Reflections on the Use of an African Language in Science Teaching and Learning in the Intermediate Phase: A Case Study in two Western Cape Primary Schools

Vuyokazi Nomlomo

Abstract

This article reflects on the use of an African language, isiXhosa, in science teaching in selected primary schools in the Western Cape, South Africa. Guided by the social constructivist view and the notion of epistemological access to knowledge, the article sheds light on the successes and constraints that were experienced by teachers when using isiXhosa home language instruction in science. It argues that while home language instruction in African languages is a right and priority for all children, its implementation should not hinder learners' epistemological access to science knowledge. Data were collected by means of classroom observations, document analysis and interviews with teachers, learners and parents. The article concludes that isiXhosa has a potential to develop as an intellectual language of science, but appropriate resources and teacher professional development programmes should be prioritised.

Keywords: epistemological access, isiXhosa, home language, language of instruction, science, Intermediate Phase

Vuyokazi Nomlomo ***Izimbuyiswa Ekusetshenzisweni Kolimi Lwase-Afrika Ekufundeni Nasekufundiseni ISayensi Emabangeni Amaphakathi: Isibonisocwaningo Ezikoleni Ezincane Ezimbili ZaseNtshonalanga Koloni***

Isifingqo

Leli phepha libuka ukusetshenziswa kolimi lwama-Afrika, isiXhosa, ekufundisweni kwesayensi ezikoleni zamabanga aphansi eNtshonalanga Kapa, eNingizimu Afrika. Silawulwa umbono wongoti abaqonda inhlalo kanye nokuthola ulwazi, i-athekili ikhanyisa ngempumelelo kanye nangezingqinamba okufanele zibhekwe ukuze kusetshenziswe ngokuyikho isiXhosa njengolimi lwasekhaya uma kufundiswa isayensi. I-athekili ithi ukufundisa ngolimi lwebele okuyizilimi zomdabu zase-Afrika kulilungelo futhi kusemqoka kuzo zonke izingane, ukusetshenziswa kwalo akufanele kuvimbele umfundi ukuthola ulwazi lwesayensi lokuqonda lokho esikwaziyo. Ulwazi lwatholakala ngokubukela kufundiswa, ukuhlaziya imiqulu kanye nokwenza izingxoxo nabafundisi, abafundi kanye nabazali. I-athekili iphetha ngokuthi isiXhosa sinamandla okuthuthuka njengolimi lolwazi lwesayensi, kodwa imithombo efanele kanye nezinhlelo ezithuthukisa abafundisi ngobungcweti kufanele zibekwe eqhulwini.

Introduction

The question of language of instruction in Africa has received much attention in the last two to three decades. There have been arguments for and against the use of African languages as languages of instruction in schools. One part of the argument pertains to the low socio-economic status of African languages and their lack of adequate resources and scientific terminology which make them unsuitable as languages of teaching and learning (Bunyi 1997; Elugbe 1990; Hameso 1997; Prah 2003). The other side of the debate is the concern about the dominance of ex-colonial languages in Africa (e.g. English, French and Portuguese) after many decades of colonial independence (Alidou 2004; Alidou & Mazrui 1999). The role of ex-colonial languages in marginalizing local African languages and their negative effects on children's academic achievement are widely documented (Simango 2009; Alexander 2005; Bamgbose 2005, Ogunniyi 2005; Molosiwa 2005; Brock-Utne 2005; Alidou 2004; Heugh 2003; Chumbow 1990). In the South African context, this applies in particular to African language-speaking learners being

taught new concepts in different subjects through the medium of English (which is an additional or second language) from Grade 4, whilst still grappling with the challenges of learning new subjects and an additional language (English) at the same time (Desai 2012; Nomlomo 2007; Banda 2006; Langenhoven 2005; Heugh 2003; Desai 2001; McKay & De Klerk 1996 Sentson 1994).

Some initiatives towards promoting African languages in education have been taken in some African countries. For example, the Six Year Primary Project (SYPP) of Nigeria, which was implemented in the 1970s, inspired similar research projects in other African countries, such as the experimental school project in Mali in 1985. Similar quasi-experimental research studies were conducted in Tanzania where Kiswahili was used as a medium of instruction in science and geography in secondary education (Form 1) from 2004 – 2007 (Vuzo 2007; Mwinshneike 2008). Yohannes' (2009) study in Ethiopia focused on the use of African home languages in education.

