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Impact of Code-Switching in Learning and Teaching of Mathematics: A South African Perspective

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ABSTRACT

This paper examines the impact of code-switching on the learning and teaching of Mathematics. The research was conducted in selected primary schools in O.R. Tambo Inland Education District in the Eastern Cape Province of South Africa. The researchers adopted a case-study research design. Four focus groups, each represented by six members, were used during data collection through semi-structured focus group interviews conducted face-to-face. Two groups were from rural-based schools and two groups were selected from urban-based schools. Purposive sampling was used to select participants with a focus on Mathematics grade six (6) teachers. The results show that code-switching is inevitable in teaching learners whose first or mother tongue is not English language when English language is used as the language of learning and teaching (LoLT). Secondly, code-switching is a useful and effective learning and teaching strategy for grade six (6) learners in Mathematics. The study recommends that teacher trainees should be introduced to a minimum of three (3) languages during their training in the teaching profession. In addition to making code-switching acceptable and official, Mathematics teachers should use it as a learning and teaching method or strategy.

Keywords: *Bilingualism, Code-switching, Learner Competence, Multi-cultural Classrooms*

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INTRODUCTION

Language use has dynamic facets which include standard semantics of the language, dynamic information flow and values that contain low and high confidentiality information,[1] some of which may not be easily understood by second-language speakers necessitating the need for code-switching. Linguists have invested greatly in reasons, types and functions of code-switching and code-mixing.[2] Therefore, this paper looks at the inter-relationship between learner competencies and code-switching in the teaching of Mathematics.

[1] Thomas H Austin, Tommy Schmitz, and Cormac Flanagan, "Multiple Facets for Dynamic Information Flow with Exceptions," *ACM Transactions on Programming Languages and Systems (TOPLAS)* 39, no. 3 (2017): 1–56.
[2] Mahmoud Itmeizeh, Salem Saleh Ibnian, and Malak Sha'fout, "Code-Switching among Teachers of English Language Service Courses at PAUC: Types and Functions," *Asian Journal of Humanities and Social Studies* 5, no. 4 (2017).

The study reviews the literature on international and South African contexts to gain an understanding of how broad the impact of code-switching is on teaching Mathematics. A study conducted in California found that Latina English Language Learners (ELLs) in mathematical classes have the dual responsibility of understanding mathematical content while simultaneously acquiring disciplinary language in English.[3] They argue that lack of understanding of the role of English proficiency in instruction and assessment results in English Language Learners' (ELLs) lower mathematics achievement, owing to the absence of linguistic support strategies in the classroom.

Code-switching has a great bearing on student learning in Africa. This is because most African states use many languages and as per ethnologue, there are more than 500 languages spoken in Nigeria and 400 languages are spoken from coastal Senegal to Benin, Bukina Faso, Mali and Niger.[4] Too many languages in a country imply that learners cannot be fluent in all such languages. Multilingual learners of Mathematics show interpretation problems in the language of instruction, exacerbated by cultural misunderstanding and barriers.[5] The authors' intention in this research was to focus on the process of code-switching in mathematics teaching. Amongst other factors, researchers looked at learner understanding of mathematical language and teacher code-switching.

The researchers support the view that code-switching is used for distinct reasons, such as a communicative function, to fill in a lexical gap, for emphatic statement among other uses.[6]

People code switch in order to fill in lexical gaps, express identity, for solidarity, economy, aesthetic effects, direct quotations and interjections.[7] In light of these statements, authors looked at code-switching as a support mechanism for learners at the General Education and Training (GET) level focusing on grade six (6) Mathematics teachers, the level where learners ought to gain basic mathematical skills before proceeding to higher-grade levels. In addressing the objectives of the study, this research addressed the following question: What are the effects of code-switching on the learning and teaching of Mathematics?

LITERATURE REVIEW

Definition of Code-Switching

Key in this study is classroom code-switching which is defined varyingly. Classroom code-switching refers to the alternating use of more than one linguistic code in the classroom by any of the classroom participants; teacher, students and teacher aide.[8] Code-switching is a structurally constrained combination of two (or more) languages and can take place either in a single sentence ("intrasentential") or from one sentence to another within a conversation ("intersentential").[9]

[3] Eduardo Mosqueda et al., "Preparing Middle School Students for the Transition to High School Mathematics: Assessing Latinas/Os' Mathematical Understanding, Academic Language and English Proficiency," *Bilingual Review/Revista Bilingüe* 33, no. 2 (2016).

[4] Evershed K Amuzu and John Victor Singler, "Codeswitching in West Africa," *International Journal of Bilingualism* (Sage Publications Sage UK: London, England, 2014): 329-345.

[5] Núria Planas, "One Speaker, Two Languages: Learning Opportunities in the Mathematics Classroom," *Educational Studies in Mathematics* 87, no. 1 (2014): 51–66.

