners are taught should be relevant to them personally and to the society in which they live. In science education teachers' insufficient knowledge of science and/or learner diversity has been blamed for poor guidance of learners towards meaningful learning (Lee & Luykx, 2007). As such science subjects, particularly Physical Sciences remain unpopular among learners (Hofstein, Eilks, & Bybee, 2011; Osborne & Dillon, 2008). In addition, previous research has revealed significant gaps in achievement in standardised tests among learners of diverse racial/ethnic and socio-economic backgrounds (Reddy, 2016). One could infer that such poor results may be due to lack of motivation on the part of learners as they fail to see relevance and meaning in what they learn beyond the science classroom. It is against this background that the current study investigated how pre-service Life Sciences teachers conceptualise and interpret how relevant and meaningful the curriculum is to South African learners.

## 2. THE LIFE SCIENCES CURRICULUM IN SOUTH AFRICA

### 2.1. Nature of the Life Sciences curriculum

The National Curriculum and Assessment Policy Statement Grades 10-12 for Life Sciences gives expression to the knowledge, skills and values worth learning in South African schools (Department of Basic Education, DBE, 2011). This curriculum aims to ensure that learners acquire and apply knowledge and skills in ways that are meaningful to their own lives. In this regard, "the curriculum promotes knowledge in local contexts, while being sensitive to global imperatives" (DBE, 2011, p. 4). The teachers are required to show understanding of science and pedagogy so that they interpret and implement the curriculum appropriately in order to realise this aim. According to Vygotsky's (1986)

socio-cultural theory, learners learn best when the content relates to their socio-cultural context, which means learning becomes more effective when related to what learners do, experience and observe in their everyday lives. In support, Okwara (2016) posits that the purpose of learning Life Sciences is to help the learners develop scientific knowledge and an understanding of how science works in real life.

In South Africa there is a diversity of socio-cultural, economic, political and religious backgrounds of learners in science classrooms, which is coupled with the influx of immigrant learners. This results in teachers finding themselves in classes with learners from linguistic, cultural and educational backgrounds very different from their own. Such issues have important pedagogical implications in the science classroom as science teachers are challenged to continually strive to identify content of relevance and applicability for their diverse learners. The current study uses both social constructivism and socio-cultural theories as frameworks. While social constructivism emphasises the crucial role played by social interactions in the learning environment (Putnam & Borko, 2000), the social-cultural theories bring out the nature of that interaction in terms of authority and culture. Socio-cultural perspectives question the type of discourses and representations that are useful to the learners in a science classroom (Lemke, 2001). At the same time, questions are raised on issues of who makes decisions and whose interests the pedagogy and curriculum of the social constructivist classroom serve (O’Loughlin, 1992).

## **2.2. Making science relevant and meaningful to learners**

In a case study to investigate cultural conflict in a Biology classroom, Chang and Rosiek (2003) revealed that teachers need some knowledge of the history of learners’ specific cultural groups in order to teach science well to all learners. In as much as low performance is attributed to teacher ineffectiveness, it is imperative to also relate it to how the curriculum decisions impact on the teaching and learning process (Williams & Atwater, 2014). As such these authors advocate for mandatory inclusion of issues pertaining to learners’ cultural and social capital into teacher preparation programmes.

The first general aim of the CAPS Document relates very well with the principles of equity and social justice as outlined by Williams and Atwater (2014) – that science knowledge should be applicable in ‘learners’ daily lived experiences’. However, the CAPS does not stipulate such intentions to be the teachers’ focus. Therefore, this study sought to answer the following research questions:

Do the pre-service life sciences teachers view the South African life sciences curriculum as responsive to learners’ needs?

If so how does it ensure learners’ acquisition and application of knowledge, skills and values in ways meaningful to their lives?