In South Africa, particularly in the Western Cape, there has been a growing support on the use of isiXhosa as one of the languages of learning and teaching since the 1990s. For example, the South African Threshold Project in 1990 and the Project for the Study of Alternative Education in South Africa (PRAESA) from 1992 focused on projects which promoted mother tongue based bilingual education which entailed the retention of learners' home languages (Wababa 2009). There is also the Language of Instruction in Tanzania and South Africa (LOITASA) research project which was a collaborative research project between Tanzania and South Africa. It extended the use of isiXhosa in mathematics, geography and science teaching in the Intermediate Phase (Grades 4 – 6) in selected primary schools in the Western Cape. This is because African languages are not used as languages of learning and teaching after Grade 3 in many South African schools (Nomlomo & Mbekwa 2013; Nomlomo 2007). LOITASA was divided into two phases called LOITASA I and LOITASA II. LOITASA I was conducted over a period of five years from 2003 – 2007, while LOITASA II continued from 2008 – 2012. The launch of the Western Cape Education Department's (WCED's) Language Transformation Plan (LTP) in 2007 and its implementation in 16 Western Cape schools in 2008 was also in support of mother tongue based bilingual education (Pluddemann, Nomlomo & Jabe 2010).

Given the myth that African languages are unsuitable as languages of learning and teaching in science (Heugh 2003; Prah 2003), this article reflects on the use of isiXhosa for science teaching and learning in the Intermediate Phase (Grades 4 – 6) in two primary schools in the Western Cape in order to highlight the successes and challenges that were experienced. Guided by the notion of social constructivism and epistemological access to science knowledge, the article argues that while (isiXhosa) home language instruction is a priority with regard to learners' access to meaningful learning, there are constraints that have to be taken into consideration to ensure that learners' access to meaningful science knowledge is enhanced. It intends to inform future implementation of home language instruction in African languages, given the current national support of African languages in education through the Incremental Introduction of African Languages (IIAL) initiative (Department of Basic Education 2013).

This article is guided by two research questions:

(i) What lessons have been learnt from the use of isiXhosa in science teaching and learning in the Intermediate Phase?

(ii) What are the implications of these lessons for learners' epistemological access to science knowledge?

Language and Access to Knowledge

The notion of access to education has been a matter of concern in sub-Sahara Africa since the adoption of the Millennium Development Goals (MDGs) in 2000, and the commitment to Education for All by 2015 (Motala, Dieltiens, & Sayed 2009). Access to education is understood as both physical (formal) and epistemological access to knowledge. Physical access to education has to do with the numbers or enrolment rates, while epistemological access, a term coined by Morrow in 1994, entails access to meaningful learning (Motala *et al.* 2009; Jansen 2008; Morrow 2007). It is argued that language is one of the barriers (with poverty, gender inequality, social class, etc.) to learners' equal epistemological access to education, particularly in sub-Saharan Africa (Jansen 2008; Pendlebury 2008). Many children in Africa access knowledge

through the medium of a second or third language (e.g. English, French, Portuguese) in which they have limited competence (Bamgbose 2013; Brock-Utne 2010; Jansen 2008; Pendlebury 2008; Qorro 2004; Alidou 2004; Chisholm 2004; Gamede 2005). Consequently, there is a big gap in academic performance between children who are taught in their home language and those who are taught in a second language, most of whom are from low socio-economic backgrounds (Pinnock 2009).

In South Africa, access to education, particularly science and mathematics education, is receiving more attention, not only as a tool for transformation, equity and redress, but also for economic and technological development (Ogunniyi 2005). But the question of language of instruction and learners' access to knowledge is still an educational challenge (Nomlomo 2007; Suhaimi 1981). Research shows a positive correlation between the language of learning and teaching and learners' academic achievement. For example, the results of the Trends in International Mathematics and Science Study (TIMMSS) of 2003 point to the mismatch between the learners' home languages and the language of instruction (Reddy 2006). The TIMSS results, in particular, show that the worst performance was observed with learners from the ex-Department of Education and Training (ex-DET) schools, which accommodate mainly black African learners, mostly from low socio-economic backgrounds. These learners were compared to their counterparts, most of whom were home language speakers of either English or Afrikaans (Brook Napier 2011; Reddy 2006: 63). This has resulted in low numbers of black learners taking Science and Mathematics at Grade 12 level (Le Grange 2007). This is a concern given that science and mathematics are targeted for the country's economic and technological growth.

Concerning science teaching and learning, in particular, it is imperative that learners acquire scientific literacy to enable them to function effectively in the current world of science. The question of epistemological access to scientific literacy becomes relevant in that the learner's home language facilitates learners' meaningful knowledge construction. It aligns with the social constructivist view that the learners' home language is a resource upon which new learning experiences are built (Chaille & Britain 1997; Leach & Scott 2000). Social constructivists emphasize an active interaction and dialogue in the construction of knowledge in social and physical environments (Bell 2002; Bantwini 2009) through a language understood by all those who are involved in the interaction process. Given