[6] Vanessa Elias, Sean McKinnon, and Ángel Milla-Muñoz, "The Effects of Code-Switching and Lexical Stress on Vowel Quality and Duration of Heritage Speakers of Spanish," *Languages* 2, no. 4 (December 21, 2017): 29, https://doi.org/10.3390/languages2040029.

[7] Elias, McKinnon, and Milla-Muñoz, "The Effects of Code-Switching and Lexical Stress on Vowel Quality and Duration of Heritage Speakers of Spanish," 29.

[8] Angel Lin, "Classroom Code-Switching: Three Decades of Research," *Applied Linguistics Review* 4, no. 1 (2013): 195–218.

[9] Fotini Anastassiou, "Factors Associated with the Code Mixing and Code Switching of Multilingual Children: An Overview," *International Journal of Linguistics, Literature and Culture* 4, no. 3 (2017): 13–26.

Models of Code-Switching

The recent study identifies three main theories that are language rooted as code-switching models.[10] The first is the linear order constraint model pioneered by Poplack,[11] the second model is the linear order non-constraint model by Chomsky,[12] and the third is the Matrix Language Frame (MLF) model by Myers-Scotton.[13] All these models have different perspectives in trying to elaborate on code-switching.

The linear order constraint model is based on the intra-Sentential and inter-sentential modes of code-switching. Writers explain the two modes: *Intra-sentential* switching is when switching happens within the sentence and *inter-sentential* is the one that takes place at the sentence boundary.[14] The linear order model notes the use of sentences or syntagmas as sequential parts while they belong to different languages thus creating "equivalence constraint" at a syntax language level.[15]

The Matrix Language Frame (MLF) model is more focused on the psycholinguistic theories of speech production. Matrix language is usually the first language of a speaker, so it tends to be dominant over embedded language.[16] The proponent of the MLF model further claims that the base support of MLF is the Uniform Structure Principle (USP).[17]

The USP is there to clarify and strengthen the MLF through its clear phrase, "no chaos allowed". MLF operates under three principles which are, i). participating languages do not play equal roles in the bilingual clause, ii). in bilingual constituents within this clause, not all morpheme types can come equally from the Matrix Language (ML) and Embedded language (EL) and iii). that the system morpheme principles limit the occurrence of system morphemes that build the clausal structure of the matrix language.[18]

Another popular theory of code-switching within sociolinguistics is the Markedness model. According to writers Hasan and Akhand,[19] the Markedness model was developed by Myers-Scotton.[20] This model stresses that language users are rational and choose a language that marks their rights and obligations relative to others in the conversation setting. When there is no clear marked choice, code-switching is used to explore possible choices.[21]

In closing this concept, the authors believe that more positive perceptions of code-switching are developed. It should not be seen as a 'crime' to code-switch because code-switching is a product of language diversity in a society. Fachriyah avers that code-mixing is part of English development from its Germanic origins that includes words from Latin, French, Arabic, Tamil, Malay and so many other languages.[22]

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[10] E.A. Krasina and Mahmoud Mustafa Jabballa, "Code Switching: State-Of-The Art.," *RUDN Journal of Language Studies, Semiotics and Semantics* 9, no. 2 (2018): 403–15, https://doi.org/10.22363/2313-2299-2018-9-2-403-415.
[11] Shana Poplack, "Dialect Acquisition among Puerto Rican Bilinguals," *Language in Society* 7, no. 1 (1978): 89–103.
[12] Noam Chomsky, Ángel J. Gallego, and Dennis Ott, "La Gramàtica Generativa i La Facultat Del Llenguatge: Descobriments, Preguntes i Desafiaments," *Catalan Journal of Linguistics*, December 23, 2019, 229, https://doi.org/10.5565/rev/catjl.288.
[13] Carol Myers-Scotton and Janice Jake, *A Universal Model of Code-Switching and Bilingual Language Processing and Production.* (Cambridge University Press, 2009), 336-.
[14] Anastassiou, "Factors Associated with the Code Mixing and Code Switching of Multilingual Children: An Overview."
[15] Krasina and Jabballa, "Code Switching: State-Of-The Art."
[16] Anastassiou, "Factors Associated with the Code Mixing and Code Switching of Multilingual Children: An Overview."
[17] Carol Myers-Scotton, *Dueling Languages: Grammatical Structure in Codeswitching* (Oxford: Claredon Press, 1993).
[18] Myers-Scotton and Jake, *A Universal Model of Code-Switching and Bilingual Language Processing and Production.*
[19] Md Hasan and Mohd Akhand, "Reviewing the Challenges and Opportunities Presented by Code Switching and Mixing in Bangla.," *Journal of Education and Practice* 6, no. 1 (2015): 103–9.
[20] Myers-Scotton, *Dueling Languages: Grammatical Structure in Codeswitching*.
[21] Hasan and Akhand, "Reviewing the Challenges and Opportunities Presented by Code Switching and Mixing in Bangla."
[22] Eva Fachriyah, "The Functions of Code Switching in an English Language Classroom," *Studies in English Language and Education* 4, no. 2 (2017): 148–56.

