Language of Teaching and Learning (LoLT) as a barrier to learning Mathematics: Impact on Mathematics Students in Higher Education

RESEARCH REPORT: FINAL

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Abstract

Language is a barrier that hinders learning Mathematics in most schools in South African and thus may result in a lower throughput rate at most High Schools in South Africa. This is because students in most schools are taught Mathematics in their home language from Grade 1 to 3 and are taught Mathematics in English from Grade 4. This research project was motivated by the rise in number of late entry English learning students who drop Mathematics in Grade 9 and the possibilities of increasing number of students who will study Mathematics in Higher Education.

Keywords: *Mathematical Language; Teaching and Learning; Mathematical Concepts; Home-Language; English Language*

1. Introduction

There is a significant importance in understanding how language can play a crucial part in motivating students to learn and love Mathematics. When teachers do not understand the Mathematical language and how to use it effectively in the classroom students often find the subject confusing and difficult as they cannot understand it in depth. The author believe in understanding how language could or not be a barrier to learning Mathematics, we would be able to find strategies to solve challenges that hinder students in learning Mathematics effectively and the application thereof would not be seen as a complicated task.

The research focuses on the type types of students, Student A and Student B.

Student A represents a person who is now in University and who was taught Mathematics in their Home Language from Grade 1 to 3 and then had to transition to Mathematics in English from Grade 4.

Student B represents a person who is now in University and who was taught Mathematics in English or Afrikaans from Grade 1 to Grade 12. Home language in the context of this research refers to all 11 Official South African Languages.

This research focuses on the challenges that Students A and Student B face when they are required to study Mathematics at University. The research also focuses on the ability of both students to code switch from English to the Mathematical Language to understand Mathematical concepts. Code switching is a popular strategy used by teachers to unpack knowledge for students who are bilingual and multilingual. This is evident from the narratives by the following authors, according to Adler (Zazkis, 2000) code switching can be explained as an alternative in using of more than one language in a single speech act. Bravo – Sotelo (2020) explains that learning challenges occur when students do not understand what the teacher is relaying when they teach certain concepts as the subject that the teacher teaches is in a second or foreign language. Bravo – Sotelo (2020) further explains that the teacher would use a communication technique which involves a combination of two languages to reinforce understanding of the concepts, this is known as code- switching. According to the literature found in Maluleke (2019), code switching can be used in the classroom as an educational instrument or resource to assist students to be competent in a second language. This

in my view guided the research to focus on the challenges students face when they have to learn Mathematics from Basic education until Higher Education and language the that the subject is taught in influences how students will understand the subject.

The research was conducted with Twenty (12) 3rd year students who are currently at University majoring in Mathematics, 5 students who are now in University and who were taught Mathematics in their Home Language from Grade 1 to 3 and then had to transition to Mathematics in English from Grade 4 (Student A) and 6 students who are now in University and who were taught Mathematics in English or Afrikaans from Grade 1 to Grade 12 (Student B).

Research Question 1*:* Is there significant difference between students who are now in University and who were taught Mathematics in their Home Language from Grade 1 to 3 and students who are now in University and were taught Mathematics in English or Afrikaans from Grade 1 to Grade 12?

Research Question 2: Is there a significant difference in students who code switch to understand Mathematical concepts and students who do not have to code switch to understand Mathematical concepts?

These questions will be answered through the theoretical framework that underpins this study and the methodology will be presented where the narratives of the participants are discussed. This will help understand how language has affected the participants' ability to understand mathematical concepts and mastery thereof.

2. Problem Statement and Rationale

The aim of this research is to gain in depth understanding of how language could be a barrier to learning Mathematics and the impact it has on University students, in my view when they have to decide which qualification to do, when students are not comfortable with Mathematics, they will avoid qualifications that have mathematics as pre-requisites. The aim of this research is to understand the challenges that hinder learning of Mathematical concepts, such as to understand whether the delay in teaching of Mathematical concepts in English hinder the process of deep understanding of mathematical concepts. The aim is also to address these challenges

and assist teachers to ensure that Mathematical Language in its essence is not lost when translating English Mathematical terms as there are different meaning of English terms.

