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EXPERIENCES OF PRE-SERVICE TEACHERS ON LIFE SCIENCES TOPICS AND LEARNING. WHAT MAKES LEARNING DIFFICULT AND EFFECTIVE?

Abstract:

Pre-service teachers need to be adequately prepared to teach, they are expected to engage with research into teaching and learning during their training as well as reflect on their practice. They need to see themselves as evidence-based practitioners of a research informed profession. In accordance with topics outlined in the Life Sciences Grade 10-12 Curriculum and Assessment Policy Statement (CAPS) document, the study sought to identify areas in Life Sciences where pre-service students encounter learning problems as well as ways to enhance effectiveness of their Life Sciences learning. This study followed an interpretivist approach and social constructivism of knowledge. A convenience sample comprising 58 first year Natural Sciences pre-service teachers (22 males, 36 females) enrolled for the Life Sciences major was used in the study. Qualitative data were collected by means of five focus group discussions with pre-service teachers on their experiences on Life Sciences learning. The following topics were identified as the difficult to learn: Genetics and inheritance and energy transformations to sustain life and cited amongst others that the nature of the topic and teaching strategies employed by their former teachers made it difficult for them to make meaning of the subject matter. Suggestions to overcome these learning difficulties in Life Sciences were made. Teacher preparation needs to focus on highly discipline-specific programs with emphasis on Pedagogical Content Knowledge (PCK) as well so as to effect a deeper and more effective learning process, as well as strengthening the active role of the teacher as a researcher and developer of his/her own practice.

Keywords:

pedagogical content knowledge, effective teaching and learning, CAPS, reflective practice, Life Sciences

Introduction

The beliefs that pre-service teacher education students gain before university form what good teaching, effective learning and an effective teacher is (Chang-Kredl and Kingsley, 2014). It is during their pre-service period where they are confronted with realities of classroom realities. Also, pre-service students start to identify and perceive themselves as teachers through the process of learning. It has been proven through research that learning biological concepts seems to be a challenge amongst students and that the nature of the subject as well as its teaching methods are also among the reasons for the difficulties in learning science. (Cimmer, 2004; Zeidan, 2010; Lazarowitz and Penso, 1992). In most feeder schools where students involved in this study matriculated, Life Sciences (Biology) is not necessarily taught by teachers who specialised with it during training. A teacher has to be well grounded in the knowledge, skills, values, principles, teaching and learning approaches, discipline or practice and how these may be used in different ways (Biggs and Tang, 2011; Morrison and Cowley, 2017) to make his or her teaching meaningful, effective and efficient. Lack of mastery of the content affects teaching negatively.

Adjusting to a university environment and demands of daily teaching programmes can be overwhelming for most students. Determining factors that negatively affect students learning in Life Sciences learning effectively is very crucial; as cited by many researchers, to improve the quality of teaching and learning in schools, the student's opinions and views need to be taken into consideration by teacher educators, researchers, schools and teachers (Fullan, 1991; Cimer, 2004; Ekici, 2010). The student's views influence the way they learn and make a substantial contribution not only to classroom management but to teaching and learning as well as the school as a social and learning place (Cimer, 2004; Phoenix, 2000).

Theoretical framework

Teaching is not "simply a matter of following a script or carrying out other people's instructional designs" (Danielson, 2007: 2) but is instead a cognitive exercise fraught with decisions, diagnoses, and prescriptive interventions. Regardless of curriculum or resource, the educator assumes a critical role in implementing appropriate instruction.

The central idea of Constructivist learning theory is that learners construct their own understanding of the world they live in based on their experience, and they select and change their information from past and current knowledge and experience into a different form of understanding (Pritchard and Woollard, 2010; Boonen, Jolles and Schoot, 2016). What students do to learn a concept is influenced by their perspective (phenomenography) and constructivism; so, teaching is a matter of changing their perspective, or the way they see the world (Biggs and Tang, 2011). Social constructivism sees learning as a "social process where students acquire knowledge

through interaction with their environment instead of merely relying on the teacher's lecturers" (Powers-Collins, 1994: 5). It is therefore the duty of a teacher to make information meaningful to the learners and as such it must be presented logically and be related to already existing cognitive structures (Ausubel, 1968) so that learners have true understanding of concepts being taught and are able to apply these concepts to new situations.

