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Pre-Service Teachers' Beliefs and Experiences Surrounding the Use of Language in Science Classrooms: A South African Case Study

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ABSTRACT

Proficiency in the language of learning and teaching (LoLT) is an important contributing factor to learners' performance. While many studies have been conducted on the use of language in science and mathematics classrooms, the focus has been on practicing teachers, and not much is known about beliefs and experiences of South African students and student teachers whose home language is not English. This study examines student teachers' beliefs surrounding the use of language in science classrooms. Semi-structured interviews and focus group discussions were conducted with nine pre-service students enrolled for a science teaching qualification (Postgraduate Certificate in Education PGCE) at one university in South Africa. Findings indicate that English was a barrier in student teachers' understanding of science concepts both at high school and at university, and that this led to feelings of inadequacy and low self-esteem as both learners and future teachers of science. Findings also suggest that a number of pre-service students entering the PGCE program lacked confidence in their ability to teach science in the medium of English, and that teacher training programs are not effectively assisting them to acquire strategies that they may use to confidently teach science to learners whose home language is not English. These findings highlight what may be an important gap in pre-service science teachers' education in South Africa, and point to a need for initial teacher education programs that equip student teachers to effectively integrate science and language teaching.

***Keywords**: science learning, science teaching, second language teaching, pre-service teachers, language proficiency.*

1. INTRODUCTION

The Language of Learning and Teaching (LoLT) has been identified as one of the main barriers to learning science for the majority of South African learners (Rollnick & Rutherford, 1996; Rollnick, 2000; Probyn, 2006; Wildsmith-Cromarty & Gordon, 2009). While there are eleven official languages in the country, English remains the medium of instruction in many schools. The legislative framework in South Africa promotes the use of home language (referred to in this paper as L1) for learning and teaching, but leaves the decision about the medium of instruction to each school's parent body. The South African Schools Act (SASA) of 1996 (DoE, 1996), for example, confers the right to determine the Language of Learning and Teaching (LoLT) on the School

Governing Bodies (SGB), albeit within the mandate of the Constitution. The Language in Education Policy (LiEP) (DoE, 1997) advocates the use of home language as the LoLT, especially in the early years of learning, and the provision of access to additional language(s) as a subject, as the child progresses. These and other policy stipulations have not changed what goes on in classrooms, where English still dominates as the Language of Learning and Teaching, even though the majority of learners are not proficient in it (Ferreira 2011; Probyn 2001; Probyn 2006; Rollnick, 2000).

The use of a second language (referred to here as L2) as the LoLT has been cited as one of the major contributors to South African learners' poor performance in many national and international assessments. For example, Howie (2001) cited South African learners' poor grasp of English as one of the reasons for their low achievement in the Trends in International Science and Mathematics Study (TIMSS). This finding is supported by an analysis of the results of TIMSS in 2011. Results revealed that in countries where the language of instruction and testing was not the home language of learners, mathematics and science scores were lower than in those countries where learners were taught and tested in their home language (HSRC, 2011).

A number of reasons have been cited for the non-implementation of LiEP in South Africa. These include the lack of a clear government strategy to implement the policy (Taylor & Vinjevold, 1999); the continued dominance of English in policy documents and government institutions (Setati, 1998), and the lack of supportive material in African languages, as well as the training to use them in teaching (Parkinson, Baba & Mackay, 2011). The insistence by parents that English be used as a LoLT is cited in the National Education Evaluation and Development Unit (NEEDU) (DBE, 2012) report as another motivation for the use of English in selected primary schools. There is research that suggests that teacher beliefs about the superior status of English compared to African languages has also led to their continued use of English as a LoLT (Setati, 1998; Probyn, 2006; Rollnick, 2000).