The research focuses on the use of language for teaching and learning being a barrier to learning mathematics, there have been many studies regarding this issue, although in a South African Context, this can be a complex matter as we are a diverse society, different languages excluding the 11 official languages. Students who find themselves in environments where they must learn the LoLT (language of learning and teaching) Mathematics and the Mathematical language in its essence find it difficult to adapt and thus leading to them not appreciated the artistic elements of Mathematics. The aim of the study is to bring about the love and appreciation of Mathematics in Higher Education, and that will have achieved if students in Primary and Secondary School understand the Mathematical language that is used to derive Mathematical Algorithms.

It is important for the research to address how students who do Mathematics in English from Grade 1 perform in the subject, if there is indeed language a barrier to learn Mathematics, in my view, chances of succeeding in learning Mathematics effectively are high. Thus, we could investigate addressing which teaching strategies could be used to minimise or remove the barrier in language and mathematics.

According to Du Plooy et al, the truth is dependent on people's interpretation of facts, people may argue that language is not a factor but how the teacher transfers knowledge in a language that the students understand and relate to is important to learning mathematics.

The aim of the research is to determine whether the students who were taught mathematics in English from Grade 4 can reach the optimal goal of teaching and learning of Mathematics in Higher Institutions and to determine how the language strategy influenced students' learning and execution in schools

3. Literature Review

Whether you are South African or not, Language plays a vital role in learning Mathematics. Certain words in English may mean something totally different in

Mathematics, thus causing confusion for many students. The following Literature review confirms that language as a barrier to learning Mathematics is a universal challenge, we will also look how it impacts students in Higher Education.

In Sharma's (2015) view,

> *"Mathematics is strongly connected with language", this points out that for students to succeed and master Mathematics, they should be able to completely understand and use the mathematical language. Abedi & Cord (In Sharma, 2015) emphasises that if students are unable to use mathematical language, it may present some distinctive challenges as they will be required to learn ordinary English and Mathematical English simultaneously, and be able to differentiate between the two types of English. The emphasis takes into consideration that learning languages that may have similar words but different in its application can cause confusion and lack of progression in application of both languages.*

Setati & Adler (2001) argue that contrasting English language infrastructures tend to present primary school teachers with different challenges for communicating Mathematics, this shows that teachers also need support in better understanding between the English and the English language of Mathematics by linking the two languages with the student's home language.

Brown, Cady & Taylor (in Sharma, 2015) proposes that for students to be able to perform competently in Mathematics, they should understand the highly technical language used, specifically in Mathematics. Brown et al, further argues that Mathematics language is not used in everyday English and therefore in its application, it becomes less likely to be understood by English Learning Students. This is worth noting as Mathematics vocabulary is essential for the future Mathematical development of students. According to Cummin (in Maluleka, 2019) students will perform well in mathematics if they are proficient in the language that is used as the language of teaching and learning for mathematics, as the language of teaching and learning will assist them to express their understanding of the concepts.

Sharma (2015) put forward that there is a continuous and growing need on students' linguistic skills in Mathematics lessons, this reveals that students at all levels are not only required to listen, talk and read, but they also have to demonstrate their understanding of the concepts by writing about their work in Mathematical language. Sharma (2015) underpins that students come with a pre-knowledge or existing vocabulary, Sharma explains that some of the words that students are familiar with may be used in Mathematics to express different or certain concepts, for example, the word 'Expands'. This highlights that confusion can develop due to contradiction between the students' prior knowledge of the word and the way it is used in Mathematics. Edward's (in Sharma, 2015) concern with the learning and teaching of Mathematics is that, while Primary School teachers may be aware that language development is an important element of learning Mathematics as they had been trained, Secondary School Mathematics teachers may not know how to help students with low levels of English language competence. Importantly, this suggests that teachers should be trained on language development and how to promote it.

According to Frans (2016) The investigations of both Wolfaardt and Frans concentrated on the language strategy and how it influenced students' learning and execution in schools. It rose out of these investigations that the psychological language aptitudes of students (for instance comprehension of texts and question instructions in content subjects) were poor. Students had difficulties with problem-solving in Mathematics and written language. For instance, syntaxes affected students' abilities to express themselves clearly and adequately, for the most part more established instructors who showed subjects, for example, Accounting, Mathematics, Physical Science, History, Geology, Biology and English had been prepared in Afrikaans however had been compelled to instruct these subjects in English after autonomy (Wolfaardt, 2001).