The construct of Pedagogical Content Knowledge (PCK) was originally conceptualised by Shulman in 1986, with the key elements according to him being, knowledge of representations of subject matter and the understanding of specific learning difficulties and student conceptions. He described PCK as "the capacity to transform the content knowledge he or she possesses into forms that are pedagogically powerful and yet adaptive to the variations in ability and background presented by students" (1987: 15). This involves knowledge and beliefs for teaching subject matter; knowledge of students' understanding, conceptions and misconceptions of topics in a discipline; knowledge of the curriculum; and knowledge of instructional strategies and representations. Pre-service teachers face significant challenges to understand the content, learners, instruction, learning environments and professionalism (Davis, Petish and Smithey, 2006) because they do not only have to develop content knowledge but PCK as well. This results in anxiety amongst them.

Novice or pre-service teachers and recently graduated teachers usually struggle to apply their knowledge due to the way they were trained at tertiary level. Sometimes the training does not correspond to the reality in schools (Coetzee, 2012). Maree (2015) argues that the inadequate training of teachers (either unqualified or underqualified) in terms of subject knowledge and knowledge of teaching practices contribute to this problem. Learners' underperformance is often attributed to a lack of teaching skills. A learner's scholastic achievement may reflect well on the teacher's teaching ability, but it is not always the case, since some learners remain uninspired and possess no motivation to excel academically, despite having highly qualified and able teachers. This explains why it is important to reflect on experiences and own practice allowing novices to be analytical of their developing practice. (Zwozdiak-Myers, 2011) for improved results.

The South African curriculum policy reform, the Curriculum and Assessment Policy Statement (CAPS) was implemented in March 2011 based on a mode of teaching that includes strong classification and framing that ma es curricula knowledge visible and explicit to all students (Bernstein,1975; Fataar, 2010). According to Life Sciences Grade 10-12 Curriculum and Assessment Policy Statement (CAPS)**,** the Further Education and Training (FET) Phase, Life Sciences content framework is organised according to four 'knowledge strands'. Knowledge strands are developed progressively over the three years of FET. the curriculum is dealt with as policy and the intended curriculum for schools. These knowledge strands are:

- Knowledge Strand 1: Life at the Molecular, Cellular and Tissue Level;

- Knowledge Strand 2: Life Processes in Plants and Animals
- Knowledge Strand 3: Environmental Studies;
- Knowledge Strand 4: Diversity, Change and Continuity. (Department of Basic Education, 2011).

To be able to promote the learner's active engagement in experiences that foster the learning of life sciences concepts with understanding, they need to cultivate an environment for thinking by emphasising the thinking processes of students rather than student performance, Life Sciences teacher teaching efficacy, self-efficacy, and Life Sciences beliefs should be taken into consideration.

Aim of the study

The aim of the study was to determine the Life Sciences topics that pre-service students have most difficulties learning as well as to investigate their views regarding factors affecting their learning and suggestions to make Life Sciences teaching and learning effective. Also, the strategies which they think could make their learning more effective and efficient.

Based on the stated aim, the following research questions were formulated:

- Which Life Sciences topics did the pre-service students find difficult to learn?
- What are the reasons why they encountered these learning difficulties?
- and in their opinion, what could make the teaching and learning of Life Sciences meaningful and effective?

Method

Design

This study followed an interpretative approach in order to enable the researcher to explore and describe as accurately as possible the Life Sciences pre-service student's experiences on life sciences topics. Fifty-eight prospective Life Science teachers studying first year participated in this study voluntarily.

Population and sample

The target population for the study were Life Sciences major and Didactics (Life Sciences) pre-teachers enrolled at the Central University of Technology. Participants involved in this study comprised a purposively selected sample 58 first year Natural Sciences pre-service teachers (22 males, 36 females). The participants could still

relate their high school learning experiences to what they observed during teaching practice and how they are taught at university.