Although much has been written about how teacher beliefs influence their decisions and classroom practices (Smith, 2005; Seung Park & Narayan, 2011; Ambusaidi & Al-Balushi, 2012), science teachers' beliefs and experiences relating to the use of language in classrooms is an area that is still under-researched. While teachers base their classroom practices on what they learnt in initial education, their pedagogical knowledge is also influenced by a variety of experiences, including their experiences as learners (Smith, 2005; Oyoo, 2012). Teachers are argued to rely more on their beliefs system than on academic knowledge when making decisions about classroom activities. These beliefs are said to be made up of 'episodic knowledge', contained in stories and events they remember as well as feelings associated with those events (Wallace & Kang cited in Ambusaidi & Al-Balushi 2012).

This paper reports on a study conducted among pre-service science teachers at one South African university. The purpose of the study was to explore pre-

service-teachers' experiences of learning and teaching science in English (L2). The study also sought to explore pre-service teachers' beliefs around the use of English to teach learners to whom English was a second language. It may be argued that teachers' beliefs about the use of learners' home languages (L1) and how it affects their access to future educational and employment opportunities might influence their decisions on how to teach second language (L2) learners.

2. THEORETICAL UNDERPINNING

This study is informed by Vygotsky's (1986) view on the important role that language plays in concept formation. This view forms the basis of the socio-cultural perspective to learning, which regards language as an important psychological and cultural tool for learning and cognitive development (Mercer & Sams, 2006). Vygotsky (1986) argues that learning happens through mediation of shared discourse using language, and that learning happens with the assistance of a knowledgeable other, in this case, a science teacher. How a teacher uses language as a tool to teach science therefore becomes crucial (Lemke, 2001). In teaching science, the teachers' role is that of ensuring that learners acquire scientific knowledge as well as scientific habits of the mind (Westby, Dezale, Fradd & Lee, 1999). Acquiring scientific knowledge involves, among other things, ensuring that learners know the science vocabulary and concepts, engage in class discussion, and are able to "talk in scientifically literate ways" (Westby et al., 1999: 52). Communication between a teacher and learners, and among learners becomes crucial in making learners fluent speakers of science (Lemke, 1990).

Language becomes the mediator of thought between the teacher, who mediates scientific thought within the zone of proximal development (ZPD), and the learner. This view is in line with Wenger' s (1998) notion of participating in communities of practice, which in this case begins with legitimate peripheral participation when science learners learn scientific concepts through collaboration and dialogue with the teacher and other learners. In classrooms where learners and teachers are L2 speakers, teachers have a difficult task of teaching science content and [English] language simultaneously.

This paper is also informed by research that shows the advantages of bilingualism for learners' educational development (Cummins, 2001 Skutnabb-Kangas, 2000). Findings of this research indicate that when L1 is promoted in school, the concepts, language and literacy skills which learners learn in L2 can be transferred to L1. By contrast, not developing and encouraging learners' L1 skills hinder their conceptual foundation for learning. Research conducted in classrooms reveal that in trying to address language problems during instruction, teachers whose home language is similar to that of the learners (L2) use code-switching or code-mixing, where they alternate between English and an L1 to varying degrees (Probyn, 2006; Clegg & Afitska, 2011). Teachers are reported to

use code-switching in varying degrees and for different purposes. These include curriculum purposes, for example, to clarify unfamiliar concepts, or purposes relating to social relations in the classroom, like classroom management. However, the same research also shows that code-switching is used in an unsystematic and haphazard manner. Teachers are also said to be uncomfortable using L1 for curriculum purposes because of their beliefs about the superior status of L2.

3. The Research Context

The research was conducted at the University of KwaZulu-Natal among nine Postgraduate Certificate in Education (PGCE) science students. The PGCE is a one year program designed for students who would like to become teachers and already have a bachelors degree. The assumption on which the PGCE program is based is that students have acquired the appropriate content knowledge of subjects to be taught. The program therefore focuses mainly on the practical aspects of 'how to teach', while also introducing students to the core debates in the field of education. The curriculum of the PGCE is structured such that students attend three core education modules, two to three teaching specializations, depending on the level at which the student will teach and two 'endorsements', i.e. language competency and competency in the use of computers. Students are placed in schools for teaching practice in two blocks of four and six weeks during April and July, respectively. During this teaching practice, students are assigned to mentor teachers who are experts in the subjects that the pre-service teachers are enrolled to teach. An attempt is made to provide pre-service teachers with diverse school experiences, where each student gets an opportunity to teach across diverse South African school contexts.