ACARA (In Fox, 2016) argues that students use literacy to interpret and comprehend word problems and instructions that hold specific language features of Mathematics. Which illustrates that language plays a vital role in understanding Mathematics and promotes the application of Mathematics in the real world. In my view, Word problems are Mathematics applications into the real world, and if students are unable to respond to the concept of Word problems, they will struggle with Mathematics. ACARA further

explains that students use literacy to pose and answer questions, they use literacy to engage in Mathematical problem-solving, and to analyse, construct and elucidate solutions. Martiniello (2008) argues that English students have unique challenges with word problems whether their home language is English or not. Martiniello (2008) explains that there are two linguistic challenges for English students such as the assessor using unfamiliar problems in a mathematics assessment questions and using unnecessary complicated vocabulary and grammar in an assessment. The view that Martiniello (2008) puts forward clearly explains that application of Mathematics is though language, it should be relevant and clear, it should not confuse students.

Lager (In Mosqueda, Bravo, Solis, Maldonado & De La Rosa, 2016) found that there are challenges related to differences between everyday language and Mathematics language that hampers English Learning Students when they are required to respond to certain Mathematical terms. However, in its limitations, the study involved a sample of 221 middle school English Learning Student and 138 English Learning students in low performing schools and 88 non-English Learning students. It may have been more illustrative if the sample was equally related, in other words, if the same number of students were studied.

Fox (2016:33) realised the importance of talking with students about certain Mathematics vocabulary asked in the subject assessments and evaluate words or terms in Mathematics that may mean something different in English subject, this tells us that when students engage in Mathematical language dialogues, they will gain confidence and understanding in applying Mathematics in the real world.

Fox (2016:34) realised that focusing on a certain language and vocabulary of Mathematics instructions, can provide student with relevant tools for application of Mathematics, this reveals that focusing on ensuring that students understand the instructions given in a Mathematics task will assist students to do well. Fox further argues that it is important to provide students with opportunities to be able to convey themselves in ways that motivate reflection and learning through shared oral discussions. This is significant because students should be able practice writing their own understanding and ideas using Mathematical language. This tells us that there is a lot to learn in the teaching and learning of Mathematics, it is important to note that

literacy competencies play a vital role in conquering some of the challenges experienced in the process of learning Mathematics.

Fillmore & Fillmore (In Mosqueda, Bravo, Solis, Maldonado & De La Rosa, put forward the need to address the language implemented in certain Mathematics areas that will shape ideas, reveal relationships between certain concepts in Mathematics and support reasoning that differs between the language that is spoken and written daily.

In the study that Molotja (2008) conducted, it was evident that the school that applied code switching as a method to explain mathematical concepts in a language that the students would understand, such as their home language, performed well in Mathematics over the school where code-switching was not applied, this is an important aspect to address code switching as part of the research.

Molotja (2008) states that the problem arises when students encounter concepts in Mathematics which are written in English and need to be explained in English, Molotja further explains that Students regularly attempted to understand these concepts with the results that lecturers resort to using their home language to attempt to clarify what these concepts mean and this is important to note as this could lead to understanding whether the effect of code switching is seen in students studying Mathematics in Higher Education.

Gouia and Gunn (2016) highlights that, in most cases, Mathematics is difficult and challenging for students, and it is difficult for teachers in Early learning up to University level to assist students to achieve the subject at their full potential. Gouia et al further explains that Mathematics courses can be an obstacle towards majoring in STEM fields. Gouia et al underpins most students struggle with understanding and applying the higher-level concepts presented in a traditional lecture class, this is clear that when students are taught Mathematics well, and they are comfortable with Mathematics, they will be able to understand and apply the higher-level concepts in Mathematics, this can be achieved when language of instruction goes together with Mathematics.

According to Frans (2016) there are several factors that contribute to learning a second language and applying it especially in Mathematical subjects. These factors

are, poverty, motivation to learn, age of students, socio-linguistic, phonetics used in mathematics and semantic concepts, poor foundation skills or early English exposure.

According to Frans (2016) another significant perspective that can likewise be considered as obstruction to learning a subsequent language seems to be "first language", which influences second language adapting contrarily.

