

Translanguaging as an instructional method in science and mathematics education in English second language classroom contexts¹

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ABSTRACT

The teaching of science and mathematics in African languages has been debated at various academic platforms that include seminars, conferences and publications where the major concern that has recurred is how it could be possibly done. The questions raised are mainly about the inadequacies of these African languages ranging from orthographies, terminologies to reading materials. For the reading materials to be produced there has to be agreed upon terminologies and the thrust of this paper is to delve on how such terminologies can be produced and how the teaching and learning can be done in African languages. Four secondary schools, two rural and two urban, were used as case studies, two in Bulawayo, and the other two in Matabeleland South province in Zimbabwe. The perceptions of science and mathematics teachers about translanguaging as a method of teaching science and mathematics were sought through interviews from eight teachers, that is, two from each of the four schools. The results showed that teachers have always been applying translanguaging as an instructional method in the teaching of science and mathematics although they were not aware that translanguaging is a concept that can be singled out amongst other strategies of instruction. The paper concludes that adopting translanguaging as a teaching method in bilingual classroom contexts aids learners' cognition thereby enhancing comprehension of concepts better than when only English language is used in teaching and learning.

Keywords: translanguaging, teaching and learning, mathematics and science, African languages

INTRODUCTION

African languages in education have for a long time played non-important roles despite being the first languages of the majority of Africans (Web & Du Pleiss, 2016: 50; Or & Shohany, 2017: 67). Those few local languages in Zimbabwe that have enjoyed recognition have been taught as subjects. At times when these languages are taught as subjects, they do not have the liberty to enjoy autonomy since a European language dominates as the medium of instruction (Web & Du Pleiss, 2016). An ex-colonial language dominates in all subjects that are taught at school except where the subject is an African language. Learners are faced with the burden of trying to learn new concepts that are introduced to them through a language that they are still trying to grasp. Research has shown that African languages have not been considered to be at par with European languages as indicated by Bamgbose (2015: 22) who argues as follows:

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How can a language be used for literacy and as medium of instruction if it is yet to be reduced to writing?; How can a language be used for teaching Science if there is no terminology already worked out in such languages for the scientific concepts to be encountered?

Such statements like that of Bamgbose are bound to create negative attitudes towards the teaching and learning of science and mathematics in African languages, and the development of orthographies and terminologies of these languages.

Learners who have an African language as their first language are already at an advantage because that African language should be treated as a resource in learning process and not as a problem (Bialystok, 2001; Cenoz, 2003; Rodriguez, Carrasquillo & Lee, 2014; Grammes & Hu, 2014; Goral, 2015). According to Garcia (2011), Vygotsky is one of the first researchers in bilingualism who concluded that children who are bilinguals have better cognitive advantages than those who are monolingual. It is an undoubtable fact that a learner understands better when concepts are introduced to him or her in his or her first language. In studies carried out by Bialystok (2001); Cenoz (2003); Rodriguez, Carrasquillo and Lee (2014); Li (2015) and MacWhiney and O'Grady (2015), it was proved that bilingualism improves mind development and that the use of the learner's first language in learning understanding of academic content. Cognitively, a learner would grasp concepts better if such concepts are availed in the learner's first language (Garcia, 2011; Radriguez & Carrasquillo, 2014). However, English cannot be done away with in the teaching of science and mathematics and this paper does not advocate for the total abandonment of English but to have English language and African languages being used together in teaching and learning since these languages coexist in the Zimbabwe speech community. The coexistence of English with African languages has continued to be downplayed when it comes to the classroom (Bangura, 2014) which this paper regards as a wrong approach to teaching and learning. Bangura (2014) argues that the mother tongue has been greatly neglected in the teaching of mathematics in Africa. The paper advocates for the adoption of translanguaging in situations where an African language is in coexistence with English language. Canagarajah (2011: 40) defines translanguaging as 'the ability of multilingual speakers to shuttle between languages, treating the diverse languages that form their repertoire as an integrated system'. Translanguaging does not make clear cut boundaries between the learner's L1 (first language) and L2 (second language). According to Garcia and Wei (2014: 21), translanguaging does not refer to 'two separate languages, nor to a synthesis of different language practices, nor to a hybrid mixture' but to 'new language practices that make visible the complexity of language exchanges among people with different histories (Makoe, 2018: 17). Translanguaging carries the promise of recognising all the languages and linguistic resources presenting in the learning space; all the politically and historically situated sets of resources (Heller 2007). It promises to bring to an end a 'hidden curriculum that favors some and excludes others' (Gamede 2005: 58).

One of the imagined problems of teaching science and mathematics in African languages revolves around the multiplicity of languages in each African state. In Africa there exists more than 2100 African languages (Bangura 2014: 15). Many nation states view policies that promote linguistic diversity as a problem rather than a right or resource (Kibler, 2005; Kriel, 2003). Denying the existence of multilingualism in the African education system can be viewed as a serious violation of linguistic rights because multilingualism is synonymous with Africa. Makalela (2015: 15) argues that 'African multilingualism has always been construed from a monoglossic (i.e., one language at a time) lens despite the pretensions of plural language policies in Sub-Saharan Africa'. The studies that have been done reveal that classes in African schools Africa, particularly in urban settings, are composed of learners from diverse linguistic backgrounds (Brijlall, 2008; Henning, 2012; Makalela, 2015; van der Walt, 2016). Henning (2012: 69) in a study done in South Africa concurred that when young children go to school in urban areas the chances of them entering 'a monolingual environment are almost none'. Brijlall (2008) observes that learners in

a multilingual classroom do not perform well when they are taught in English and proposes that the learning process should involve switching between the languages of the learners. Van der Walt (2016) concludes that classes in higher learning institutions in Africa are composed of students from diverse linguistic backgrounds, and therefore proposes that there is need to come up with strategies that can be used to handle such classes effectively. The conclusions and recommendations from predecessor research show that mathematics poses some challenges to the learners in bilingual and multilingual settings, and that there is a need to come up with strategies that will be suitable for such linguistic settings so that at the end learners can perform better.