Data collection and analysis

The data for this study were collected by means of focus group discussions with pre-service students on topics outlined in the Life Sciences Grade 10-12 Curriculum and Assessment Policy Statement (CAPS) document where they encounter(ed) learning problems as well as ways to enhance effectiveness of their Life Sciences learning. Data were then categorised into themes in accordance with the research questions

Ethical considerations

The concept of informed consent guided this study's ethical norms in terms of voluntary participation. Ethical issues of consent, confidentiality, anonymity and privacy were complied with.

Results and discussions

In response to the research question: Which Life Sciences topics did the pre-service students find difficult to learn? Amongst themes and topics outlined in the Life Sciences CAPS document, the following topics were identified as the most difficult to learn by pre-service students:

- Genetics and inheritance, which is part of Life Sciences knowledge strand 2 and energy transformations to sustain life which is part of Life Sciences knowledge strand 1.

Reasons

In response to the research question: Why difficulties with these topics?

Genetics and inheritance:

The students claimed that the topic is complex to learn, and the way they were taught did not enable learning. To quote verbatim some students said:

> *"it involves a lot of terminology and you need to have understood mitosis and meiosis to fully understand genetics."*

"mendelian genetics has too many complicated words/ terms to learn; I just crammed some terms without understanding them"

"Genetics is not easy to follow because you cannot see what is being taught (genes) with your eyes. You have to imagine stuff"

"my educator did not link what he was teaching to what we know. Everything seemed so complicated and foreign and I lost interest in his lessons"

Quite often teachers assume that learners have already mastered prerequisite ideas and they fail to check if learners have the necessary pre-knowledge before imparting new knowledge. Establishing how much learners know to build on is very important. If the teacher does not establish links between new knowledge and what learners know (pre-knowledge) (Kidman, 2008), meaningful learning does not happen. Content must be related to the student's everyday life situations as much as possible to ensure effective meaningful teaching and learning. This will also serve as motivation to learn on the part of students.

Majority of students mentioned amongst others that the nature of the topic was problematic and hence they resorted to memorising and that their educator's teaching styles were such that Life Sciences topics were not related to their everyday life situations hence it was difficult for them to comprehend the abstract level of concepts and they as a result resorted to cramming the work. This is said to be very common amongst high school students as a biology learning strategy (Osborne and Collins, 2001; Cimer, 2004). This attitude usually leads to disinterest in the subject. Quoted verbatim, some students mentioned that:

"my life sciences classes were the most boring classes ever""

"we are taught about too many things in a short time. Inheritance, crosses, chromosomes and so on, you are expected to remember everything. It is not easy to do so"

"our teacher never ever did experiments on the topic, genetics with us. Maybe it could have been different, the topic would make sense to me"

"I found it difficult to relate genetics to meiosis. Again, I used to think character was hereditary. For example, if your father always gets angry and the like… then you also will have that to an extent"

"my school did have a room called a laboratory, but there was nothing to do experiments with in the room"

From the comments by students, lack meaningful insight into genetics was a concern, they also found it difficult to see the relationship between genetics concepts on the different levels of organisation. The relationship between meiosis and inheritance must be made explicit to the students.

How Life Sciences is taught in class goes a long way. The teaching strategies of teachers may also be factors that affect student's learning in Life Sciences (Cimer, 2004). Due to lack of facilities at some schools, as cited by one of the students, Life Sciences is taught mainly in a lecture method, teacher centred method (Cimer, 2004) and this results in a lesson becoming boring and students losing interest in what is being taught. When students challenge and reconstruct, they are interested to understand knowledge, to integrate it with existing knowledge and to apply it to the real-world situations (Briggs and Moore, 1993; Pritchard and Woollard, 2010). Also, wherever possible, learners need to be engaged in practical work and learner-centred activities.