## **3. METHODOLOGY**

### **3.1 Research Design**

The study employed a qualitative research design. Qualitative research is a naturalistic approach that seeks to understand phenomena in context-specific settings, where the researcher does not manipulate the phenomenon of interest (Patton, 2002), but probes for deeper understanding rather than examining surface features (Johnson, 1995). Previous research has shown that part of teachers’ knowledge is narrative in form (Connelly & Clandinin, 1999), and that this knowledge can be best documented in collaboration with teachers themselves (Cochran-Smith, 1999). Hence such narrative methods were used to capture participant Life Sciences teachers’ ‘wisdom of practice’ (Shulman, 1987).

### **3.2 Selection of Participants and Data Collection**

All Bachelor of Education 4<sup>th</sup> year students enrolled in one university for life sciences methodology and practicum (77 in total) participated in the study. They were tasked to evaluate how well the first general aim is realised in the Life Sciences curriculum (Grades 10–12) in terms of content and activities. They responded to this task by documenting their evaluation in the form of essays. The participants were in the final year of a teacher training programme. They had already been involved in two sessions of work-integrated learning experiences in schools that lasted 10 weeks in that year, in addition to the short session they had the previous year and microteaching experiences. These participant teachers were, therefore, considered to have the knowledge and skills to interpret and teach the Life Sciences curriculum. In addition, involvement in such a study enabled the participants to extend their existing insights based on their own experiences, reflections and participation in their studying to become Life Sciences teachers. The study, therefore, also aimed to enhance participant teachers' repertoire of knowledge and skills for their careers.

### **3.3 Data Analysis**

The responses given by the participants were coded using Saldana (2009) manual coding and then subjected to content analysis. The codes were categorised deductively using the main aspects espoused in the general aim. To promote more dependability on the data, coding was done as soon as data were collected and then recoded after some time and then results compared (Krefting, 1991). Four major categories emerged, which are discussed below.

## **4. RESEARCH FINDINGS**

The findings are presented under each of the four major categories identified. In addition, teachers' pedagogical role and capabilities in implementing the curriculum is discussed using the reported participant teachers' school experiences. This approach is important because intentions in the formal curricula are not always translated into what learners receive (Bantwini, 2010).

### **4.1 How the Life Sciences curriculum gives expression to the knowledge, skills and values worthy in South African schools**

The participants noted important values that learners can develop from engaging with the content in the very first topic on cell division and mitosis in Grade 10. One of the subtopics taught is cancer, a disease that continues to destroy many households in South Africa. Through teaching of this content, learners acquire key knowledge that will enable them to recognise the symptoms of cancer and how best to prevent it through a healthy lifestyle. In learning about cancer, learners come to sympathise with cancer patients instead of stigmatising them. This value and attitude of sympathy enables learners to become responsible citizens that aim to uplift each other in times of adversity, and build a culture of caring for the good of the country as a whole. The study of cancer also exposes learners to diverse technologies employed to treat cancer, which in turn promotes the "understanding of the impacts of science on industry and the quality of life" (White, 2004). In addition, inclusion of traditional methods of cancer treatment serves to bring the curriculum closer to the realisation of its first general aim. Importantly, learners' socio-cultural beliefs about the causes of cancer, such as witchcraft, could also be challenged, which develops critical-thinking skills as learners relate their worldviews to scientific concepts. The pre-service Life Sciences teachers distinguished the content in the third strand: Environmental Studies as an important area where learners see the relevance and application of Life Sciences knowledge beyond the classroom. Notably, they mentioned how it provides knowledge and understanding of the ways in which humans have impacted positively and negatively on the environment and organisms living in it. Ultimately, this gives the learners a deep appreciation of the unique diversity of past and present biomes in Southern Africa, and the importance of conservation. The set of activities covered in the topic of human impact on the environment in Grade 11 to 12 requires learners to identify how human practices impact the environment, such as through pollution

or poaching. Such knowledge is not alien to the learners as it is topical in the media and therefore they can relate to it.