This paper therefore explores translanguaging as an instructional method in the teaching of mathematics and science because other research not mentioned in the introduction has shown that science is also a challenge to the learners when only English is used as a sole language of instruction. Researchers in the field of language teaching and learning who include Makalela (2015), Mwindi and van der Walt (2015), Ngcobo, Ndaba et al. (2016), Mbirimi-Hungwe and Hungwe (2018), Ngcobo (2018), Wildsmith-Cromarty (2018) and Hungwe (2019), have proved that translanguaging is an important vehicle in the delivery of instruction in the classroom with learners from diverse linguistic backgrounds and even in a classroom where learners would be having the same first language (L1) but also using English as a second language (L2). The paper contextualises the use of translanguaging in the multilingual science and mathematics classrooms in Zimbabwe's Bulawayo Metropolitan province and Matobo District in Matabeleland South province. Bulawayo is an urban setting and Matobo is a rural setting. Class composition in Bulawayo is normally multilingual with learners mainly speaking Shona, Ndebele and some other languages that are found in Zimbabwe. In Matobo, the predominant language is Ndebele although there are cases where learners with languages such as Sotho, Kalanga and Shona as their L1 are found. Teachers in the two focus areas of research mainly speak either Shona or Ndebele as their L1 although there are a few cases where some would be speaking other languages found in Zimbabwe as their L1. The main language of instruction in science and mathematics is English although the curriculum of the Ministry of Primary and Secondary Education (2014: 34) of Zimbabwe stipulates that

The introduction of a second language and its alternate use with the indigenous language in the learning environment helps learners master concepts and achieve linguistic competency for learning and communicative purposes.

This implies that the languages of the learners found in the classroom can also be used although the main language of instruction remains as English. The major interest in the paper is on how the learners' L1 is utilised where the main language of instruction is English.

BACKGROUND TO THE TEACHING OF SCIENCE AND MATHEMATICS IN AFRICAN LANGUAGES

A lot of debates by scholars and researchers who include Rugemalira et al. (1990), Dlodlo (1999); Weddirage (2009), Bangura (2014), Bamgbose (2015), Mbirimi-Hungwe and Hungwe (2018), Venter and van Niekerk (2018) among others have been made regarding the use of African languages in science and mathematics education. Some of the debates have totally regarded the African languages as unfit for handling science and mathematics in the classroom but others have raised positivity towards the adoption of such an approach as will be shown in the discussion. Science and mathematics education in African languages has remained a dream because those who support the idea of the use of African languages want to adopt the idea of totally doing away with English and a good example is Dlodlo (1999) who is taking a radical approach by advocating for an approach that totally dislodges English in the arena of science and mathematics. If proper approaches are made that recognise the coexistence of African languages and English which this paper proposes, then the teaching of science and mathematics in African languages will see the light of day. It is important to first look at what predecessor researchers have found and proposed towards mathematics and science education in African languages.

Bamgbose (2015: 22) proposes that instead of teaching science and mathematics in African Language the easier option will be to 'simply go for an imported language such as English' because African languages orthographies and terminologies are not adequately developed. According to IBE-UNESCO (2017: 41), 'Even if it is true that there are no orthographies for the majority of African languages, this fact provides little reason to object generally to the use of African languages in education'. Rugemalira et al. (1990: 31) argue that

It should be demonstrated that countries such as Finland, Norway, China or Japan, which do not teach their children through the medium of an 'International' language, are isolated and have lost track of technological developments beyond their borders.

In addition, Osborn (2010), although writing positively about the use of African languages in a digitalising world, is on the other hand sceptical about the inclusion of these languages in the teaching and learning of science and mathematics which he says according to *Ethnologue* are over 2000 and constituting a third of the total number of languages in the world. The concerns bring negativity towards finding ways of including African languages in the teaching of science and mathematics.

These negative ideas towards the inclusion of African languages in the teaching of science and mathematics are stemming from the idea that English should be totally removed yet the idea is to utilise all the languages that are available to the learner. When English is used together with African languages then there is no way in which Africans can be isolated from the rest of the world in terms of cognition and innovativeness. Each language can develop as long as its speakers make use of it and it is the prerogative of the speakers of any particular language who should take the task of developing it so that it communicates their needs. In Papua New Guinea, according to IBE-UNESCO (2017), 450 languages are used in teaching and this shows that the problem of multiplicity of African languages is surmountable.

Weddirage (2009) questions where the belief comes from that science is better learnt in English than in other languages and that 'English is the language of Science and technology'. Babaci-Wilhite (2016: 6) observes that '... engagement with local language and local knowledge is necessary to facilitate the teaching and learning process'. Dlodlo (1999) argues that the fact that science and technology in Sub-Saharan Africa is not taught in an African language implies that no scientific ideas could be formulated in an African language or from an African perspective in the present education system. The problem that results in fear of using African languages is because both concepts and language used in science and mathematics are imported. It is argued that African languages need not to be isolated from English when it comes to the teaching of science and mathematics but should be included through the process of translanguaging.