that science is a complex, abstract and highly specialized language, learners who are taught through the medium of a second language may struggle to engage with and conceptualise the language of science to acquire process skills (Jones 2000; Puhl 2000; Monk & Dillon 1995) which involve thinking, observation, classification, communication, measurement, estimation, predictions and making inferences (Beisenherz & Dantonio 1996; Padilla, Muth & Padilla 1991). So it may be argued that the learner's home language is an important tool in mediating and developing the learners' process skills which are necessary for acquiring scientific literacy. Therefore, scientific literacy depends on one's language competence which acts as the main regulator of thinking (Einstein 2002:6; Kecskes & Papp 2000:5). Conversely, the mismatch between the learners' home language and the language of instruction is a concern with regard to science knowledge construction and acquisition of scientific literacy (Ogunniyi 2014; Ogunniyi 2005:133; Bell & Freyberg 1985:33). In this article, the aim is to gain insight on how the implementation of isiXhosa home language of instruction in science in the Intermediate Phase enhanced or constrained learners' construction of science knowledge.

Research Methodology

This article is based on a small qualitative longitudinal study which was conducted with Intermediate Phase (Grades 4 – 6) teachers and learners in two selected primary schools (Schools A and B) in the Western Cape from 2008 - 2012. The two schools were located in low socio-economic townships of Cape Town where the majority of teachers and learners were home language speakers of isiXhosa. The total sample comprised sixty eight (68) learners, two (2) teachers and thirteen (13) parents.

Concerning the selection of learners for this study and to adhere to ethics of working with children as capable contributors to research (Harcourt & Conroy 2011), permission was sought from their parents to place them in the science class in which they were to be taught through the medium of isiXhosa. The learners were selected on the basis that they were doing Grade 4 at the start of the project, which was the transition grade from home language instruction (isiXhosa) to English (L2) instruction. Negotiations with the parents were conducted verbally in a meeting and were followed by

letters which were written to parents in isiXhosa. Out of the 69 letters that were sent to School A, 33 parents granted permission for their children to participate in the study. In School B, 71 letters were sent to parents, and 35 of the parents responded positively to the request of having their children taught science through the medium of isiXhosa from Grade 4 – 6. In total, there were 68 learners who participated in the study; 33 learners from School A and 35 learners from School B. The average age of the learners who participated in the study ranged between 10 and 13 years.

The data collection methods were classroom observations, focus group discussions with learners, focus group interviews with parents, individual interviews with teachers and document analysis which involved the analysis of learners' science workbooks written in isiXhosa. The use of these various methods was for triangulation purposes (Strydom & Delport 2005; De Vos *et al.* 2005; Henning van Rensburg & Smit 2004). Triangulation was necessary to maintain the stability or consistency of the research results (Mouton 2001).

The learners were observed in their interaction with teachers in science classes taught through the medium of isiXhosa from Grade 4 – 6. Focus group discussions with learners were conducted on the last year of the project when they were in Grade 6. This arrangement was influenced by the understanding that Grade 6 learners would have had three years of experience in learning through their home language, and would be able to express their reflections meaningfully. Two focus groups of five learners were conducted in each school. In other words, there were two focus groups in each school, and a total of twenty learners participated in the group discussions. These were learners who volunteered to take part in the discussions, although a control in numbers was also taken into consideration in order to avoid very large groups. In School A, there were four boys and six girls in the focus group discussions and there were five boys and five girls who participated in the focus group discussions in School B. The focus group discussions focused on learners' reflections on learning science through the medium of isiXhosa from Grade 4 – 6.

Two teachers were involved in the study; one from each school. Both were women with more than fifteen years of teaching experience. They were home language speakers of isiXhosa. The School A teacher was in her fifties, and had trained for a Primary Teachers' Certificate (PTC) which prepared her to teach all subjects for lower primary education in the 1970s. The School B

teacher was in her forties with a Primary Teachers' Diploma. None of them were science specialists. The two teachers who participated in this study were individually interviewed to investigate their experiences and views on teaching science through the medium of isiXhosa from Grade 4 – 6. They were also observed in their classrooms (from Grade 4 – 6) as they interacted with learners in the science lessons conducted through the medium of isiXhosa. The observations took about nine weeks scattered over three school terms in each year i.e. from the first to the third year of the longitudinal research study. With the permission of teachers and parents, the lessons were video-recorded for analysis purposes.

Thirteen parents were conveniently selected to participate in focus group interviews in the last year of the study in order to investigate their views on the use of isiXhosa in science teaching and learning in each school. There were six parents (one male and five females) with children in School A, and seven parents (all females) with children in School B. All the parents who participated in the study were mother tongue speakers of isiXhosa, with low educational qualifications which ranged from Standard 1 (Grade 3) to Grade 12. Nine of the thirteen parents who were involved in the study did not have high school education (i.e. Grades 8 – 12). Two of the parents had attempted Grade 10, one dropped out of Grade 11 and only one of them passed Grade 12. Their ages ranged between 26 and 56 years. Eight of the parents were unemployed, while five of them had non-professional jobs which did not require high academic qualifications. The parents were interviewed in focus groups. All the interview data and focus group discussions were audio-taped to facilitate transcription and analysis of data.