Code-Switching and Learner Competence

Many writers and linguists agree that the code-switching debate is still to take years before the extent of its positive or negative effects on learner performance are encoded.[23] Literature from various countries shows that code-switching is universally practised. In Spain, Planas found that, regarding Spanish and Catalan languages used in the teaching of Mathematics, there were challenges found to be unmanageable for the learners as they have English as their second language (L2).[24] With Mathematics presented in English, code-switching was a solution. Such areas of concern were Mathematical vocabulary, inventions of additional terms and word-for-word translation.

In Botswana, Mokibelo indicated that code-switching from Setswana to English or English to Setswana in this study was used where it was not necessary with ethnic minority learners, where the learners did not understand the two target languages used, especially in rural primary schools.[25] In synopsis, the view is somehow contrary to other findings that argue for the role of code-switching as an effective strategy.[26] For example, researchers aver that code-switching is a meaningful classroom interaction strategy that can contribute to the success of the lesson.[27]

In Kenya, Muyuku states that code-switching is prevalent in everyday conversations, particularly in daily newspapers.[28] This may be so, as Kenya has almost 68 spoken ethnic mother-tongue languages. It is within these premises that the authors conclude that code-switching and code-mixing have come to be daily phenomena. This is caused by the fact that many societies are multilingual and trilingual.[29]

Code-Switching and Policy Framework in South Africa

Language policy in South Africa has been framed to address the imbalances of the past. The Constitution of the Republic of South Africa guarantees rights to all citizens to use their language of choice. Sections 6, 9, 29, 30, 31 and 35 of the Constitution describe language rights in the public domain. Section 6 (1) affords official status to eleven (11) languages of South Africa; nine (9) of eleven (11) languages are indigenous African languages, the other two being English and Afrikaans.[30]

The National Language Policy framework (NLPF) is the first document that aims at enforcing the use of multi-languages in the country. Ngcobo opines that NLPF is the major document that binds all government structures to a multi-lingual mode of operation.[31] The Pan South African Languages Board (PANSALB) has played its part in trying to intervene in the language problem generally.

Wright has observed that although South Africa has a highly regarded Language in Education Policy (LiEP) which is intertwined with the country's national language policy (NLP), the two do not work effectively.[32] Wright further explains that this language problem is setting the country back to a neo-colonialist state that makes the use of the mother tongue in education an unviable practice. The

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[23] Sister L. Songxaba, Adriaan Coetzer, and Jacob M. M. Molepo, "Perceptions of Teachers on Creating Space for Code Switching as a Teaching Strategy in Second Language Teaching in the Eastern Cape Province, South Africa," *Reading & Writing* 8, no. 1 (December 8, 2017), https://doi.org/10.4102/rw.v8i1.141.

[24] Planas, "One Speaker, Two Languages: Learning Opportunities in the Mathematics Classroom."

[25] E Mokibelo, "Code-Switching: A Strategy for Teaching and Learning or a Problem in Botswana," *Research & Reviews: Journal of Educational Studies* 2, no. 4 (2016):30-38.

[26] Songxaba, Coetzer, and Molepo, "Perceptions of Teachers on Creating Space for Code Switching as a Teaching Strategy in Second Language Teaching in the Eastern Cape Province, South Africa."

[27] Khairul Firhan Yusob, Asyura Abd Nassir, and Nor Habibah Tarmuji, "Code-Switching in Mathematics Classroom: Relationship between Students' Attention and Attitude and Their Learning Success," *LSP International Journal* 5, no. 1 (2018).

[28] J.A. Muyuku, "Code Switching in Newspaper Discourse: A Case of Crazy Monday Articles in the Standard News Paper," *Baraton Interdisciplinary Research Journal* 1, no. 7 (2017): 1–8.

[29] Muyuku, "Code Switching in Newspaper Discourse: A Case of Crazy Monday Articles in the Standard News Paper."

[30] Dumisile Mkhize and Robert Balfour, "Language Rights in Education in South Africa," *South African Journal of Higher Education* 31, no. 6 (2017): 133–50.

[31] Mtholeni N Ngcobo, "Language Planning, Policy and Implementation in South Africa," *Glosa, An Ambilingual Interdisciplinary Journal* , 2007, 156–69.

[32] Laurence Wright, *South Africa's Education Crisis: Views from the Eastern Cape* (NISC, 2012).

sociolinguistics in South Africa's linguistic ecology support the removal of a colonial or neo-colonial language model.