Those that advocate for the teaching of science and mathematics in African languages argue that learners understand better when they are taught in their first languages. Babaci-Wilhite (2016: xiv) argues that students face challenges in comprehension when they are taught science and mathematics in English at the expense of their local languages. Ranaweera (1976: 423) commenting on the shift from English to Sinhala and Tamil in the teaching and learning of science in Sri Lanka said

... it helped to destroy the great barrier that existed between the privileged English educated classes; between the Science educated elite and non-Science educated masses; between Science itself and the people.

It gave confidence to the common man that science is within his reach and to the teachers and pupils that a knowledge of English need not necessarily be a pre-requisite for learning science (Ranaweera, 1976). Mbiriri-Hungwe and Hungwe (2018) carried out research on the use of translanguaging in a multilingual

second-year computer science class at a university in South Africa and the research showed that students perceive translanguaging to be helpful learning strategy which should be adopted by the whole faculty. Taking from Mbiriri-Hungwe's (2018) research this study is looking at how translanguaging is being implemented in secondary schools in Zimbabwe.

It is a common opinion amongst various researchers that African languages should be used in teaching and learning but the problem is that most of these researchers end at making it an opinion without showing how these languages can be utilised in a platform where English has already dominated and where people have developed a negative attitude towards these African languages. Asabere-Ameyaw and Ayelsoma (2012: 55) observe that 'language is crucial to the teaching and learning of Science'. They go on to say that words, tenses and sentence structure would influence the learners' understanding during a teaching-learning encounter (Asabere-Ameyaw & Ayelsoma, 2012). Babaci-Wilhite (2016) is also of the view that using a local language in science teaching will improve teaching and learning and will form a basis for new innovative learning. The general idea is that the learners' first language (L1) is the best instructional tool that should be used in teaching and learning. However, although the idea being shared here is that the learners should be taught in their L1, it is not clear how that can be done and the proposal made in this paper is that such should be done through translanguaging which is going to be explained in detail later.

Sutman (1993) and Asabere-Ameyaw and Ayelsoma (2012) have observed that limited English language proficiency is the major factor that contributes to lack of academic success in science and mathematics. It has been proven beyond doubt through studies that limited English proficiency inhibited students' science achievement when learning in English (Bamgbose, 1984; Curtis & Millar, 1988; Brock-Utne, 1997; Torres & Zeidler, 2002; Asabere-Ameyaw & Ayelsoma, 2012). Proficiency in the language of instruction, which in most cases is English in Southern Africa, is a key determinant to science achievement (Asabere-Ameyaw & Ayelsoma, 2012). Asabere-Ameyaw and Ayelsoma (2012: 56) argue that 'For a learner to be able to understand scientific concepts and communicate effectively using the concepts, the learner must first understand the language in which the concepts are being presented'. The language that is used determines success in the learning of science and mathematics (Dlodo, 1999; Bandura, 2014; Mbirimi & Hungwe, 2018). Asabere-Ameyaw and Ayelsoma (2012: 57) write that it is a misconception that in bilingual or multilingual settings, English should be settled as the best option for language of teaching and learning because of its neutrality. Asabere-Ameyaw and Ayelsoma (2012: 58) relate the example of Ghana where an experiment was carried out by giving mathematics and science tests to level eight students and it was proven that they performed better when they wrote in their home language than in English language.

Asabere-Ameyaw and Ayelsoma (2012) argue that the imposition of English on bilingual children is done by educators on the assumption that they are helping the learners to use only one language so that they can comprehend easily. The shortcoming from the ideas advanced by these researchers is their preference of using an African language only in the teaching of science and mathematics, which some sections of the society may not accept. The best option in such bilingual situations where English is the L2 will be to use both the learners' L1 and L2 through translanguaging as a method. What is important is for the learners to have what Asabere-Ameyaw and Ayelsoma (2012: 56) refer to as 'cognitive academic language proficiency' (CALP) as opposed to 'basic interpersonal communication skills' (BICS). Rao (2018: 30) refers to BICS or social language as that which learners acquire in the first two years of exposure to English, and CALP or academic language, as the language which learners acquire after seven to 10 years of exposure to English and is the language of the text books, class lectures and essays. Cognitive academic language proficiency is required by the learner to be able to read, to dialogue, to debate and to provide written responses (Asabere-Ameyaw & Ayelsoma, 2012). The cognitive academic competence is important to the learner so that comprehension is facilitated in understanding the science and mathematics concept.

The mistake that is made by others who advocate the teaching of science and mathematics in African languages is that they make an assumption that when these two subjects are communicated in African languages, they should become general to the learner. That is a wrong approach altogether because they forget that science and mathematics are specialised subject fields so much that they are not general even to the L1 speakers of English.

It has been shown that education in African countries takes place within a bilingual context although such a bilingual reality is ignored in favour of English language (Kotze, 2013; Makalela, 2015). However, it has been proven that the use of more than one language in learning enhances comprehension and therefore such a bilingual situation should be taken advantage of. Use of more than one language in teaching and learning also enhances cognition amongst the learners (Saville-Troike, 2006; Kovelman, Baker & Petitto, 2008; Bialystok, 2009; Braun & Cline, 2014; Sharwood Smith, 2017). The general idea is that in African education contexts, a learner inevitably finds him- or herself operating in his or her home language and a language of instruction, which is an ex-colonial language and in this case English. Of the many factors that can influence learners' comprehension in science and mathematics, the key determinant factor is the degree to which learners are bilingual (Asabere-Ameyaw & Ayelsoma, 2012).