4. Methodology

This study adopted a qualitative interpretive approach in that it seeks to explore pre-service teachers' experiences of learning and teaching science in a second language. Interpretive research tries to understand phenomenon not just through the researchers' eyes, but also through the meanings participants assign to these (Henning, van Rensberg, & Smit, 2004). It is informed by the situated perspective of context, which emphasizes the importance of lived experience in the formation of teachers' beliefs (Smith, 2005). The study aimed at answering the following research questions:

- What are pre-service teachers' experiences of the use of the English language in the learning and teaching of science?
- What are pre-service teachers' beliefs on the use of the L1 and L2 in the teaching science
- How have pre-service teachers' learning experiences shaped their beliefs about the use of language in science teaching?

Individual, face-to-face, semi-structured interviews were conducted with nine PGCE students enrolled for science teaching specializations towards the end of the second Teaching Practice (TP) period. Semi-structured interviews were best suited to try and understand the lived experiences of the participants. Because of their flexibility, semi-structured interviews allow the researcher to probe the respondents' responses at a deeper level (Hitchcock and Hughes, 1995). These were followed by one focus group discussion after the teaching practice. Validity was ensured by allowing for in-depth responses from participants, and ensuring that representative data were selected (Cohen, Manion & Morrison, 2011). All participants were English L2 speakers, and were Bachelor of Science (BSc) majors. Their majors included Biochemistry, Agricultural Sciences, Chemistry, Physics, and Mathematics. All participants had completed their degrees in the previous year or two. The sample consisted of two female and seven male participants. Individual interviews lasted for about an hour, and the focus group discussion lasted for two hours. Both the interviews and focus group discussion were recorded and later transcribed. A thematic approach to data analysis was used, where descriptions from data were analyzed for patterns that emerged (Cohen, Manion & Morrison, 2011). Similar as well as contrasting themes were identified, and these were later developed into categories. Pseudonyms were used when reporting the findings to ensure anonymity of the participants.

5. RESULTS

All pre-service teachers that participated in this study underwent their schooling in South Africa where the language of learning and teaching was English, which was their second language. Eight of them spoke isiZulu and one spoke isiSwati as their home language. During the interviews and focus group discussion, participants were asked to reflect on how the use of English influenced their learning of science, both at school and university. They were also asked to reflect on their experiences of the use of English as a language of teaching and learning science during the TP period.

5.1 THE IMPACT OF THE USE OF ENGLISH ON PRE-SERVICE TEACHERS' LEARNING OF SCIENCE

Although all participants may be regarded as qualified in science - they had all graduated with at least one science major - each could recall having struggled, at some stage of their schooling career, with the use of English as a LoLT. Some participants reported experiencing difficulty understanding their teachers' explanations of science concepts, others reported that they struggled to understand questions in tests and examinations, while others reported that they had difficulty communicating science ideas either orally or in writing.

5.1.1 A BARRIER TO UNDERSTANDING SCIENCE CONCEPTS

One of the key challenges participants identified related to how the use of English was a barrier to their understanding of science terminology and concepts. Of the nine (9) participants, six (6) reported that they struggled to understand their teachers' explanations of concepts. For Hlengi (pseudonym), who attended a former Model C school (a school that previously catered for white learners only), language affected her understanding:

> Language can be a barrier because it affects the child's understanding. Learning science in English was a challenge for me. There were science terms that I did not understand, terms that I learnt in English at high school that I could not understand, up until I came to university and did practical work, that's where my eyes could open.

Hlengi attributed her struggle in understanding science terms and concepts to the language used by her English speaking teacher:

> …I was taught Physical Science by an Indian teacher, who could not explain concepts in ways that I could understand because he could not speak Zulu. If those terms were taught in Zulu it would have been easier to understand them.