The authors' observation from the above argument is that the policy framework does not make any mention of code-switching; however, researchers' understanding is that it is embedded in the concept of multilingualism. It is a common norm that countries use one or two languages as official languages regardless of the number of languages spoken. Stoop concurs to say that most countries and their societies are multi-lingual, but their education systems operate in only one or two languages.[33] In the South African context, learner competence is significantly attached to code-switching. Naude and Meier comment that there is a mismatch between learners and teachers who do not share the same linguistic background.[34]

Essien argues that most teachers in South Africa teach in multicultural classrooms but teacher education research in mathematics education has not, thus far, focused on multilingual mathematics education.[35] Songxaba, Coetzer and Molepo state that the acceptance of code-switching in South Africa is still problematic as it is not explicitly catered for in any curriculum-prescribed language teaching and learning methods.[36]

Despite all the efforts undertaken by the Department of Basic Education to support learners for better performance in Mathematics, learners still perform poorly in Mathematics. There seems to be a dearth of research on the issue of language and the teaching of Mathematics in primary schools in Africa. Findings from Essien's study reveal that there was a lack of longitudinal studies that investigated the impact of language, particularly code-switching on the teaching and learning of Mathematics and that there were few studies conducted on how teachers were and should be trained to teach Mathematics in the early grades.[37]

THEORETICAL FRAMEWORK

This study adopted social constructivism as the most relevant theory to address the phenomenon of code-switching. Constructivism is defined as a theory that equates learning with creating meaning from experience,[38] where learners build personal interpretations of the world based on individual experiences and interactions.[39] Creswell asserts that social constructivism believes that individuals seek an understanding of the world in which they live and work, and they develop subjective meanings of their experiences.[40] Constructivist theory is premised on learner-centred pedagogy and promote learners' active participation.[41] In social constructivism, language is conceived as a meaning-making tool.[42]

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[33] Chrizell Stoop, "Children's Rights to Mother-Tongue Education in a Multilingual World: A Comparative Analysis between South Africa and Germany," *Potchefstroom Electronic Law Journal/Potchefstroomse Elektroniese Regsblad* 20, no. 1 (2017).

[34] Mariana Naudé, Corinne Meier, and Linda Bosman, *Teaching Foundation Phase Mathematics: A Guide for South African Students and Teachers* (Van Schaik Publishers, 2014).

[35] Anthony A Essien, "What Teacher Educators Consider as Best Practices in Preparing Pre-Service Teachers for Teaching Mathematics in Multilingual Classrooms," *Perspectives in Education* 28, no. 4 (2010): 32–42.

[36] Songxaba, Coetzer, and Molepo, "Perceptions of Teachers on Creating Space for Code Switching as a Teaching Strategy in Second Language Teaching in the Eastern Cape Province, South Africa."

[37] Essien, "What Teacher Educators Consider as Best Practices in Preparing Pre-Service Teachers for Teaching Mathematics in Multilingual Classrooms."

[38] Anne K Bednar et al., "Theory into Practice: How Do We Link?," in *Constructivism and the Technology of Instruction* (Routledge, 2013), 17–34.

[39] Peggy A Ertmer and Timothy J Newby, "Behaviorism, Cognitivism, Constructivism: Comparing Critical Features from an Instructional Design Perspective," *Performance Improvement Quarterly* 6, no. 4 (1993): 50–72.

[40] John Creswell, *Research Design: Qualitative, Quantitative and Mixed Methods Approaches* (California: Sage Publications Ltd, 2014).

[41] Rajendra Kumar Shah, "Effective Constructivist Teaching Learning in the Classroom," *Shah, RK (2019). Effective Constructivist Teaching Learning in the Classroom. Shanlax International Journal of Education* 7, no. 4 (2019): 1–13.

[42] Lev Semenovich Vygotsky and Michael Cole, *Mind in Society: Development of Higher Psychological Processes* (Harvard university press, 1978); Lev S Vygotsky, "Thinking and Speech," *The Collected Works of LS Vygotsky* 1 (1987): 39–285.

METHODOLOGY

This study is premised on the qualitative research approach. Beins and McCarthy define qualitative research as an investigation where data do not consist of numerical information, but rather of narrative or textual information, often in the natural setting. [43] The target population from which the sample was selected are grade 6 Mathematics teachers in the Qumbu Satellite primary schools. Johnson and Christensen define population as a set of all elements of interest to the researcher.[44]

Population for this study consisted of two hundred and thirty-five (235) grade six (6) mathematics teachers. A sample of 24 teachers was used. A sample is a portion or a subset of a larger group called population.[45] Multi-stage purposive sampling was used to select the teachers, where first the purpose was to select only grade 6 teachers as they were the focus of the study. [46] The second purpose was to get insights from rural and urban teachers separately as distinct groups and therefore teachers were classified into urban and rural based, followed by simple random sampling from each of two the categories.