Finally, the learners' science workbooks which were translated from English to isiXhosa were analyzed in order to determine whether the use of isiXhosa facilitated learners' understanding of science concepts. The workbooks that were analyzed were randomly chosen from Grade 4 – 6 in both schools. Data were transcribed and analyzed qualitatively into different broad themes and categories which corresponded with the broad aims of the study.

Ethical considerations such as respect, voluntary participation and anonymity were adhered to throughout the data collection process (Henning *et al.* 2004; De Vos *et al.* 2005). Permission to conduct research in schools was sought from the Western Cape Education Department (WCED), and from the teachers, parents and learners who participated in the study.

Research Findings

From the triangulated data, many lessons which portray the successes and challenges of isiXhosa as a language of instruction in science were learnt. On the overall, there were more successes or achievements than challenges. The successes pertained to parents' and learners' positive attitudes towards isiXhosa as a language of instruction in science, learners' academic achievement in science, the production of science learning materials in isiXhosa and improved parental involvement. However, linguistic and pedagogical challenges were also observed.

Parents' and Learners' Positive Attitudes Towards the Use of isiXhosa as a Language of Instruction in Science

The findings of this study derived from all the data sets show not only the feasibility of home language instruction in an African language (isiXhosa), but also the practicality and dynamics of using an African language in science teaching. In this study, parents and learners displayed positive attitudes towards isiXhosa as a language of instruction in science. This finding challenges the general misconception that all (black) parents do not want their children to learn through the medium of African languages (Nomlomo 2007). It was interesting to note that about 50% of the parents (33/69 and 35/71) supported the use of isiXhosa as a language of instruction for their children, although mother tongue education in African languages is still a controversial issue in South Africa as it is associated with inferior education that was perpetuated by Bantu Education of the apartheid era (Heugh 2003; De Klerk 2000).

The analysed data showed that parents were not aware of their right to choose the language of instruction for their children. Whilst three of them showed an awareness of the historical and political situation regarding the use of languages in education in South Africa, they lacked a deeper understanding of the theoretical and practical issues underpinning the use of learners' home language as LOLT. Due to their low academic qualifications, they also lacked knowledge and exposure to current educational issues and debates on LOLT.

The interview data also revealed the parents' sense of pride in isiXhosa, as they were given an opportunity to choose which language they

preferred for their children's learning. This is apparent in P1's utterance below:

> *P1: Into eze kundi-surprise(a) kukuba sifikelwe ziileta ezithi ezi zinto ziza kufundwa ngesiXhosa; kwangona ndizidlayo ngoku… ukuba ikhona into ibi-wrong(o) xa ezi zinto bezititshwa ngesiNgesi…so ke xa ngoku ezi zinto ikho into ethi mazititshwe ngesiXhosa,… which means besinalo ilungelo, although besilivinjiwe ukuba abantwana bethu bafunde ngee-languages zabo abakhula ngazo.*
> *What surprised me was to receive a letter saying that these things (subjects) will be learnt through isiXhosa; it was then that I became proud… that there was something wrong when these things were taught in English… so now that there is something saying that these should be taught in isiXhosa… which means we had a right, although we were deprived of that right that our children should learn through their languages that they grow with.*

Some parents showed loyalty to isiXhosa, not only as a vehicle for better academic achievement, but as a transmitter of cultural identity. The status of English as an international language was also affirmed, but parents suggested that English should be taught as an additional language for learners' socio-economic advancement**.** One of the parents had this to say:

> *P2: Ulwimi lwesiXhosa lulwimi lwasekhaya, kufuneka azazi izithethe zesiXhosa…kuba le i-English yeyokuba afumane umsebenzi…abe ulwimi lakhe engalulahlanga … Akhule eyazi inkcubeko yakhe.*
> *The Xhosa language is home language, she must know the Xhosa cultural traditions …because this English is for the purpose of getting a job…while maintaining her own language…. She must grow up knowing her culture.*

The learners wanted to retain isiXhosa as a medium of instruction, while learning English as a second language. They showed awareness of the role of the home language in acquiring additional language/s. The learners' attitudes towards isiXhosa reflected their intuitive awareness of additive bilingualism as shown in L1's response below:

> *L1: Kufuneka ilanguage yakho uyifunde,… awunakufunda ezinye ii'language' ungayazi eyakho. Kufuneka uqale ngeyakho, ulandelise ezinye.*
> *You must learn your language,… you cannot learn other languages if you don't know yours. You must start with your own (language), and thereafter learn others.*