However, five (5) of the participants were taught by science teachers who could speak their home language, which was isiZulu, but still found the use of English as a LoLT difficult. This, they said, was because their teachers were not able to clearly explain science concepts, and because they conducted all assessments in English.

Participants further indicated that their problems were not just limited to understanding teachers' explanations, but that they had problems understanding explanations in textbooks that were prescribed, and sometimes notes that their teachers made them copy from the board. Dumi (pseudonym), who attended a

township school, had a Physical Science teacher who made the students copy notes from the board because they did not have textbooks, said:

> Our teacher gave us a lot of notes which he did not explain but expected us to go and read at home. I found those very hard to understand, and I ended up just memorizing them for the test.

Some participants felt that their lack of proficiency in English resulted in them performing poorly in matric science. Thembi [pseudonym], commented:

> I feel at high school not enough justice was done to ensure that I could clearly understand physics. I feel I would have passed better, if I had clearly understood the subject. (rural school)

Although participants agreed that the use of English had impacted negatively on their learning of science, they seemed to realize that there was no easy solution to this problem. During a focus group discussion, they debated the extent to which their teachers could have used isiZulu to explain some of the science concepts.

> For example, if you take an atom, how were teachers supposed to explain what an atom is in isiZulu? There is no word for it. Say you want to explain molecules? I didn't understand these things until I got to university where I was put into a lab and saw them through a microscope … microscopes… things that were not there at high school. (Sthe [pseudonym], township school)

Participants appeared to have also realized that even for teachers who were fluent in the home language of the learners, explaining science concepts in English affected learners' understanding in a negative way, particularly because there were no isiZulu or siSwati terms that were equivalent to some of the science concepts. It was interesting to note that while participants complained about the use of English in learning science, those who went to rural and township schools felt that not enough English was spoken in their schools. They blamed this for their non-proficiency in English.

5.1.2 Difficulty in Speaking and Writing Science

Students also expressed experiencing difficulties communicating science orally and in written form, and said this caused them to perform poorly in assessments. Three participants who attended rural and township schools said this was a significant barrier for them at university. Gcina said:

> …especially during presentation times, you would just see that "I have a problem with my English and I cannot present my facts the way I wanted to… the way I would have put them in isiZulu". That is where the problem was. You would find that you ended up getting low marks, not because you did not know your facts. Sometimes English would limit you, when

> you find that you are talking about a certain concept, you can't explain it the way you wanted to.

Participants were of the view that their lack of proficiency in English also influenced their level of participation in science classes, both at high school and university:

> Here at university you would find that you really did not understand something but you would be scared of asking. (Thembi)

When asked why they were scared of asking questions in class, Sipho responded that *"because I would just see that my English is really not up to scratch"*.

Hlengi and Sipho indicated that what they perceived to be their poor command of English led to feelings of low self- esteem:

> My problem was more of a lack of confidence whenever there was a question that I wanted to ask. I would not be free to ask the question and would be scared that my English is not good enough so I would not be able to express it well. (Sipho [pseudonym])

Hlengi indicated that even as a pre-service science teacher, she was still not confident in her command of English, and that this affected her confidence as a beginner teacher.

Two participants indicated that their biggest difficulty was answering written examination and test questions at both high school and university. They believed that if written assessments were in their home language they would have performed better. They indicated that they experienced difficulties understanding written questions, and felt that this was the main reason their written responses were incorrect. Max (pseudonym), for example, said although he had no problem understanding his teachers at school and passed matric, he struggled in his first year at university:

> English was a big barrier for me, especially I had problems understanding questions, especially in Biochem [biochemistry] because it deals with long questions. You'd find that sometimes I had to write essays, even though they weren't long, I'd find that I'd write and answer something that was not asked.

Participants indicated that they found writing essays and answering open-ended questions more challenging than answering multiple choice and other closed questions, where they could guess the answers.