Research methodology literature shows that the experience of most qualitative researchers conducting an interview-based study with clearly specified research questions is that new information is generated after interviewing 20 people or so belonging to one homogenous group.[47] In the same vein, other studies conclude that a sample size of between ten (10)) and thirteen (13) may be sufficient for interview studies designed to explore common experiences in a relatively homogeneous sample.[48]

Four focus groups of six members in each were formed for interview purposes. McGrath, Palmgren and Liljedahl assert that interviews afford researchers the opportunity to explore, in an in-depth manner, matters that are unique to the experiences of the interviews and they give an insight into how different phenomena are experienced.[49] Each focus group interview session took approximately two hours. A common time when all participants from the different schools could be off duty and therefore be available was negotiated with each focus group. To observe ethical principles, informed consent was obtained from all participants; permission was sought from the education authorities and school principals and ethical clearance was obtained from the university where the researchers are affiliated. For confidentiality, all participants were given pseudonyms as agreed before the interviews. Triangulation of the data from the different focus groups served as a quality measure in addition to member checking of the interview transcriptions.

RESULTS

Researchers have used tables with clips indicating participants' comments on various questions. The views from two categories of rural schools (RSs) and township schools (TSs) are put together. Each participant is represented by a code (See table 1 below). Tables 2 to 6 represent participants' views. Five themes are derived from the questions given to the participants.

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[43] Bernard C. Beins and Maureen A. McCarthy, *Research Methods and Statistics in Psychology* (Cambridge University Press, 2018).

[44] Burke Johnson and Larry B. Christensen, *Educational Research : Quantitative, Qualitative, and Mixed Approaches* (London: Sage Publications Ltd, 2008).

[45] Tim May, *Social Research: Issues, Methods and Process* (New York: McGraw Hill Open, 2011).

[46] Julius Omona, "Sampling in Qualitative Research: Improving the Quality of Research Outcomes in Higher Education," *Makerere Journal of Higher Education* 4, no. 2 (2013): 169–85.

[47] Judith Green and Nicki Thorogood, *Qualitative Methods for Health Research* (London: Sage Publications Ltd, 2018).

[48] Greg Guest, Arwen Bunce, and Laura Johnson, "How Many Interviews Are Enough? An Experiment with Data Saturation and Variability," *Field Methods* 18, no. 1 (2006): 59–82.

[49] Cormac McGrath, Per J. Palmgren, and Matilda Liljedahl, "Twelve Tips for Conducting Qualitative Research Interviews," *Medical Teacher* 41, no. 9 (September 2, 2019): 1002–6, https://doi.org/10.1080/0142159X.2018.1497149.

Table 1: Participants with their identifying codes

Participants from Township Schools (TSs)	Codes next to their names	Participants from Rural Schools (RSs)	Codes next to their names
Viwe	(A1)	Likho	(C1)
Njongo	(A2)	Tembela	(C2)
Hlehle	(A3)	Nako	(C3)
Bongie	(A4)	Khwezi	(C4)
Luyanda	(A5)	Bhuzubhuzu	(C5)
Mamie	(A6)	Dalby	(C6)
Qaqa	(B1)	Lizo	(D1)
Lima	(B2)	Yolo	(D2)
Njimba	(B3)	Sanele	(D3)
Nozie	(B4)	Sethu	(D4)
Zesipho	(B5)	Kani	(D5)
Ntsethe	(B6)	Mendu	(D6)

Theme 1: Impact of Learner Language Competence on the Learning and Teaching of Mathematics

This study found that Language has an impact on learner progress and teacher pacing during the learning and teaching process in Mathematics. Learner understanding is a priority in every learning and teaching practice. The amount of work to be covered by a teacher is largely dependent on the learner understanding of the language used. Code-switching, therefore, becomes an avenue to increase pace by using a language that learners easily understand. Four teachers commented in table 2 below.

Table 2: What impact does learner language competence have on learning and teaching of Mathematics?

Focus Group	Clips
TSs	*It is when you start assessing may be orally during the lesson you would realise that you are galloping alone leaving learners behind. It is at this stage that an experienced teacher would obviously do code-switching to ensure that learners do understand.*
RSs	*As teachers, we are expected to cover a prescribed amount of work per term but unfortunately, understanding is delayed by the learner's poor language competence.*
RSs	*In some cases, rural school-based learners struggle to understand a sentence, let alone to construct one.*
TSs	*To cope with time constraints we resort to code-switching*.

Theme 2: The impact of Code-switching on understanding Mathematics concepts

The study institutes that concepts can only be understood through knowing the language used in Mathematics and being more practical. Therefore, Code-switching is an unavoidable practice when teaching Mathematics concepts. Participants concurred in table 3 below:

Table 3: What is the impact of code-switching in learning Mathematical Concepts?