In the teaching of science and mathematics, the first option where both languages are used simultaneously is opted for. Using the learner's L1 together with the L2 has advantages in that the learner will be able to grasp concepts easily by using the two languages, which are learning resources, at his or her disposal and then later on may shift exclusively to the L2 now having grasped the concepts fully well. UNESCO proposed that learners should be taught in their L1 in the first six years of their schooling (IBE-UNESCO, 2017), but it is argued here that both the L1 and the L2 should be used with the L1 dominating the teaching and learning so that learners are not faced with another burden of comprehension when the L2 is introduced at a later stage. The other proposal is that both the L1 and the L2 should be used throughout the learner's education even up to tertiary level because the learner will still be getting introduced to concepts that demand higher-level cognitive processes as he or she goes up. When the learner is operating in both the L1 and the L2 then that learner will be translanguaging and therefore it is important to briefly contextualise translanguaging in this study.

CONTEXTUALISING TRANSLANGUAGING IN TEACHING AND LEARNING

Translanguaging was briefly defined in the introduction for purposes of providing a working definition since the whole discussion revolves around issues of translanguaging. A deeper understanding of translanguaging is necessary and it is the reason why a more elaborate discussion about translanguaging is done under this section. The term 'translanguaging' was first used by Cen Williams as *trawsieithu*, a Welsh word, to describe a teaching methodology adopted in Welsh-English bilingual classrooms to strengthen and develop children's dual language listening, speaking, reading, and writing (Chumak-Horbatsch, 2012). Lubliner and Grisham (2017: 1) reveal that 'Translanguaging builds on research conducted by Moll and his colleagues in 1962, stressing the importance of historically accumulated and culturally developed bodies of knowledge and skills essential for functioning'. Otheguy, Garcia and Reid (2015: 283) define translanguaging as 'the deployment of a speaker's full linguistic repertoire without regard for watchful adherence to the socially and politically defined boundaries of named and usually national and state languages'. Translanguaging is a reality in the use of language in multilingual settings and this should not be downplayed in the teaching and learning in African educational contexts. Lubliner and Grisham (2017: 1) argue that 'Translanguaging is reality-based; it is the way bilingual children and adults use a full repertoire of linguistic resources to communicate with one another'. Garcia (2011: 43) argues that translanguaging is a communicative norm for all bilinguals throughout the world. Since translanguaging is a communicative norm for all bilinguals then this should be adopted in African education particularly in the teaching of mathematics and science where African languages have been tabooed.

Chumak-Horbatsch (2012: 56) argues that as bilinguals translanguage, they 'make use of multiple communicative possibilities, practices, and choices. They use their language flexibly, shifting, mixing, and blending linguistic features'. In the process of translanguageing, 'they go back and forth from one language to the other, combining elements from each language to convey their language and social skills and their cultural knowledge and understanding' (Chumak-Horbatsch, 2012: 56). Translanguageing dismisses the idea of monolingualism in education and the treatment of the learners' L1 and L2 as autonomous. Lubliner and Grisham (2017: 1) observe that 'the movement toward translanguageing reflects a tremendous change in perspective and practice regarding the education of children who enter schools speaking languages other than English'. Translanguageing is important for bilingual children in that the 'opportunity to use home languages in the classroom gives them a voice and builds and capitalises on their home language practices, allowing them to take ownership of their home language' (Chumak-Horbatsch, 2012: 56). Childs (2016) points out that it is vital that the language that the learners bring be valued and included in the classroom. Translanguageing strategies work better in multilingual contexts as learners have a good chance of succeeding and where the teacher shares the same language with the learners (Mwinda & van der Walt, 2015; Garcia, 2016). However, the question that may arise is what then would happen in situations where the teacher has a different L1 from that of the learners? Garcia (2016) answers this by saying that, in circumstances where the teacher is not familiar with students' first language, they would need to be prepared to be a co-learner and to organise the classroom activities so that the learners are able to engage in collaborative groupings that are constructed according to home languages.

METHODOLOGICAL PATH

A qualitative approach was adopted in data collection, presentation and analysis. The qualitative approach was adopted because the discussion is narrative and descriptive of cases of translanguageing in science and mathematics classrooms. Four secondary schools were used as case study in collecting data making the study adopt a case study design. Two were urban schools in Bulawayo and two were rural schools in Matobo District. A total of eight non-participant lesson observations were conducted. The observations were non-participant because the researchers did not interfere or make any contributions during the lessons but were there physically just to observe how language was used during the lessons. From each of these eight schools, two lesson non-participant observations were conducted, one in mathematics and one in science. Form 3 and Form 4 classes were observed where Form 3 is the 10th year level of schooling and Form 4 the 11th. The researchers targeted double period lessons with each lasting for 70 minutes. The researchers were mainly interested in establishing how communication between the teacher and the learners, and between learners themselves takes place in these bilingual contexts. Cases of translanguageing were observed to be taking place although the teachers and learners seemed not to be aware that they were translanguageing. Shifting from one language to the other was the most dominating strategy more than translanguageing although shifting from one language to the other language was accompanied by translanguageing. After the lesson observations, semi-structured interviews were conducted with each of the eight teachers with the aim of establishing how language is used on a daily basis during mathematics and science lessons. Each semi-structured interview lasted for an average of 30 minutes. The main idea was to inquire how the teachers engage learners in multilingual classrooms.

Data were presented and analysed qualitatively. The presentation of data was done through describing and narrating how language was used during the non-participant observation of lessons. Data from semi-structured interviews with the eight teachers were also presented in a narrative form. Data were analysed through the lenses of dynamic bilingualism as a theory and tracing how translanguageing took place.

As way of adhering to research ethics, the researchers sought clearance from the Ministry of Primary and Secondary Education before going to seek permission from the school heads. The researchers did not directly involve themselves with the learners or interact with them in any way. The researchers also did not

coerce teachers to be allowed to carry out observations in their classrooms and the interviews were done on a voluntary basis with the teachers. The purpose of the study was also fully explained to the teachers who were research participants. The purpose of the presence of the researchers was explained to the learners by their teachers, and not by the researchers since the researchers were not supposed to interact with learners.