5.2 PRE-SERVICE TEACHERS' EXPERIENCES AND BELIEFS SURROUNDING THE USE OF THE L1 AND THE L2 IN THE TEACHING OF SCIENCE

Participants were asked to talk about their views on the use of the L1 and L2 in teaching science, as well as their experiences of the use of the L1 and L2 during their Teaching Practice period.

5.2.1 LEARNERS' DIFFICULTIES IN SPEAKING AND WRITING SCIENCE

All students indicated that English was the language of teaching and learning in schools where they did their TP, and that isiZulu was the home language of many of the black learners in these schools. However, while those who went to township schools reported that learners were free to code-switch and speak isiZulu whenever they wanted to, those who went to ex-Model C schools indicated that these schools were very strict about the use of English and reported that learners were not allowed to speak in isiZulu during lessons.

Participants who went to township schools reported that learners struggled more with communicating science ideas, and that they memorized definitions of science terms but "*were not able to use these terms to converse or to talk about ideas in science"* as one participant expressed. Similarly, those who went to ex-Model C schools reported that even though learners could speak English, they still found it difficult to understand scientific concepts:

> I still found that even for first language [English] speakers [learners], the language of science is difficult. They can speak English to communicate but when it came to science concepts, they found these hard to understand. I found that it was important to simplify and to give examples.

The participants reported that learners preferred 'true or false' types of questions during written assessments, and that they struggled with 'describing', 'comparing', or answering any type of open ended questions.

5.2.2 THE USE OF CODE-SWITCHING

Most of the participants believed the use of code-switching by teachers was the solution for learners whose home language was not English. Drawing from their schooling experiences, those participants who studied at the same university where this study was conducted reflected on a 'tutoring system', where senior science students conducted tutorials for junior students:

> They were called 'tutor demonstrators', some of them spoke isiZulu. They were of great help because they would explain in English and again explain in isiZulu for us who were Zulu speakers. This helped us a lot in understanding science…we were very fortunate.

Some participants indicated that they used code-switching during Teaching Practice, and found it useful. One participant, who taught at an ex-Model C school where isiZulu was discouraged, explained how allowing his learners to use isiZulu helped him pick up a misconception among learners:

> At one point I was teaching them about traditional medicine. There's something called the African potato. I was teaching them in English, but then I overheard these kids talking among themselves in isiZulu saying "Oh, i-African potato ubhatata", of which African potato is not ubhatata. But because I know isiZulu I was able to pick that up and intervene and tell the whole class that "no, I'm hearing people saying this is ubhatata, this is not ubhatata, ubhatata is sweet potato". If I didn't know isiZulu or if I hadn't allowed them to speak in isiZulu I would not have been able to correct this wrong idea that African potato is sweet potato.

Participants agreed, however, that code-switching was not always possible because not all science terms could be expressed in isiZulu. One of them shared her difficulty during Teaching Practice:

> And there are other scientific terms that you cannot say in isiZulu. For example, I was teaching them about 'chemical equations'. I struggled to make them understand where the 'valence charges' came from. I had to go back and explain about the 'orbital rules', you see those scientific terms, you cannot explain them in isiZulu. How do you explain a 'charge', the 'valence charge' in isiZulu? I didn't know how to. I could just see that learners could not understand, but I couldn't do much about it.

Participants identified other concepts that they had struggled to explain in isiZulu, for example, 'force', 'power' and 'energy', for which they only knew one isiZulu word, '*amandla*'. Three participants described how they struggled to explain the concept of electric current and how electricity travelled in an electric circuit, even though they could speak isiZulu. This they attributed to the fact that learners come to class with everyday knowledge of some science terms like electricity, which in isiZulu is called *'ugesi'.* One participant said:

> When you explain what 'electrons' are, and later you ask them, they think 'electrons' and 'electricity' means the same thing. They just call it 'ugesi'. In fact they think you made a spelling mistake and instead of 'electricity', you wrote 'electron'. No matter how many times I corrected them, they still thought I was the one making a mistake. It was very difficult to use isiZulu to explain the difference between the two terms because there is no Zulu word for 'electrons'.