Learners also displayed confidence, positive aspirations and better life expectations if they were to learn science through their home language, even in higher education. Such aspirations are reflected in L2's utterance below:

> *L2: Besifuna ukuthi gqi nathi ngesiXhosa kwiNatural Science,… sibe zii-Black…. umntu wokuqala esiya phezulu,… siye kwi-space, singaziyekeli. Sifuna ukungenela i-competition, sifuna abanye abantwana, sibabonise ukuba sifunda kanjani ngesiXhosa.*
> *We wanted to come up with isiXhosa in Natural Science,… and become Blacks… the first person going up,…. (and) go to the space, (and) do it. We want to enter for a competition, we want to show other children how we learn through the medium of isiXhosa.*

The parents' and learners' positive attitudes towards isiXhosa home language instruction correspond with Boothe and Walker's study (1997) where Amharic was successfully introduced as a language of instruction in primary education in Ethiopia. In this study parents, teachers and students developed positive attitudes towards the use of the learners' mother tongue (Amharic) in education (Boothe & Walker 1997:13).

Better Academic Performance in Science

Throughout the three years of this longitudinal study, the learners performed well in their science class tests and in the final examinations. They also wrote one summative assessment which was designed by one of the science education researchers who was involved in the project, in consultation with the subject teachers. The assessment was written towards the end of each year and it covered all the content taught for a particular grade, taking into

consideration the science learning outcomes of each section covered at each level. It aimed at determining whether learners were able to demonstrate their knowledge and understanding of science concepts, and the extent to which they were able to apply scientific knowledge in related contexts.

With the introduction of isiXhosa as LOLT in science, in School A the pass rate increased exponentially from 78,8% in Grade 4; 83% in Grade 5 and 84,2% in Grade 6. In School B, it increased from 62% in Grade 4, 67% in Grade 5 and 69,5% in Grade 6. It was noted that School B's learners' grades were lower than the grades that School A learners' obtained. This could be attributed to a number of variables like the instability in School B due to regular change of principals and teachers, which were beyond the researcher's control.

The learners' good academic performance in science could be linked to the delayed shift to English (L2) medium of instruction and the learners' developed and rich linguistic competence in their home language (Leach & Scott 2000). In this study, the learners' written work showed learners' good understanding of certain science concepts which were expressed in rich idiomatic expressions in their home language (e.g. *Amanzi nombane yinyoka nesele/Water and electricity are enemies/You cannot mix water and electricity*).

Similar findings have been reported in numerous research studies conducted in South Africa and elsewhere (Desai 2012; Nomlomo 2007; Vuzo 2007; Mwinsheike 2007; Bamgbose 2005; De Klerk 2000; Sentson 1994). For example, the results of the SYPP project in Nigeria showed that learners who were taught in their mother tongue, Yoruba, performed better than those who were taught in English (Bamgbose 2005). The delayed switch to English medium of instruction led to greater proficiency in English, and better understanding of mathematics and science concepts. Interestingly, follow-up longitudinal studies also showed that the learners who had six years of mother tongue education coped better at the secondary and tertiary levels (Bamgbose 2005).

Development of Science Materials in IsiXhosa

Learning materials serve as mediation tools in teaching and learning (Leach & Scott 2000:43). As the study formed part of the LOITASA II research

project, science materials were developed by translating existing English workbooks into isiXhosa, as there were no science materials written in isiXhosa for the Intermediate Phase classes at the start of the research project. A similar finding by Yohannes' (2009) in Ethiopia reports that books were translated by teachers from French/English to Amharic when mother tongue education in this African language was introduced in schools.

The translation process was guided by the semasiological and the onomasiological approaches (Jokweni 2005; Mbekwa 2009). The semasiological approach gives the meaning of the term instead of giving an equivalent term e.g. photosynthesis is translated as *'ukuguquka kwekharbhoni-diokside okwenziwa ngeklorofili nelanga ibe ziikharbohidrate/ changing of carbon dioxide made of chlorophyll and sunlight into carbohydrates'* (Fischer, Weiss, Tshabe & Mdala 1985). The translation is a complete description of the process of photosynthesis, with borrowed words such as carbon dioxide, chlorophyll and carbohydrates. While the semasiological approach to translation is often criticized by those who believe in 'pure languages' (Jokweni 2005), in the case of this study it was preferred in that it mediated or facilitated learners' access to scientific terminology.

The onomasiological approach, on the other hand, involves naming the terms, instead of describing them (e.g. matter = *inkqunto*; oxygen = *umongo-moya*). As some of the terms were unfamiliar to both teachers and learners, the translator used both isiXhosa and borrowed terms interchangeably to enrich learners' science vocabulary (e.g. matter as *inkqunto or imatha;* oxygen as *i-oksijini or umongo-moya*).