In addition, learners get the opportunity to learn how people's daily activities such as farming (particularly those in farming and rural areas) and mining (as they see mine dumps) impact on the environment. Most importantly learners have experienced some of the effects, for instance, the floods, the change in climates and drought spells experienced in 2015 and 2016 (Manderson, Kubayi

4. Drimie, 2016). Learners are also required to do a practical observation or research investigation on one example of human influence on the environment in their local areas. In this way, they learn several skills meaningful and relevant in their lives, for example the different ways to protect and restore the environment in order to continue benefitting from it.

#### **4.2 How the Life Sciences curriculum allows acquisition and application of knowledge in ways meaningful to learners' lives**

The participants showed mixed views about the curriculum promoting the acquisition and application of knowledge in ways meaningful to learners. For instance, they noted the conflict between providing contextually-relevant instruction versus what is assessed. There exist an anomaly between the curriculum assessment requirements and instructional requirements. This is supported by Conley et al (2010) who note that, "Teachers may claim to expect learners to think critically and holistically, yet use assessment practices that encourage rote learning and memorization".

The participant teachers also argued that despite the potential relevance of most of the topics to learners, their knowledge remains disconnected from the life experiences of learners and their personal ideas. They blamed this on the curriculum's silence and vagueness on how best to help learners link this knowledge to their local contexts and experiences. On the positive note, however, participant Life Sciences teachers commented that the curriculum does give provisions for learners to acquire and apply knowledge in ways meaningful to their lives.

They mentioned the topic 'Biodiversity and classification', as providing opportunities for learners to study diseases such as tuberculosis and HIV/AIDS that are causing 'havoc' in their communities. Life Sciences also instils a greater awareness of the ways in which biotechnology has benefited them. The incorporation of indigenous knowledge systems (IKS) with reference to the use of traditional medicines makes the content more meaningful to learners' lives and helps learners develop respect for other cultures, which is important in a diverse South African society.

By engaging learners in studying the various syndromes such as HIV/AIDS, learners got to experience various emotions such as sympathising and empathising. They learn to show support toward those affected and not stigmatise them. Such values are ingrained in the concept of '*ubuntu*', the African philosophical notion that values sharing and emphasises interdependency, which encourages learners to share and help each other (Tutu, 2004). Learners also learn to make healthy lifestyle choices.

#### **4.3 How Life Sciences curriculum promotes knowledge in local and the global contexts**

The participants noted that the Life Sciences CAPS document prescribes content on issues of global warming, climate change and the effect of human activity on the environment. It also takes cognisance of issues of habitat loss, mass extinctions, pollution and contamination, natural resource depletion and management and how to manage/prevent these occurrences, which are both local and global imperatives. The topic 'Reproduction in plants' may seem peripheral, but it provides knowledge about organisms vital in agriculture. Its presence in the curriculum is thus relevant as many South African families depend on subsistence agriculture both in rural areas and in township backyard gardens. Moreover, topics such as 'Energy transformation to sustain life' along with 'Animal nutrition' are also relevant to small-scale agriculture and healthy-lifestyle choices and an appreciation of nature. A

related activity of relevance is that of evaluating food packaging at home. In this activity, learners develop skills in selecting nutritious food, thus avoiding obesity and other food-related diseases.

The participants acknowledged the significant progress being made by the Department of Education in recognising local knowledge by integrating Indigenous Knowledge Systems (IKS) in classrooms. This is evidenced in the acknowledgment of the role of traditional knowledge and technology in the topic 'Human impact on environment', including reference to traditional farming. The participants noted that the inclusion of IKS in the curriculum also allows exploration of the tenets of the Nature of Science (NOS), particularly the tenet on the social and cultural embeddedness of science, which helps to demystify science as being the exclusive preserve of the elite (Ogunniyi, 2007). Population ecology was also identified as very relevant in understanding current issues in South Africa, especially the issue of Xenophobia. This is a typical example of competition for resources and opportunities, and lack of tolerance; referred to by Solomon & Kosaka (2014) as the fight for government resources and benefits.