THEORETICAL FRAMEWORK

Dynamic bilingualism, a theory that informs the ideas that are advanced in this paper, 'refers to the development of different language practices to varying degrees in order to interact with increasingly multilingual communities and bilinguals along all points of the bilingual continuum' (Garcia & Kleifgen, 2018: 57). Garcia (2011: 144) defines dynamic bilingualism as 'language practices that are multiple and ever adjusting to the multilingual multimodal terrain of the communicative act'. Chumak-Horbatsch (2012: 54) explains that Garcia proposed dynamic bilingualism in response to globalisation and changes in communication technology. Garcia and Kleifgen (2018: 57) explain that dynamic bilingualism is not about adding a second language but is about 'developing complex language practices that encompass several social contexts'. Dynamic bilingualism here should not be confused with Sanchez's (1983: 44) concept of bilingualism, who says that it is typical among people 'on the move socially and geographically'. Sanchez's idea of bilingualism here is that of a person who is moving from place to place assuming different L2s which is not the understanding of dynamic bilingualism in this paper. Garcia and Kleigen (2018: 57) note that 'within a bilingual perspective, languages are not simply perceived as autonomous and separate systems that people 'have', but rather as linguistic and multimodal features of a semiotic meaning-making repertoire from which people select and 'do'. Chumak-Horbatsch (2012: 53) is of the idea that dynamic bilingualism is 'a theory that focuses on languages that speakers use rather than on separate languages they have'. In other words, dynamic bilingualism focuses on natural language competence in a bilingual or multilingual setting without any conscious restriction to L2 mental lexicon of the speaker. This means that an individual who is a dynamic bilingual is one who also translanguages. This theory is used in this paper to deconstruct the idea that language is an isolated, autonomous, and self-contained system in education in a multilingual setting. It is proven here that dynamic bilingualism is an important approach in the teaching of science and mathematics where learners already have their L1 and are also adding the L2 to their learning without relegating the L1 so as to achieve the best results at the end.

The mode of instruction in science and mathematics classroom contexts

The non-participant observations that were conducted showed that translanguaging is now taking place during teaching and learning although the teachers and learners will be unaware that they will be actually translanguaging. There was a significant number of cases where languages would be used separately and interchangeably in the classroom showing that although these research participants are dynamic bilinguals it did not follow that they always translanguage when they engage. However, although the learners' first languages were also used during lessons, the teachers gave contradicting views as to whether the ministry allowed them to use African languages in the teaching of science and mathematics or not. However, two of the teachers who were interviewed from an urban school who also indicated that they are examiners, pointed out that the new curriculum allows teachers to use the learners' L1 where learners did not understand but such use of the learners' L1 should be restricted as is not supposed to be the sole medium of instruction. The curriculum states that English shall be the main medium of instruction although the learners' L1 can also be used as resources (Ministry of Primary and Secondary Education, 2014: 34). The teachers from both urban and rural schools mentioned that whilst they were aware that the Ministry of Primary and Secondary Education did not allow them to use African languages as the sole medium of instruction in the classroom, it was necessary for them to go against the regulation because they know of the positives that come from the use of the learners' L1. One of the teachers from a rural school who teaches science said that

I am not very sure about the position of the ministry in teaching the learners in isiNdebele but the head is very strict on that as he does not want learners to be taught in isiNdebele at all. We sometimes explain to him that this is a rural school and learners have no exposure to English, they don't even understand simple grammatical constructions but the head has always advised us to simplify the language that is used in science because once learners are aware that we also explain in Ndebele they will never at all put an effort to make themselves proficient in the English language.

Five of the eight who were interviewed were also not clear about the position of the ministry regarding the use of the learners' L1 in teaching science and mathematics. However, the general consensus amongst the research participants was that the ministry should come up with a policy in the curriculum that would allow teachers to also use African languages instead of sticking to English language as the sole medium.

During a total of the eight lesson observations which took 70 minutes each, it was observed that learners participated more when isiNdebele, their L1, was used. In most instances the teacher would speak in English and then make explanations or emphasis in isiNdebele. One example that was observed in the science lesson at a rural school was where a teacher was talking about an energy chain:

As you can see at the top we have the sun, followed by vegetation - trees and grass, then grazers and herbivores impala, ondlovu, amadube, lenkonkoni (impala, elephants, zebras and wild beasts), then carnivores right below. So liyabona ukuthi ilanga liqakathekile ngoba yilo eliletha impilo. Yonke lenenergy isukela elangeni kusiya kusehla yikho abadala babengadli inyamazana ezidla inyama ngoba azila kudla ukuqakathekileyo emzimbeni. (So you see that the sun is important in bringing life. All the energy in foods comes from the sun that is the reason why our elders never ate animals that feed on meat because they are not rich in nutrients that are required the body).

What is deduced from this excerpt is that the teacher was not translating what was said in English but would make further clarifications using isiNdebele. Also, there is use of both isiNdebele and English at the same time but a clear message to the learner is still maintained.

In such scenarios where Ndebele was used, many learners raised their hands when questions were asked, but in situations where English only was used only a few hands were raised. In a Form 3 science classroom, where the lesson was on ecosystems in a rural setting, the teacher used English first throughout and then afterwards asked questions in English and only one learner raised the hand and answered correctly in English but had challenges in constructing grammatically correct sentences. The teacher then explained the same concepts of ecosystems using Ndebele and asked questions afterwards mixing Ndebele and English and many hands were raised. This experience demonstrates the importance of shuttling between the teaching of science and mathematics. All the eight science and mathematics teachers who were interviewed concurred that learner participation becomes high when the use of language is not restricted to English only. The general view coming from all the teachers was that the learners' L1 should be used in teaching and learning. All of them were also of the idea that both the learners' L1 and L2 should be used in teaching and not exclusively one or the other. Some of the sentiments that were raised by the teachers were as follows:

Some of the concepts cannot be easily explained in English especially here in rural areas. If you don't use vernacular you cannot meet the set objectives of the lesson.