The lesson learnt from this exercise was the feasibility of developing science terminology in isiXhosa which contradicts the general perception that African languages cannot be used in science education as they lack appropriate terminology (Nomlomo & Mbekwa 2013). The use of the two translation approaches was useful in developing Intermediate Phase science materials in isiXhosa and in supporting learners' epistemological access to science knowledge.

Improved Parental Involvement

Parental support is still a problem in African schools, especially with working class parents (Prinsloo 2005). In most cases, the problem is perpetuated by

the gap between the languages used in schools (e.g. English) and the learners' and parents' home languages. As a result, parents who are not competent in the language(s) used in teaching and learning are unable to assist their children with schoolwork. Other barriers to effective parental involvement include feelings of intimidation, difficult work schedule, cultural and socio-economic barriers (Lemmer, Meier & van Wyk 2006:144).

In this study, it was interesting to note that parents were able to assist their children with schoolwork as they could read and understand their children's science workbooks which were written in isiXhosa in which they had good competence. This was confirmed by one of the teachers that parents were assisting with their children's school work, particularly in science. One of the teachers (T1) stated thus:

> *T1: Nabazali bayayinika inkxaso,….. ndithetha nje ngezi eksperimenti… ufumanise ukuba abazali bayayijonga yonke le nto uyititshayo,… batshintshile kunakuqala…abuye (umfundi) ethetha 'more' kunakuqala,.. esithi: 'Umama ebejonge le ncwadi waze wandicacisela yonke into ekule ncwadi.'*
> *(And) parents are giving support… I am talking about these experiments…you find that parents look at everything that you teach… they have changed than before… and s/he (the learner) comes back talking more than before…saying: 'My mother looked at this book and explained everything that is in this book'.*

Some of the parents also confirmed that they were able to read the workbooks and explain certain concepts to their children as they understood the language of instruction, which was isiXhosa. For example, parents could explain some of the scientific concepts such as seed germination, fertilisation, natural vegetation, etc. in the learners' home language which they knew very well. Parents' explanation in isiXhosa seemed to be a good vehicle for learners' better epistemological access to science knowledge than in English. The following utterance by one of the parents (P3) attests to this finding:

> *P3: … uyafika athi kuthiwe mabeze mhlawumbi ne'seed' yengqolowa… ndithathe isonka ke ngoku mna ndikhangele phaya ezo 'seed',… mhlawumbi makeze namagqabi ezityalo ezi zizikhulelayo,…*

> *sihambe siye phandle siyozikhangela, abuze ukuba yintoni, ndimchazele ukuba yinto ethile, and 'then' ayibhale ke ngoku.*
> *S/he comes and says that they have been asked, perhaps, to come with a wheat seed… I take bread and look for those seeds…perhaps he must come with leaves of natural vegetation… we go outside to look for them, and he asks what it is, and I tell him what it is, and then he writes it down.*

From the social constructivist viewpoint, learning is a collaborative process, and knowledgeable individuals like parents and teachers play a significant role in scaffolding learners to reach higher levels of comprehension (Bell 2002). The above parent's utterance suggests that isiXhosa was easily accessible to the parents, and it was used as a mediation tool to assist learners in their construction of science knowledge. However, there were some pedagogical and linguistic challenges that were experienced with regard to the use of isiXhosa in science teaching and learning.

Pedagogical Challenges

In this study, it was observed that despite the fact that learners showed good understanding of the lessons and performed well in science tests conducted through the medium of isiXhosa, both teachers made use of less interactive teaching approaches, with less thought-provoking questions. Observation data showed that the teaching strategies were teacher-centred, and were characterised by more teacher talk, one word answers and chorus responses from the learners (e.g. *Ewe/Yes Miss*).

More teacher talk leads to less learner participation which often results in long silences in the classroom (Tsui 1996:152). When the learners are passive and silent, the teacher is prompted to talk even more. According to the social constructivist paradigm, teacher-centred approaches do not facilitate active learning and creativity by the learners (Freeman & Freeman 1994). As science learning involves process skills such as observations, experiments, etc., the use of interactive teaching strategies is crucial for acquiring science literacy, irrespective of which language is used for teaching and learning.

Observation data showed that apart from teacher talk, some of the teachers' questions did not challenge the learners' higher order thinking skills. This was evident in cases where learners were required to repeat certain concepts, with no attempt to use the concepts to make meaning of science knowledge. The following excerpt is one example of such practice where the teacher was trying to explain the round shape.

1. Teacher: Sithi kaloku into engqukuva yinto enje, (*showing her fist*)…. Injani le nto ndiyibonisileyo?
We are saying a round thing is like this…. How is this thing that I have showed?