Focus Group	Clips
TSs	*A failure to emphasise when giving rules and introducing of a new concept would lead to poor or no understanding on the part of learners. When a Mathematical principle is introduced the mother tongue is always necessary to make a better explanation.*

TSs	*In most cases as teachers we code-switch concepts. Language use tends to be a problem in teaching concepts like problem-solving e.g. a learner may be given a statement:* *A farmer planted 45 trees last week and 50 trees this week, how many trees has the farmer planted?* *The learner is expected to use the operation sign which is addition, but one learner may be challenged by failure to understand instructions and the sign to use. Therefore, as a teacher, one will have to give a clue where one says add (dibanisa – in IsiXhosa) trees for last week and those for this week and get the total".*
TSs	*One needs to ensure code-switching for Mathematical principles like subtraction (thabatha – in IsiXhosa), division (hlulahlula – in IsiXhosa) and multiplication (phindaphinda – in IsiXhosa).*
TSs	*With grade six (6) learners, general concepts like fractions, percentages, time zones, and the general rules in numeric and geometric patterns, division and multiplication, all pose a challenge to learners. Therefore, we are compelled to code-switch in our presentation*.
RSs	*One of the topics that need a lot of code-switching is 3 Dimensional shapes where one has to explain edges and vertex, pyramids, 3d objects, bases, sides and so on.*

Theme 3: Code-switching during rule or principle setting for Mathematics

The research found that it was important to code-switch to ensure learners do not miss important mathematical steps. Findings indicate that it is difficult to understand mathematical concepts and rules without resorting to code-switching. The following table, table 4, gives some of the responses from participants.

Table 4: What is the impact of code-switching in setting Mathematics Principles?

Focus Group	Clips
TSs	*Code-switching is indispensable for rule setting in Mathematics. All problem-solving Mathematical principles like addition, subtraction division and multiplication need code-switching for a better understanding*
TSs	*When introducing a new concept, code-switching is a 'must' practice. Some of the methodologies that were used in the past are not popular nowadays, for example, brackets of division multiplication and subtraction (BODMAS) is not always applicable and the issue of language would be key in setting such principles. Most unfortunately, code-switching would always be necessary when introducing any principles*
TSs	*Mathematics is 'step bound' and that means it is rule based. Teaching methodology and language are key in teaching certain concepts and when working with more than 2-digit numbers.*
RSs	*Probability is another problem in Mathematics. Learners only understand probability using concrete objects that are scarce and some older learners refuse to use easily accessible objects. Key probability concepts like likely or unlikely, possible or impossible do not make sense to learners. We as teachers always recommend probability number line as the best method to assist learners.* For example, *0 25% 50% 75% 100%* *0 ¼ ½ ¾ 1* *"In the above number line,*

	¼ means it is unlikely to happen (fewer chances) 25 per cent of chances, *½ states that there is a 50 per cent of a chance to happen,* *¾ means high chances to happen at 75 per cent and* *1 means it is possible or is going to happen chances are almost 100 per cent. All such key probability terms needed a profound understanding of language.*

Theme 4: Impact of code-switching during assessment

This study noted that assessment is influenced by language in the teaching of Mathematics. Code-switching is playing an important role in learner performance during assessment. Participants indicate that learners sometimes do not understand the instructions given on the examination papers. To mitigate this and ensure learners understand questions, code-switching becomes the solution. Table 5 below gives some participants' comments.

Table 5: Comments on the Impact of Code-switching on Assessment

Focus Group	Clips
RSs	*Failure to understand questions might lead to complete failure to respond to the question. In most cases, learners perform well only when the questions have been explained to them.*
TSs	*In the process of explaining, code-switching becomes necessary to ensure understanding. For example, the concept of 'word problem' needs a lot of code-switching for better understanding during an assessment. Consider this scenario in the form of a statement:* "One box of ceramic tiles costs R89.99; how much will five boxes of ceramic tiles cost? " *In the above question, the learner must read with understanding and know which mathematical operation to use.*
TSs	*Understanding language has two key roles to play in the above, to interpret the statement and to decide on the operation to use. The learner is expected to understand that to get the answer he or she must use multiplication operation (R89.99 x 5 = R449.99)*
TSs	*Schools considered English as (LoLT) and therefore, educators were barred from applying code-switching, particularly in the examinations. However, knowing your learners one may secretly talk to individual learners who are known to be having a barrier in English.*
TSs	*As teachers, we know if a learner has a problem and we will provide an opportunity for the subject teachers to visit in order to interact with such learners in a smart way that will not be detected by other learners or management.*
TSs	*Here we are, we were taught in a home language most of the time and we managed to perform. Some of our colleagues are having advanced professions; others are medical doctors, lawyers, and engineers yet are from schools like ours.*
RSs	*The challenge of language would be severely felt by learners when they deal with assessment. Starting from being invigilated by a non-Mathematics specialist who probably knows nothing about Mathematics and cannot explain anything.*

Theme 5: Code-switching is ideal to finish annual teaching plans (ATPs)

This research indicates that completion of ATPs is hard to do without code-switching. It is perilous to both finish the syllabus and do effective learning and teaching without code-switching. Finishing ATP is greatly dependent on learner understanding and on their pace. To help learners who cannot cope due to language (English in particular) problem, code-switching is used. Here are the participants' views (table 6) on the issue of ATPs.