Another participant reported how she struggled teaching the difference between 'mass' and 'weight' because of learners' prior understanding of 'weight':

> It really disturbs them to know these everyday words because they hear things like "I want to lose weight" every day. I will come in one period [lesson] and explain in a scientific way, but they will go out and hear the everyday use [of the term]. It's a real problem because even if you can provide the scientific meaning, when you assess them they bring back the everyday meaning that they have.

Two participants who reported to have used code-switching, indicated that although it was helpful, they found it to waste a lot of class time, impacting negatively on how much work they covered in a given class period. One said:

> The problem I found was that when I kept trying to explain in English and then in isiZulu time was being wasted…the period would come to an end. Now I cannot cover…let's say I had planned that in one week this is what I will cover, now because of the language barrier I have to go back and keep explaining in isiZulu… now time gets wasted, you cannot cover material you had planned to cover in the time you had planned. It takes you off your schedule.

Participants reported that during their teacher training they had not been exposed to many strategies that they could use to support learners with language barriers. They agreed that even though their lecturers had encouraged them to use the learners' home language to explain difficult concepts, they were not taught how to do it, and they felt ill-prepared to address such challenges. All nine participants reported being taught their science and mathematics modules by lecturers who did not speak isiZulu, a home language to eight of the participants. Although four participants reported having their Physical Science lecturer as black, they said she was Zimbabwean, and did not speak any of the languages spoken by Black South Africans. Lecturers could not, therefore, model how to use learners' home language to explain difficult concepts, even though they encouraged student teachers to do so.

5.2.3 Competence in Learners' Language

Participants cautioned that for code-switching to be used successfully, teachers needed to be competent in English and in learners' home languages. Those who did their TP at ex-Model C schools were critical of the schools' language policies, where learners were only expected to speak English. They talked about how they were forced to teach only in English, and how the schools did not make any effort to encourage teachers to learn isiZulu, which was spoken by the majority of black learners in these schools. One participant reported that he would speak to learners in isiZulu when his mentor teacher was not in class because he believed that "language should not stand in the way of learner's understanding. If a child was

comfortable to ask in isiZulu, I would let them do so". He indicated that he knew that this was against the school policy, and that he made sure that his mentor teacher never found out about this.

Participants expressed concern at their own competence in isiZulu, and said they were not confident enough in their own proficiency to be able to use it in teaching science:

> In as much as I am Zulu and speak isiZulu but we are not experts in isiZulu. You wouldn't want a situation where you have told children that this is what this term means, and only to find that the experts tell you, you have misled the learners because that is not the true meaning of that term, even though you are Zulu, so I think it will still take time to say we can teach science in isiZulu.

Participants were of the view that teaching science in African languages would be good, but that it was not possible because, among other reasons, there were no textbooks and no teaching resources to support this process.

5.3 How Pre-Service Teachers' Learning Experiences Shaped Their Beliefs about the Use of the L1 and L2 in the Teaching of Science in Schools

Participants in this study had different learning experiences regarding the use of the L1 and L2 in the teaching of science, depending on the type of high school they attended. It was clear, however, that their beliefs about the use of the L1 and L2 in the teaching of science in schools were influenced by their learning experiences. Those, like Hlengi, who were taught science by teachers to whom English was a home language (L1), believed their teachers were a barrier because they could not code-switch to explain difficult concepts. On the other hand, those that were taught by teachers to whom English was a second language (L2), believed that their teachers did not do enough to familiarize them with English.

5.3.1 English as a Medium of Instruction

Although all participants had experienced English as a barrier to learning science at school and at university, they nevertheless believed science had to be taught in English. Their experiences of struggling to understand and answer exam and test questions at high school appeared to be the main reason for the focus on English, as Gcina commented:

> Even though I passed matric I was not satisfied with my results 'cause I felt if I didn't have a problem with English I would have performed better. (Gcina [pseudonym], township school)

Participants felt strongly that because high school learners were expected to write their final matric examinations in English, it was crucial that they be prepared to answer examination questions in English. This is understandable as academic success in South African high schools continues to be associated with a good matric mark, which opens up opportunities to prestigious career options. Participants' university experiences of struggling with understanding, speaking and writing science because of the language barrier also influenced their beliefs about the use of English as a medium of instruction. Their self-perceived '*poor English'* [Thembi]; and English that was "*really not up to scratch",* as Sipho put it, led to feelings of low self-esteem even though they were about to complete their training to become science teachers. This shaped and influenced their beliefs that learners had to be taught science in English.