Energy transformations to sustain life

Regarding the topic energy transformations to sustain life, students raised a concern about the teaching strategies employed by their former teachers, they also indicated that a lot of terminology and too much detail in textbooks is involved in Life Sciences which urges them to end up memorising things. According to Banger (2008), some high schools do not prepare students well, particularly for a successful transition to higher education. Hence an effort should be made to increase the rigour, relevance

Cited verbatim one student mentioned that:

> *"our teacher expected us to cram and give answers and some definitions the same way as they are written in the textbook, word for word and not the way I understand the topic taught "*
>
> *Another one said:*
>
> *"the way I was taught energy transformations was not motivating me. I actually liked to be spoon-fed to get the good marks. This was not because I knew what I was writing about"*

Students indicated that they often fail to realise links amongst topics and to conceptualise them because of how they were taught. Success in a study career according to Jansen and Surhe (2010) is achievable when the student's study and time-management skills are functional. Inadequate teaching strategies and study skills can have a negative impact on students learning.

How best can teaching and learning of Life Sciences be made meaningful and effective?

In response to this question pre-service students, amongst others, commented that:

> "*Life Sciences is about our daily life experiences and it has to be taught likewise"*
>
> "*it would be good if we could be involved in what is being taught. For example, if we are given an opportunity to do experiments"*
>
> *"maybe if a teacher can use charts and so on if the school does not have resources. This will help simplify what is being taught to the learners"*
>
> *"the most important thing is that Life Sciences should be taught by teachers who are trained to teach the subject. Well qualified"*

From these comments, when students are actively involved in the learning task, they learn more than when they are passive recipients of instruction (Cross, 1987). Effective and meaningful learning is active, not passive. It involves the use of the mind, not just the memory. It is the process of discovery in which the student is the main agent, not the teacher (Adler, 1987).

It has also been indicated that Life Sciences teachers, like other science teachers must understand the content, disciplines of science, learners, instruction, learning environments and professionalism (Baird, Brodie, Bevins and Christol, 2007; Kind and Wallace, 2008). Teachers also need to improvise teaching and learning resources where deemed necessary and establish links between what learners know and the new knowledge to make teaching and learning of Life Sciences meaningful and effective. "While it is acknowledged that it is not ideal to use improvised equipment, teachers should remember that it is more important for learners to have the experience of carrying out a variety of investigations than to depend on the availability of standard laboratory equipment. If equipment is limited, teachers should be encouraged to improvise. The same skills can be developed using improvised equipment. Moreover, if there are no alternatives, it is more effective for teachers to demonstrate an investigation than to not do investigations at all due to a lack of equipment" (Dept of Basic Education, 2011: 19).

Pre-service teachers must be adequately trained to teach because inadequate training of teachers can potentially harm the learners, also, learners who had poorly trained teachers and resources at school will not be adequately prepared for higher education (Botha, Brand, Cilliers, Davidow, De Jager and Smith, 2005; Dlomo, Jansen, Moses and Yu, 2011). To have and attain an understanding of and the development of Life Sciences knowledge while taking into consideration the needs of diverse groups of learners, teachers and lecturers must display differentiated and integrated knowledge domains to effectively design and guide learning experiences (Dlomo, Jansen, Moses and Yu, 2011). An opportune time to ascertain knowledge of an educator or pre-

service teacher's knowledge regarding teaching is during their practice teaching period as it is the induction period of pre-service teachers into teaching.

Lecturers must look for new connections between (discover new things) theory and practice (integrate and apply knowledge and findings) so that various knowledge areas, such as genetics and energy transformations can be communicated through different and effective forms (Boyer, 1990) for example, using innovative tools and trends in teaching for the benefit of their students who are being prepared to teach in the future.

Conclusion

From the study it is evident that pre-service teacher's difficulties in Life Sciences meaningful learning can be attributed to teaching and learning-strategies, the nature of content, failure to relate content to the learner's everyday life experiences and lack of sufficient practical work. All these present different learning difficulties regarding some Life Sciences topics and impact on interest and motivation on the part of learners. Life Sciences must be taught by educators well trained and be taught dynamically to be made more meaningful and interesting to the learners.

Life Sciences pre-service teachers had an opportunity to step back from their learning experience and to develop critical thinking skills and improve on their future practice by analysing their experiences. Knowing the students views regarding challenges in learning Life Sciences and suggestions to make Life Sciences teaching and learning effective will assist the lecturer immensely regarding the students' needs when preparing for teaching also to enhance on pedagogical content knowledge of pre-service students in preparation for teaching practice and their future career as Life Sciences teachers.

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