#### **4.4 Lack of teacher instructions on proper implementation of the Life Sciences Curriculum**

Most participants argued that the content in the curriculum is less important than the way in which it is taught, which needs to be context-specific. This argument is supported by De Villiers (2011). Consequently, the responsibility to teach context-specific science rests with the teacher. They posed the following questions which challenge teachers' professional practices when in the science classrooms: *Do they develop learners with the knowledge and skills that will enable them to apply science in their lives beyond the science classroom? How much do teachers' practices make science content meaningful to the learners?* Some of the participants felt that teachers should concentrate on developing learners and equipping them with critical, analytical and creative skills, which gives learners a competitive advantage in the world of work. Their arguments resonated around the idea that the relationship between the content taught and how it is taught has implications on learner retention of the subject matter knowledge and how they apply it in their lives.

On the issue of IKS, the participants noted the absence of a clearly defined framework and guidelines on its implementation. Thus, the recognition of IKS in the science classroom is left to the discretion of the individual teacher (Khupe, 2014). This was also evidenced by the failure of the participants to give satisfactory examples of how IKS is being utilised in the classroom.

On the issue of practical or investigation activities in the Life Sciences classes, the participants mostly bemoaned how teachers disregard the importance of inquiry in science learning. Using examples from their school experiences, the participants recalled how learners often complained that they could not see the relevance of many of the practical tasks in relation to the Life Sciences content. Furthermore, learners felt that they played a passive role and would like to be more actively involved. In his exploration of some of the challenges in Science Education, Thornburg (2009) concurred how cutting back on hands-on science has affected learner acquisition of scientific concepts.

The participants also mentioned the contextual factors that stifle the implementation of investigative work in most classrooms. They pointed out that its practicality in most South African schools is compromised due to lack of resources, teacher's inability to utilise the resources even if they are available, and teachers' attitudes towards practical work. This is compounded by the fact that the curriculum document states that the "curriculum does not prescribe particular instructional strategies or methodology; instead teachers have the freedom to expand concepts and to design and organise learning experiences according to their local circumstances" (DBE, 2011, p.10). The participants viewed this as a curriculum shortfall as effective implementation is compromised when instructional decision-making is placed completely in the hands of individual teachers.

## **5. DISCUSSION AND IMPLICATIONS**

Findings showed that the pre-service Life Sciences teachers had mixed views regarding the realisation of the first general aim in the content and activities of the CAPS Life Sciences curriculum. They did

identify relevant and meaningful aspects in the content. However, they argued that the curriculum lacked clarity and provided inadequate guidelines on how to develop such knowledge, skills and values in learners. Further, they argued that it is not the content that matters, but the way in which it is taught, which places the responsibility on the teachers. They felt that teachers lacked the pedagogical skills to develop, in learners, relevant and applicable knowledge and skills for their lives beyond the science classroom. Some of the important aspects raised included unfavourable teaching-and-learning contexts, and negative teacher attitudes towards involvement of local context, which is precisely the vehicle needed to make concepts more meaningful and relevant.

This concurs with findings by De Villiers (2011) that revealed that the content specified in the Life Sciences curricula is very context-sensitive. The participants' sentiments on lack of clarity on how the curriculum can be implemented to meet its goals are explained by Keane (2008) who notes that science curriculum or textbooks often fail in their attempt to address diversity and relevance, providing only non-substantive additional content. Commenting on American education programmes, Tharp (1989) also reports poor progress in educational efforts to provide meaningful and familiar contexts or processes compatible with diverse home cultures.

In showing the ineffectiveness of the curriculum, other participants raised the issue that the fruits of such a curriculum are taking too long to be realised, which questions the manner in which it is implemented. They mentioned that despite inclusion of topical issues in the Life Sciences, such as reproductive health and contraception, South Africa is beleaguered by high rates of adolescent pregnancy; high youth HIV/AIDS mortality rate; and poor environmental management. It is this lack of social reconstruction that challenges confidence in the education system.

These findings have implications for teacher professional development programmes as well as for curriculum developers to relook at ways to include specific instructional guidelines for the teachers and also provide relevant resources and materials for proper implementation of the curriculum.

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