One participant, for example, reported that he believed learners should be taught science in English so that "*they can become familiar with English*". He maintained that he still struggled with expressing himself in English, and that this made him doubt himself. Another participant described how, when he was a learner, he experienced problems understanding questions during tests and exams, and maintained that familiarity with English would help learners. Yet another participant suggested that learners be taught scientific terms in English, and that these terms be used "repetitively, over and over again; and learners will eventually understand them".

While there was consensus among the participants about English as the medium of instruction, they nevertheless believed that code-switching should be used to promote understanding of difficult scientific concepts. They cited their difficult learning experiences at school, but more importantly at university, where English was the only language of instruction, as a motivation for this. They suggested that code-switching be used only to explain concepts that learners found difficult.

Participants also talked about other strategies that could be used together with teaching in English. These included using practical work to demonstrate the meaning, as one participant expressed:

> Practical work also helps them to see practically what is meant by terms like 'liquids take the shape of the container'…they actually see the liquid taking the shape of the container.

While practical work could be viewed as obvious in science classes, this is not the case in South Africa, where the majority of schools still lack basic facilities to conduct even the simplest forms of scientific practical work. All participants reported having had to 'read' practical investigations from textbooks because of lack of resources at some stage of their schooling careers. It was understandable therefore, that some viewed practical work as a teaching strategy.

Participants also suggested that learners needed to be given ample opportunities "*to summarize notes in their own English words",* and to discuss their summaries in groups, using code-switching where possible. This was in

response to Dumi's schooling experience of being asked to take notes that the teacher never explained. Participants drew from their schooling experiences, and emphasized the need for science teachers to make every effort to equip learners with the English language skills necessary to be successful science learners.

6. DISCUSSION

Findings from this study support the claims that learners experience problems understanding science when it is taught in a language that is not familiar to them (Probyn, 2006; Brock-Utne, 2012; Oyoo, 2012). All participants identified the process of getting to know and understand science concepts as an important aspect of learning science that they struggled with. The language background of the participants became a challenge in their acquisition of the scientific vocabulary, and understanding of content and concepts necessary for one to be scientifically literate (Westby et al., 1999). Participants reported that this inability to acquire appropriate scientific knowledge resulted in them performing poorly in assessment tasks and examinations. Those participants who went to township and rural schools blamed these contexts for their poor grasp of English, and felt that if they had used English more at school they would have performed better in science. Those that went to ex-Model C schools blamed their English medium teachers for their language problems in science classes. Both groups used their experiences to argue for English to remain the LoLT in science classrooms. This finding supports the claim that pre-service teachers enter teacher education programs with well-developed belief systems about student learning, and that these are influenced by their [pre-service teachers] experiences of science learning (Smith, 2005; Seung et al., 2011). This challenges teacher education programs to provide pre-service teachers with opportunities to reflect on their beliefs and to make them explicit.

Learning science also involves 'doing science', which Westby et al. (1999) describe as "the ability to engage in class discussion, develop science projects, and contribute to science activities" (p. 52). They further argue that learners of science must be able to "talk in scientifically literate ways" (p. 52). Participants reported that there were times when they were unable to engage in classroom discussion and to ask questions because of the language barrier. They indicated that this led to their lack of confidence in their knowledge of science. It can be argued, therefore, that their science learning experiences did little to instill in them a belief that they could understand science. It also did little to provide them with opportunities for legitimate peripheral participation that support their full participation as members of the scientific community. Attending to the emotional or affective aspects and paying attention to the environments in which learners learn science have been identified as important factors in the success of science learners, particularly for the groups that are under-represented in science (Brickhouse, Lowry & Schultz, 2000). Opportunities for dialogue and

collaboration between learners and the teacher, and among learners promote confidence in learners and a belief that they are capable of succeeding in science. When learners can see potential for academic success they are more likely to decide to follow careers in science and improve the pool of potential scientists that South Africa needs.