The other teacher said:

Using Ndebele would make learners understand better. For the teacher to flow together with the learners, use the language that they understand better. It is proper for Ndebele to be used for delivering concepts but teachers should also use English because it is the language that is used for assessment.

Another teacher who is also a mathematics examiner said:

Use of vernacular cannot be ruled out. When solving word problem maths learners lose out when these are given in English. A teacher has to make explanations in English at the same time throwing in vernacular here and there. Where they don't understand then vernacular only can be used but mindful of the fact that they will at the end be assessed in English.

Although translanguaging is an ideal strategy that can be used, these classrooms seem to be using more of code switching. However, it is clear that these learners and teachers are dynamic bilinguals meaning that they can translanguage during the lessons if the idea is made known to them.

The researchers also wanted to find out whether the teachers introduce new concepts in English, then explain in the learners' L1, or they begin with the learners' L1 then explain in English, or they use both languages concurrently, or they use the languages without necessarily looking at the boundaries and the linguistic repertoires of each language. Of the eight teachers who were interviewed, four said that they begin by giving instruction in English and then move on to vernacular when they explain the concept, one science teacher indicated that he begins with vernacular then English, and three said that they mix English and vernacular throughout. However, two of those who said they begin with English indicated that sometimes they mix depending on the nature of the concept being taught. The mixing of languages is evidence of dynamic bilingualism and the subsequent translanguaging process. Gracia (2009) argues that translanguaging has much value for the bilingual learners since they are given an opportunity to use their home language which they understand best. What should be noted here is that all these approaches that teachers use in bringing the learners' home language on board to the teaching of science and mathematics are all important in the sense that what is more vital is to include the learners' L1 which is a valuable resource instead of sticking to their L2 in which they are not even proficient.

Another important dimension that was revealed by the research participants during interviews was the issue of using local resources in teaching and learning of which the learners' L1 was also considered to be one of the resources. The three who demonstrated knowledge of the contents of the science and mathematics curriculum mentioned that over and above language, teachers are supposed to contextualise the contents of the topic to objects and ideas that fall within the physical environment of the learners and which are communicated in their language. One of the mathematics teachers who was interviewed said that the curriculum stipulates that

Locally available resources should be used and the learners' local language is one of those resources. Indigenous knowledge systems should be used together with any other tools that are available in the learners' environment.

Bangura (2014: 12) argues that 'children in Africa should be taught African-centred Mathematics as such an approach would lead to development'. The language of the learner is a key resource that makes concepts being learnt a reality and relevant thereby boosting curiosity and cognitive ability of the learner.

The most striking issue that comes to the minds of many when translanguaging is used as a teaching and learning method is the issue of assessment. This issue was addressed earlier on but it is important to revisit it again here to see what those teaching involved in teaching say about it. The teachers were very clear that assessment is and should be done in English. It was pointed out that the inclusion of learners' L1 during learning does not have negative effects as compared to its exclusion. All the eight teachers who were interviewed concurred that the learners L1 should be included in learning but assessment should be done in English so that learners are not isolated from the rest of the world. One of the teachers said:

It is proper to include vernacular in teaching because it helps learners grasp concepts which they can write in English in the examinations. The ministry is strict on assessment as it stipulates that learners should write their exercises in English. We are allowed to teach in vernacular where learners do not understand but it should not be vernacular throughout. I can tell you that in one year I was using English throughout in teaching maths and the pass rate was very low but in the following year when I also used vernacular students passed very well.

The most important thing for learners is to develop an understanding of the concepts that they will be learning, and that can be achieved through translanguaging. The whole point behind translanguaging is to develop towards the L2, to carry concepts from the L1 to the L2. Therefore, that means that if learning is done through translanguaging then learners are better equipped to present their understanding in the L2 because the L1 would have been used as a resource towards cognitive development.

CONCLUSION

Translanguaging has been shown to be one of the methods of instruction in teaching science and mathematics in bilingual contexts and multilingual contexts of Bulawayo and Matobo in Zimbabwe. However, code switching proved to be the most common method as compared to translanguaging. There was general consensus amongst all teachers of science and mathematics that the learners' L1 should be utilised in teaching as doing so has proved to yield positive results on the part of the learner. In bilingual contexts both languages should be included in learning because they are all valuable resources that aid cognition. Involving the learners' L1 improves participation in the classroom which then helps the teacher to know whether learners have understood the concepts or not. English only silences the learners and leads to lack of improvement in English itself as a language and lack of comprehension of the concepts that are taught through it. The co-existence of ESL (English as a second language) and African languages as L1 should not mean viewing African languages as inferior but as important resources that aid the understanding of concepts. What came to light here was that although the ministry recommends the use of the learners' L1 to a limited extent, it is not clear to the teachers how they should use these African languages together with ESL in science and mathematics classrooms. The use of African languages in the teaching of science and mathematics should not be perceived as the total abandonment of English but as utilising the learners' L1 as valuable resources in teaching and learning.