2. All learners: *(chorus)* Ingqukuva (*It is round)*

3. Teacher: Injani? *(How is it)?*

4. All learners: Ingqukuva *(It is round)*

5. Teacher: Injani? *(How is it)?*

6. All learners: Ingqukuva *(It is round)*

7. Teacher: Injani? *(How is it)?*

8. All learners: Ingqukuva *(It is round)*

9. Teacher: Injani? *(How is it)?*

10. All learners: Ingqukuva *(It is round)*

11. Teacher: Yintoni umzekelo wento engqukuva? *What is an example of a round thing?*

12. Learners: Ngamehlo enkomo *(It's the eyes of a cow)*

While repetition is one of the learning strategies, its use in the above excerpt does not seem to be useful with regard to learners' science knowledge

construction. The teacher asked the same question five times (lines 1, 3, 5, 7 and 9) which did not seem to reinforce any new kind of knowledge as the whole class gave the same single word response five times (lines 2,4,6,8 and 10). In this case, it may be argued that the teachers' pedagogical strategy did not seem to facilitate learners' critical thinking and science literacy skills.

Linguistic Challenges

Most of the language related constraints were associated with inaccuracies in the translation of the science material from English to isiXhosa. The challenges had to do with the specialized language of science and the use of unfamiliar scientific terms in isiXhosa which tended to affect learners' understanding of science terminology.

The analysed data showed that it was difficult to translate some of the abstract scientific terms such as photosynthesis, positive and negative charges, etc. As a result, literal translations were made and, in most cases, these translations were irrelevant and distorted the scientific meaning of the terms. For example, the concept of *'positive/negative charge'* was literally translated as *'itshaji yemo eqinisekileyo/engaqinisekanga'* i.e. *'a charge of being sure/unsure'*. This translation was taken directly from the Xhosa/English dictionary (Fischer, Weiss, Tshabe & Mdala 1985), and it does not make sense at all in the science context. Although the translator employed the semasiological approach to translation (Jokweni 2005) in this case, the translation was meaningless and did not support learners' epistemological access to science knowledge.

As there are many science concepts with no direct or equivalent translations in isiXhosa, an onomasiological approach that entailed borrowing English terms (e.g. *'iklorofili')* was preferred. Borrowing from other languages is a normal strategy to build terminology. For example, English as a language has borrowed terms from other languages like Latin (Mazrui 2002). Another observation was that there were science terms that had equivalents in isiXhosa, but their meanings were unfamiliar and inaccessible to learners as they were not used for daily communication in isiXhosa, although they were relevant in terms of their scientific and functional meanings. Such concepts include *'matter'* which was translated as *'inkqunto'* in isiXhosa and *'Oxygen'* with an isiXhosa translation of *'umongo-moya'*.

Apparently, teachers experienced difficulties in using some of the translated terms in their teaching. As a means of mediation and support to learners, they resorted to borrowing or giving descriptions and examples as stated below:

> *T1: Ndisebenzisa isiXhosa ngaphandle kwelo gama kuthe kwanzima ukulibiza ngesiXhosa, mhlawumbi kuthi kube nzima ukulicacisa, … umzekelo i'nkqunto' …. Ndibhenele esiNgesini but ndithethe isiXhosa.*
> *I use isiXhosa except for that particular word that is difficult to pronounce in isiXhosa, perhaps it becomes difficult to explain it, … for example 'inkqunto'(matter)… I resort to English but I speak isiXhosa.*

> *T2: Ulwimi olusetyenzisiweyo luntsonkothile, luntsonkothile kakhulu… nalapha esiXhoseni akhona amagama endingawaziyo. Uthi mhlawumbi i'nuclear power'. Abazi kwaloo nto…. Ubone ke ngoku ukuba awuna'language' yokuyicacisa le nto. Ndiqonde, okay, ndizokwenza umzekelo.*
> *The language used is complicated, very complicated… there are words I don't know even in isiXhosa. Perhaps you say 'nuclear power'. They do not know that….And you see that you don't have any language to explain this. I just decide, okay, I will make an example.*

Other linguistic challenges that were experienced had to do with the lack of equivalent scientific symbols in isiXhosa for elements such as oxygen (O_2), carbon dioxide (CO_2), Nitrogen (N), Potassium (K), Iron (Fe), etc., and scientific measurements (e.g. litres (l), millilitres (ml), centimetres (cm). So, these symbols and measurements were left in English, although the texts were in isiXhosa. The use of English symbols seemed to be problematic as it was difficult for learners to conceptualise them as they are non-existent in isiXhosa everyday terminology. The teachers had to borrow and describe them according to their atomic structure in English.