Table 6: Participants' comments on code-switching and completion of ATPs

Focus Group	Clips
TSs	*Learners suffered greatly during an assessment. They are slow learners and the transition process is a challenge, no individual attention and ATPs are not completed.*
RSs	*Mathematics then is about rules and such rules need to be explained, it is in this context that teachers see themselves forced to code-switch in order to counter-act time constraint to complete ATPs.*
TSs	*I may argue that code-switching is key to teaching Mathematics to bilingual learners. To finish ATP we ought to code-switch.*
TSs	*Subject principles should be presented in a familiar or home language where possible to learners. Lesson presentation should be supported by other strategies like LATIS and the use of clue boards in order to bring understanding to learners. All these need code-switching for better understanding.*

DISCUSSION

The results show that the Language of Learning and Teaching (LoLT) has an impact on learner progress and teacher pacing during the learning and teaching process. The amount of work to be covered by a teacher cannot be divorced from the language used in learning. The findings are corroborated in the literature. Research has shown that children's first language or mother tongue is the optimal language for literacy and learning throughout primary school.[50] In the same vein, Bilgin, in a study conducted in Turkey, recommends that students should be allowed to use their home language until they feel comfortable using only a second language.[51] Meaning making, as social constructivism shows, happens through language.[52]

In any subject, language terminology is critical. Mathematics, like all other subjects, has its own concepts that are peculiar to it and code-switching helps understand these concepts. It can be concluded from the data that code-switching is essential to ensure learners understand the concepts. The intention is to ensure that learners grasp the initial content to progress well. In this regard, researchers note that Mathematics uses English terminologies that are not understood by many learners and it is in this context that CS becomes imperative for learners to understand.[53] Mosqueda further argues that the presence of abstract mathematical concepts, mathematical symbols and notations, and unfamiliar ways of using academic language for mathematical reasoning, present issues for English second language speakers, unless these learning challenges are addressed by teachers through code-switching.[54]

In addition, with regard to the theoretical framework of this study, De Sanchez, Gabriel, Anderson and Turnbull aver that socio-constructivist and socio-cultural theories propose that language acquires meaning in context and that language and context are inseparable.[55] It is the researchers' considered view therefore that since concepts depend on language understanding for their application, for learners whose mother tongue is not English, code-switching becomes obligatory for such learners to understand.

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[50] Rockie Sibanda, "Mother-Tongue Education in a Multilingual Township: Possibilities for Recognising Lok'shin Lingua in South Africa," *Reading & Writing* 10, no. 1 (August 29, 2019), https://doi.org/10.4102/rw.v10i1.225.
[51] Sezen Seymen Bilgin, "Code Switching in English Language Teaching (ELT) Teaching Practice in Turkey: Student Teacher Practices, Beliefs and Identity.," *Educational Research and Reviews* 11, no. 8 (2016): 686–702.
[52] Vygotsky and Cole, *Mind in Society: Development of Higher Psychological Processes*.
[53] Edward Nkonde et al., "Evaluating the Impact of Teaching and Learning of Mathematics and Science Using Local Language (Language of Play) in Primary Schools in Muchinga Province, Zambia, a Case of Chinsali District," *American Journal of Educational Research* 6, no. 8 (2018): 1153–63.
[54] Mosqueda et al., "Preparing Middle School Students for the Transition to High School Mathematics: Assessing Latinas/Os' Mathematical Understanding, Academic Language and English Proficiency."
[55] Gabriela Arias de Sanchez et al., "Code-Switching Explorations in Teaching Early Number Sense," *Education Sciences* 8, no. 1 (2018): 2-14.

As the participants indicated, it seems difficult to effectively put across to learners' mathematical concepts and rules without resorting to code-switching. This then forces teachers to use a language that learners understand to ensure the assimilation of concepts. As Bozkurt states, "Mathematics is the theory of form and structure that arises within language." [56] Therefore, instructional language is critical and any challenge in this regard affects learners' performance. Teachers argue that when they give instructions to learners or introduce a topic, content or concept, they (teachers) tend to code-switch for better understanding.

As the participants show, it seems difficult to effectively put across to learners' mathematical concepts and rules without resorting to code-switching. This then forces teachers to use a language that learners understand to ensure the assimilation of concepts. Furthermore, as Nurhamida, Fauziati and Supriyada aver, code-switching bridges the gap by allowing translating language 1 (L1) into language 2 (L 2) and vice-versa so that both teachers and learners connect. [57]

From this research, it can be noted that assessment is predisposed to language in the teaching of Mathematics. During assessment, learners sometimes do not understand the instructions given on the examination papers. To remedy this challenge teachers' code-switching becomes the solution. As research shows, the learners' inadequate comprehension of assessment activities given to them prevents their completion of such tasks and the use of code-switching has become the norm in many South African classrooms to help learners.[58]Akbari however feels that a large number of teachers help students cope with examinations through code-switching not because they feel this will enhance learner understanding, but to preserve their reputation as good teachers when learners pass.[59]