RECOMMENDATIONS

There is a need for the ministry to come up with a clear strategy as to how the learners' L1 should be applied in the classroom because what is happening now is that each teacher is doing what they think is right. There is need for thorough research that will inform recommendations as to how translanguaging should be applied in the classroom. It was also realised that teachers are not aware what the policy says about the use of African languages in science and mathematics classrooms as they gave contradicting opinions. It is important also for the responsible ministry to conscientise teachers on the position of African languages in classrooms. For assessment to be done in English only is not a problem as learners would have translanguaged between their L1 and ESL and now are in a position to communicate knowledge gained in both their L1 and in ESL.

REFERENCES

Asabere-Ameyaw, A. & Ayelsoma, S.J. (2012) Language proficiency and Science learning. In A. Asabere-Ameyaw & G.J. Sefa Dei (Eds.) *Contemporary issues in African Sciences and Science education*. Rotterdam: Sense Publishers, pp.55-62.

- Babaci-Wilhite, Z. (2016) The use of local languages for effective Science literacy as a human right. In Z. Babaci-Wilhite (Ed.) *Human rights in language and STEM education: Science, technology, engineering and Mathematics*. Rotterdam: Sense Publishers, pp.3-16.
- Bamgbose, A. (1984) The changing role of mother-tongue in education. In A. Bamgbose (Ed.) *Mother-tongue education-The west African experience*. London: Hodder and Stoughton, pp.9-26.
- Bamgbose, A. (2015) African Language Dilemma in African renaissance and development. In O.O. Orié, J.F. Ilori & L.C. Yuka (Eds.) *Current research in African linguistics: Papers in honor of Oladele Awobuluyi*. Newcastle: Cambridge Scholars Publishing, pp.10-26.
- Bangura, A.K. (2014) Domesticating Mathematics in the African mother tongue. *Journal of Pan Africa Studies* 6(7) pp.12-58.
- Bialystok, E. (2001) Metalinguistic aspects of bilingual processing. *Annual Review of Applied Linguistics* 21 pp.169-181.
- Bialystok, E. (2009) Bilingualism: The good, the bad, and the indifferent. *Bilingualism: Language and Cognition* 12(1) pp.3-11.
- Braun, A. & Cline, T. (2014) *Language strategies for trilingual families: Parents' perspectives*. Bristol: Multilingual Matters.
- Brijlall, D. (2008) Collaborative learning in a multilingual class. *Pythagoras* 68 pp.52-61.
- Brock-Utne, B. (1997) The language question in Namibian schools. *International Review of Education* 43(2) pp.241-260.
- Canagarajah, S. (2011) Translanguaging in the classroom: Emerging issues for research and pedagogy. *Applied Linguistics Review* 2 pp.1-28.
- Cenoz, J. (2003) The additive effect of bilingualism on third language acquisition: A review. *The International Journal of Bilingualism* 7(1) pp.77-88.
- Childs, M. (2016) Reflecting on translanguaging in multilingual classrooms: Harnessing the power of poetry and photography. *Educational Research for Social Change* 5(1) pp.22-40.
- Chumak-Horbatsch, R. (2012) *Linguistically appropriate practice: A guide for working with young immigrant children*. Ontario: University of Toronto Press.
- Curtis, S. & Miller, R. (1988) Language and conceptual understanding in Science: A comparison of English and Asian-language-speaking children. *Research in Science and Technological Education* 6(1) pp.61-77.
- Dlodlo, T.S. (1999) Science Nomenclature in Africa: Physics in Nguni. *Journal of Research in Science Teaching* 36(3) pp.321-331.
- Gamede, T. (2005) The biography of 'access' as an expression of human rights in the South African education policies. PhD Thesis. University of Pretoria, South Africa.
- Garcia, O. (2011) *Bilingual education in the 21st Century: A global perspective*. Chichester: Willey-Blackwell.

- Garcia, O. (2016) *What is Translanguaging? Psychology Today* [Online magazine]. <https://www.psychologytoday.com/blog/life-bilingual/201603/what-istranslanguaging> (Accessed 15 March 2019).
- Garcia, O. & Kleifgen, J.A. (2011) Bilingualism for Equity and Excellence in Minority Education: The United States. In K. Van den Branden, P. Van Avermaet & M. Van Houtte (Eds.) *English and excellence in education: Towards maximum learning opportunities for all students*. New York: Routledge, pp.166-189.
- Garcia, O. & Kleifgen, J.A. (2018) *Educating emergent bilinguals: Policies, programs, and practices for English learners*. New York: Teachers College Press.
- Garcia, O. & Wei, L. (2014) *Translanguaging: Language, bilingualism and education*. London: Palgrave Macmillan.
- Government of Zimbabwe. (2014) *Curriculum Framework for Primary and Secondary Education 2015-2022*. Harare: Ministry of Primary and Secondary Education.
- Goral, M. (2015) Multiple languages in the adult brain. In M. Faust (Ed.) *The handbook of the neuropsychology of language*. Oxford: Wiley Blackwell, pp.716-733.
- Grammes, P. & Hu, A. (Eds.) (2014) *Plurilingual education: Policies-practices-language development*. Amsterdam: John Benjamins Publishing Company.
- Heller, M. (2007) Bilingualism as ideology and practice In M. Heller (Ed.) *Bilingualism: A social approach*. London: Palgrave Macmillan, pp.1-24.
- Henning, E. (2012) Learning concepts, language, and literacy in hybrid linguistic codes: The multilingual maze of urban grade 1 classrooms in South Africa *Perspectives in Education* 30(3) pp.69-77.
- Hungwe, V. (2019) Using a translanguaging approach in teaching paraphrasing to enhance reading comprehension in first-year students. *Reading and Writing: Journal of Reading Association of South Africa* 10(1) a216. <https://doi.org/10.4102/rw.v10i1.216>
- IBE-UNESCO. (2017) *Teaching and learning to read in a multilingual context: Ways forward for three Sub-Saharan African Countries (Burkina Faso, Niger, Senegal)*. Geneva: IBE-UNESCO.
- Kibler, A. (2005) *Implementation of educational policies for minority language pupils in England and the United States*. Oxford: Symposium Books.
- Kriel, M. (2003) Approaches to multilingualism in language planning, and identity politics. A critique. *Society in Transition* 34(1) pp.159-177.
- Kotze, E. (2014) The emergence of a favourable policy landscape. In L. Hibbert & C. van der Walt (Eds.) *Multilingual universities in South Africa: Reflecting society in higher education* Bristol: Multilingual Matters, pp.15-26.
- Kovelman, I., Baker, S.A. & Petitto, L.A. (2008) Age of bilingual exposure as a new window into bilingual reading development. *Bilingualism* 11(2) pp.203-223.
- Lublinter, S. & Grisham, D.L. (2017) *Translanguaging: The key to comprehension for Spanish-speaking students and their peers*. Lanham: Rowman & Littlefield.