According to Lee (2006) mathematical language can be a barrier to the student's learning because of how particular mathematical ideas' requirements and conventions are expressed. for many students, figuring out how to utilise language to express mathematical concepts and ideas will be like figuring out how to communicate in a foreign language (Lee, 2006). This is worth noting as we must prove that it could result in the intake of mathematical students in higher institutions. Furthermore Lee (2006) explains that being fluent in a foreign language is achieved through the ability to think in the foreign language, thus it importantly suggests that in order for students to understand the language that mathematics is taught in, they have to analyse in that mathematical language and it is important to note as the statement could suggest that language is not necessarily a barrier, especially when you understand mathematical concepts and the ideas behind them.

4. Research Approach and Methodology

4.1. Research design and paradigm

Analytical objectives of this research would be to describe experiences that the participants have with the language that they were taught Mathematics with and the Mathematical language itself. This would require the research to be of a qualitative method as the research will be used as an investigation to collects evidence to answer research questions (Mack, Woodsong, MacQueen, Guest & Namey, 2005).

It is important to structure interviews as to avoid producing results that could not be used for research, but it is also important that the interview questions lead to a more in-depth understanding of participants' motivations, how they perceive things and how

they feel about the research. Thus, the qualitative methods are more relevant for the research study.

4.2. Data Collection and ethical approval

Ethical approval was obtained at the Independent Institute of Education on part of the ethics committee for the Faculty of Education. All participants were fully informed and briefed about the study, with consent provided to be interviewed.

To gain more insight, an online interview tool Google Forms has been created as it is easier and a quicker tool to use when collecting data. The questions were differentiated in by different types of questioning tools such as multiple choice, paragraph response and rating scale format as it allowed for participants to share their views on how language affected their understanding of mathematical concepts. The questions were open ended and probing as they allowed participants to share their views in their own words. Google Forms were kept confidential, the researcher (Creator of the Google Form survey) created a google form that does not require the participants to sign in to Google, this ensured that the participant's responses were kept anonymously and participants had a choice to write or not write their names or surnames or personal details on the google to ensure confidentiality - Google Form Survey has an option for 'Required' responses (Google Drive Help, 2020) - 'Required responses' have a Red Asterix on top of the question. Thus, the researcher did not select any personal details as required responses. Interview links were sent out to all participants (20 Students who are in their 3rd Year of study) and the importance of responding to the questions honestly was emphasised. The researcher received the responses from the Google Form that the participants completed and was then able to convert the template of responses to excel. This assisted in Data Analysis as the researcher used pivot tables to create graphs and other analytical tools on Excel.

4.3. Participants

The researcher is not a lecturer or employed at a Higher Education Institute and participants for this study were classified under the 'hidden population' as they were not easily accessible to the researcher, thus the researcher used snowball sampling, which is a chain referral sampling that would allow the researcher to use social

networks to find participants who are currently studying Mathematics Course and they should be in their Third Year of study (Mack, Woodsong, MacQueen, Guest & Namey, 2005). The researcher copied the link from the Google Form used for Data Collection, the link was shared to the contacts of participants by using WhatsApp. The participants accessed the link to the questionnaire and were able to respond to the questions.

To ensure that meaning of the research is closely related to the participants' social context, discourse analysis was used as a method of analysis. Responses from participants guided the researcher to categorise and discuss the meaning of words, phrases, and sentences. The participants in this study included 12 students who are in their 3rd year of study in the Faculty of Natural Sciences (BSc.) and Faculty of Education (BEd.).

5. Analysis of data & finding

The introduction on the results and the discussion section will be illustrated through the direct quotes from the participants of the study, participant 1, whose statement creates paving for the discussion forward in relation to language as a barrier to learning mathematics and the challenges experienced in understanding Mathematical Concepts.

> *Participant 1: I always had to start by understanding the English words or context used before I can understand the questions or the topics, especially on theorems and proofs.*

Through the analysis of the findings and coding process, participants who have been categorised as Student A in this report are taught mathematics in their mother-tongue or Home Language (Setswana, Sepedi, Zulu and Sesotho) from Grade 1 to Grade 3 and they are expected to be fluent in their 2nd language which is English from Grade 4 until they attend Higher Education Institutions. According to Stein (2017) Home language or mother – tongue is the language the student knows best, and is most happy with writing, reading, and speaking. Therefore, the home language taught to the student at school is frequently (however not always) equivalent to the language the student speaks at home. Furthermore Participant 11 and 6 who were taught

Mathematics in isiZulu and Sesotho respectively from Grade 1 to 3 continued a narrative of the challenges Student A would experience in understanding Mathematical concepts.