Vygotsky (1986) highlights the important role played by the teacher as a knowledgeable other. Participants in this study were all about to complete their teacher training, and almost ready to begin their teaching career yet they reported a lack of confidence in their roles as 'knowledgeable others'. Their failure to use language to mediate and develop meaning through a shared discourse with their learners meant that they could not effectively discharge their roles in ensuring the successful learning of science. Westby et al. (1999) identify 'scaffolding' as a strategy that can be used by a knowledgeable other to guide learners to gain new knowledge and skills. Pre-service teachers in this study felt ill-equipped to use scaffolding to help learners become scientifically literate because of language barriers.

Although there was consensus on the benefits of code-switching, participants were aware of the many challenges of code-switching. Some of them were uncomfortable using L1 and felt this would put their learners at a disadvantage because L2 was used during examinations. They reported a lack of awareness and training on how to use code-switching to effectively communicate scientific ideas and to help learners do the same. Mercer, Dawes & Staarman (2009:354) argue that a good science teacher will not just teach content but will assist learners to "understand the dialogic processes involved in studying and practicing science". They argue for a communicative approach to teaching science where teachers create opportunities for learners' ideas to be presented and valued as much as those of the teachers through the process of dialogic talk.

Findings of this study also support the claim that prospective teachers' beliefs about what constitutes good teaching shape their decisions about what should happen in their own classrooms (Smith, 2005). Brock-Utne (2012) argues that when more people accept particular views associated with a belief system as common knowledge, then the belief system gains momentum and power. It appears that in South Africa there is a belief that English is a language that opens access to economic opportunities for those who were previously disadvantaged, and that making it a language of learning and teaching is the best way for them to learn it. Participants in this study appeared to have accepted this view.

7. CONCLUSION

This paper has highlighted the challenges faced by L2 learners and pre-service-teachers of science in South Africa. While the country's language policy advocates a multilingual approach to teaching and learning, this paper has highlighted a number of challenges that make the implementation of such a policy a challenge. English still remains the LoLT in many schools. In spite of the challenges they faced in learning science in the L2, participants in this study believed that the use of English in science teaching and learning was a good thing. This points to the importance of the participants' lived experiences in shaping their beliefs about the use of language in science classrooms. These beliefs, in turn, shaped their use of language during teaching practice. The findings confirm Tan's (2011) assertion that where teachers are not formally trained to integrate content and language teaching, teacher beliefs "become a crucial factor guiding their classroom pedagogical practices" (p. 328).

Although this study was small, and cannot be generalized to all pre-service science teachers, it nevertheless raises serious questions about the extent to which current teacher education programs prepare teachers to deal with the challenges of L2 teaching in South Africa. Teacher preparation programs in South Africa must pay more attention to how science teachers can use 'dialogic talk' to assist L2 learners to acquire the necessary vocabulary to engage in scientific discussions meaningfully. There is also a need to pull together the work done by a number of researchers to address language issues in science education in South Africa and Africa. For example, the Center for Advanced Studies of African Society (CASAS), an NGO based in Cape Town, promotes the use of African languages across Africa (Brock-Utne & Mercer, 2013). A number of universities have also embarked on a number of projects that try to promote multilingualism. The university where this study was conducted, for example, was the first university in South Africa to make it compulsory for all students to enroll for an African language. Teacher education programs need to draw from a variety of existing resources to equip prospective teachers with knowledge and skills to address language barriers in the teaching of science. Lastly, government has to provide Learning and Teaching and Support Material (LTSM) that teachers who are already practicing can use to address language barriers in the teaching of science.

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