- MacWhinney, B. & O'Grady, W. (Eds.) (2015) *The Handbook of Language Emergence*. Oxford: John Wiley and Sons.
- Makalela, L. (2015) Translanguaging as a vehicle for epistemic access: Cases for reading comprehension and multilingual interactions. *Per Linguam: A Journal for Language Learning* 31(1) pp.15-29.
- Makoe, P. (2018) Translanguaging in a monoglot context: Children mobilising and (re)positioning their multilingual repertoires as resources for learning. In G. Mazzaferro (Ed.) *Translanguaging as Everyday Practice*. Cham: Springer, pp.13-30.
- Mbirimi-Hungwe, V. & Hungwe, T. (2018) Translanguaging for epistemic access to computer science concepts: A call for change. *Per Linguam: A Journal for Language Learning* 34(2) pp.97-111.
- Mwinda, N. & van der Walt, C. (2015) From English-only to translanguaging strategies: Exploring possibilities *Per Linguam: A Journal for Language Learning* 31(3) pp.100-118.
- Ngcobo, S. (2018) Translanguaging in summarising skills: The need to develop biliterate students. *Journal for Language Teaching* 52(2) pp.26-48.
- Ngcobo, S., Ndaba, N., Nyangiwe, B., Mpungose, N. & Jamal, R. (2016) Translanguaging as an approach to address language inequity in South African higher education: summary writing skills development. *Critical Studies in Teaching and Learning* 4(2) pp.10-27.
- Osborn, D. (2010) *African languages in a digital age: challenges and opportunities for indigenous language computing*. Cape Town: HSRC Press.
- Or, I.G. & Shohany, E. (2017) English education policy in Israel. In R. Kirkpatrick (Ed.) *English language education policy in the Middle East and North Africa*. Cham: Springer, pp.63-72.
- Otheguy, R., Garcia, O. & Reid, W. (2015) Clarifying translanguaging and deconstructing named languages: A perspective from linguistics. *Applied Linguistics Review* 6(3) pp.281-307.
- Ranaweera, A.M. (1976) Sri Lanka: Science teaching in the national languages. *Prospects* 6(3) pp.416-423.
- Rao, X. (2018) *University English for academic purposes in China: A phenomenological interview study*. Shanghai: Springer.
- Rodriguez, D., Carrasquillo, A. & Lee, K.S. (2014) *The bilingual advantage: Promoting academic development, biliteracy, and native language in the classroom*. New York: Teachers College Press.
- Rugemalira J.M., Rubagumya, C.M., Kapinga, M.K., Lwatima, A.F. & Tetlow, J.G. (1990) Reflections on recent developments in language planning in Tanzania. In C.M. Rubagumya (Ed.) *Language in education in Africa: A Tanzanian perspective*. Bristol: Multilingual Matters Ltd, pp.25-35.
- Sanchez, R. (1983) *Chicano Discourse: Socio-historic perspectives*. Texas: Arte Publico Press.
- Saville-Troike, M. (2006) *Introducing second language acquisition*. Cambridge: Cambridge University Press.

- Sharwood Smith, M. (2017) *Introducing Language and Cognition: A Map of the Mind*. Cambridge: Cambridge University Press.
- Sutman, F. (1993) Teaching Science effectively to limited English proficient students. *ERIC/CUE Digest* 87 pp.1-12.
- Torres, H.N. & Zeidler, D.I. (2002) The effects of English language proficiency and scientific reasoning skills on the acquisition of Science content knowledge by Hispanic English language speaking students. *Electronic Journal of Science Education* 6(3) <http://www2.sjsu.edu/elementaryed/cjlt/> (Accessed 13 March 2019).
- Van der Walt, C. (2016) Reconsidering the role of language-in-education policies in multilingual higher education contexts. *Stellenbosch Papers in Linguistics Plus* 49 pp.85-104.
- Venter, J. & Niekerk, D.R. (2018) A contact-based practical approach to STEM projects in South Africa. *The Independent Journal of Teaching and Learning* 13(2) pp.113-127.
- Webb, V.N. & Du Plessis, T. (2016) *The politics of language in South Africa*. Pretoria: Van Schaik Publishers.
- Weddirage, L.P. (2009) Science Education and English medium: The Sri Lankan experience. In B Brock-Utne & G Garbo (Eds), *Language is power: The implications of language for peace and development*. Dar es Salam: Mkuki na Nyota Publishers Ltd, pp.260-266.
- Wildsmith-Cromarty, R. (2018) Building a knowledge base for language teaching through translanguaging. *Journal for Language Teaching* 52(2) pp.100-120.