Linguistic ambiguities were also noted in the science texts (Nomlomo & Mbekwa 2013). For instance, according to the English/Xhosa Dictionary (Fischer, Weiss, Tshabe & Mdala 1985) the two colours *'blue and green* have the same meaning in isiXhosa i.e. *'luhlaza'*. Likewise, the colours

'purple' and *'violet'* are both referred to as *'mfusa'* in this dictionary. One has to differentiate between '*blue like the sky' (luhlaza okwesibhaka-bhaka) or 'green as grass' (luhlaza okwengca*), otherwise the actual isiXhosa meanings of these different colours may be confusing to learners.

The above excerpts show that scientific translations may be problematic, particularly if the translator does not have good knowledge of the science discipline. The teachers' experience and subject content knowledge become crucial in mediating and scaffolding learning in such situations. The teacher has to explore a variety of strategies to illuminate the meaning of the concepts in the learners' home language. Therefore, having competence in the target language of translation is not sufficient as it does not necessarily lead to accurate translations, and this can impact negatively on learners' understanding of science concepts.

Implications for Learners' Epistemological Access to Science Knowledge

Learners should be engaged in a variety of learning activities such as observations, investigations, measurements, critical thinking, writing science reports, etc. to enable them to construct meaningful science knowledge (Beisenherz & Dantonio 1996). In this study, observation data indicated that the learners understood the teachers' explanations well in their own language, but there were limited opportunities for learners to critically engage with the lessons in order to make meaning of the new knowledge. This was due to the teachers' use of less interactive teaching strategies which were characterised by more teacher talk which does not adequately facilitate active learning (Freeman & Freeman 1994).

Science is an inquiry-based subject, so it requires learners to be actively involved in their learning. With learner-centred activities that challenge critical thinking and self-discovery, learners are enabled to make sense of what they are learning, (i.e. they can construct their own knowledge). But if the teaching strategies do not promote learners' critical thinking and active learning, learners' epistemological access to knowledge may be compromised even if teaching and learning occur through the medium of their home language. This calls for innovative pedagogy which should be prioritised as part of teacher development across the curriculum.

One of the interesting findings of this study is that isiXhosa (and other African languages) has the potential to be an intellectual language like English and Afrikaans. As languages develop through use (Desai 2003), this study was an attempt to develop the status of isiXhosa in education. The use of isiXhosa as a language of instruction in science confirmed the well known fact that learners learn better in their home language. Therefore, the use of a language in which learners have adequate competence is crucial in supporting learners' access to meaningful learning and in developing human capital. Given the disparity with regard to learners' epistemological access to education in South Africa due to the language barrier (Jansen 2008; Pendlebury 2008), the use of African languages in education must form part of the agenda for equal access to education and as a means of responding to the Education for All (EFA) global discourse.

Whilst there is dearth of materials in African languages as they are not used as languages of teaching and learning beyond Grade 3, this study has shown that it is feasible to develop materials in isiXhosa through translation. However, the translation process has its own challenges as illustrated above. The challenges indicate that translation is a complex process which requires special linguistic and academic skills, as well as good knowledge and understanding of the particular field or discipline on which the translations are based. However, the lack of equivalent scientific terminology in isiXhosa should not be used as an excuse to underestimate and eliminate the role of this language (and other African languages) in science knowledge construction. Ogunniyi (2014) emphasizes the richness of local languages in integrating the indigenous knowledge in the science curriculum, thus extending the learners' understanding of science concepts. Given the monolingual use of English in science teaching in many South African schools, such conceptual, linguistic and cultural richness is not fully explored. For effective implementation of home language instruction in African languages, the translated materials should be piloted and evaluated to ensure that they enhance learners' epistemological access to science knowledge.

Finally, it is crucial to provide enabling linguistic environments for learners' easy access to scientific and technological knowledge needed for socio-economic advancement. This can be achieved through a language which learners know and fully understand, i.e. the learners' home language. South Africa can learn from the developed countries which use their own

languages in science education. Linguistic and cultural diversity can be used as a rich capital in accessing science knowledge through local languages instead of perpetuating the colonial legacy (Nomlomo 2007).

Conclusion

Although the findings of the study are not generalizable due to the small samples that were used, they provide rich information with regard to the successes and constraints that surround the use of an African language (isiXhosa) in science instruction. They shed light on what needs to be taken into account if African languages are to be used for instruction across the curriculum in the future.

While challenges with regard to the use of isiXhosa in science teaching and learning have been noted, they do not overshadow the cognitive and affective benefits of the use of learners' home language as a medium of instruction. The main gap identified in this study is the need for teacher development in using African languages across the curriculum, as the benefits of home language instruction will be compromised if pedagogical strategies do not promote learners' epistemological access to knowledge. It will be misleading to assume that all African language speaking teachers are ready to implement home language instruction in these languages. The conclusion drawn from this study is that while there are pedagogical and linguistic constraints in using an African language in science teaching, African languages have a potential to develop as intellectual languages for better access to meaningful knowledge across the curriculum if there are sufficient resources and teacher professional development and support programmes.

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