The issue of a prescribed syllabus that has to be completed within a given period seems to be one motivation for code-switching as un-earthed by this research. Regarding the completion of ATPs, participants agree that terminology used during the teaching of mathematics tends to be time-consuming and this results in the non-completion of ATPs in schools. Research findings also show that when English only is used for second language learners and or non-English speaking learners, most learners do not understand and lag behind.[60] The reason for this challenge is that they are not fluent in the language because, according to constructivism, learners construct meaning through language.[61] Mkhize and Balfour further allude that the evidence suggests that educating learners in a language that they do not understand, or which is not their home tongue, increases their risk of failure.[62]

CONCLUSION

The main conclusion of this study is the undisputed value of code-switching in teaching and learning Mathematics. Code-switching has been shown from both the study and literature to help mediate epistemological access for learners whose language of learning and teaching is not the mother tongue. Therefore, the mother tongue as a key enabler for learning should be prioritized in teaching Mathematics and the use of code-switching should be foregrounded where the LoLT is not the mother

[56] Gulay Bozkurt, "Social Constructivism: Does It Succeed in Reconciling Individual Cognition with Social Teaching and Learning Practices in Mathematics?.," *Journal of Education and Practice* 8, no. 3 (2017): 210–18.
[57] N Nurhamidah, Endang Fauziati, and Slamet Supriyadi, "Code-Switching in EFL Classroom: Is It Good or Bad?," *Journal of English Education* 3, no. 2 (2018): 78–88.
[58] Mzamani J Maluleke, "Using Code-Switching as an Empowerment Strategy in Teaching Mathematics to Learners with Limited Proficiency in English in South African Schools," *South African Journal of Education* 39, no. . (August 31, 2019): 1–9, https://doi.org/10.15700/saje.v39n3a1528; Ailwei Solomon Mawela and Sizwe Blessing Mahlambi, "Exploring Teachers' Views on Code-Switching as a Communicative Technique to Enhance the Teaching of Mathematics in Grade 4.," *International Journal of Educational Methodology* 7, no. 4 (2021): 637–48.
[59] Alireza Akbari and Mohammadtaghi Shahnazari, "Dictogloss Method as an Entrée to Hike EFL Learners ' Grammatical Competence," *Elixir International Journal* 82 (2015): 32599–604.
[60] Rosemary Wildsmith-Cromarty and Robert J. Balfour, "Language Learning and Teaching in South African Primary Schools," *Language Teaching* 52, no. 3 (July 26, 2019): 296–317, https://doi.org/10.1017/S0261444819000181.
[61] Giuliano Orru et al., "An Investigation of the Impact of a Social Constructivist Teaching Approach, Based on Trigger Questions, Through Measures of Mental Workload and Efficiency," in *Proceedings of the 10th International Conference on Computer Supported Education* (SCITEPRESS - Science and Technology Publications, 2018), 292–302, https://doi.org/10.5220/0006790702920302.
[62] Mkhize and Balfour, "Language Rights in Education in South Africa."

tongue. Code-switching is not always used because of its pedagogical value but sometimes simply as a measure to ensure prescribed content is covered within the given time frame. Code-switching is critical during learner assessment. This enables learners to appropriately comprehend both the assessment instructions and actual assessment tasks.

In conclusion, the study which was conducted within a rural disadvantaged context in South Africa provides a valuable contribution to the knowledge debate on teaching Mathematics in rural multilingual classrooms as most studies gleaned from the literature did not seem to link the issue of language, rurality and disadvantage in the teaching and learning of Mathematics

RECOMMENDATIONS

The study advances the following recommendations based on the findings and conclusions reached: First, the Department of Basic Education should provide policy implementation support for the language policy and enforce the use of African languages as LoLT. As part of the recommendations, the Department of Basic Education in South Africa is urged to pronounce an official stand or policy on code-switching. Code-switching is practised and has been viewed to be yielding improved results therefore, a policy is essential to ensure its implementation. In essence, the authors recommend that code-switching should be formalised as one of the teaching strategies in the primary schooling system.

Second, the study recommends that teacher trainees should be introduced to more languages during their training in addition to the English language. Such languages should include home languages in the areas they are likely to be deployed after the completion of their studies. This would be in congruence with the policy imperatives in schools where learners are expected to study three languages in their school subjects.

Third, it is further recommended that learner home language should be part of learners' assessment mediums during examinations in addition to the language of learning and teaching. Ideally, the home language prescribed for assessment should be the language of the majority in a given geographical location. This will help mitigate the challenge where learners must first deal with language understanding before dealing with the skill required by the task. One area for further research that the authors pose to other researchers is how technology can be leveraged to enhance the teaching of mathematics in multilingual classrooms.

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