> *Participant 11: I struggled to understand what the terms mean, especially with problem solving questions*

> *Participant 6: the complexity of the language.*

Both participants experienced challenges as the language of teaching and learning in Higher education is different from their Mother Tongue, participants must translate the meaning of the mathematical terms to English first then translate to the mathematical language. Stein (2007) refers to the above statement as language immersion, this is when the language of teaching and learning (LoLT) is different from the language the student speaks at home. This creates confusion as the student is the disadvantaged to learn mathematics effectively as they must learn the language skills and substance of mathematics at the same time (Stein, 2017).

The narrative above proves to be different for Student B as they have no challenges with language as a factor of possible barrier to them understanding mathematical concepts. Participants 8, 9 and 10 who were taught mathematics in English, Afrikaans, and English respectively from Grade 1 to Grade 12 displayed a different view of why the struggled to understand Mathematical concepts

> *Participant 8: Too many concepts to be learnt. Too many steps in problem solving. Lack of motivation to learn. loss of concentration*

> *Participant 9: The application is difficult; I must put in more time to practice and understand*

> *Participant 10: Just needs more time to practice but I could understand most of the theories and practical examples*

Participants 8, 9 and 10 (Student B) were taught mathematics in the same language from Grade 1 to Grade 12 and their challenges are different from Participants 11 and 6 (Student A). Student B had a solid foundation in language proficiency as the same language they learned to read with, is the same language that they read to learn and understand mathematical concepts.

The study focused on the relation between the application and understanding of Mathematics concepts for student A who have to code switch and Student B who does not have to code switch.

> *Participant 1: Sometimes they confused themselves trying to put the content into our language especially because some of the mathematics context cannot be said in our African home languages.*

> *Participant 4: Some language barriers, especially when changing to another language during class*

> *Participant 7: Understanding the above concept I never did before, and his accent too*

> *Participant 11: Sometimes the teacher would struggle to explain what the terms mean in isiZulu*

Adler (Zazkis, 2000) explained Code switching as an alternative in using of more than one language in a single speech act, this would mean that the lecturer or teacher would try to explain mathematical terms and concepts in a language that the students knows best, and is comfortable with writing, reading and speaking. Participant 4 explained the challenges that could be faced when the teacher or lecturer code switches to another language, the translation could mean totally opposite to what how it would be understood in mathematical language or in English. According to Maluleke (2020) explains that although there is enough and significant evidence that code switching improves student's performance in mathematics, it is arguable that code

switching disturbs the process of the lesson and hinders the ability of students from acquiring the competency in English and Mathematical Language.

The study however demonstrates that Student B did not need any code switching as explained by Participants 2, 3, 7, 8 and 9. Code switching is a method that is used to help students understand the instructions from the language of teaching and learning that the students find difficult to understand.

Student A and Student B argue that code switching will help students understand mathematical concepts better especially when the lecturer or teacher uses right terms to code switch

> *Participant 11 (Student A): English is not confusing, but It is better when the lecturer code switches to help me understand. As it is the universal language, I think it is important for students to be taught mathematics in English from a very young age.*

> *Participant 8 (student B): I think switching between English and any other language is good. Not mainly using English*

Participant 12 (Student A) puts a narrative on language being a barrier to learning and the importance of code switching.

> *Teachers need to stop teaching kids subjects like Natural science in their mother tongue but stick to the language of medium (English).*

Through this process, the researcher had an opportunity to reflect on her own ideas and perceptions about language being a barrier to learning mathematics and the impact it brings to student who are in Higher Education. The participants further argued that students should be taught in English or Afrikaans from Grade 1 as tis will help students master the language of teaching and learning throughout their schooling years, this will allow them an opportunity to focus more on the technical applications and mastery of mathematics. The narratives

gave a clear understanding that language plays a huge role in how students understand mathematics and if they do not perform well in lower grades because of language that they were taught in, they would have been disadvantaged to perform better in Higher Education.

The study highlighted negative correlation that occurred when students are required to learn simultaneously the Mathematical Language and English for the first time. This is important to note as learning languages that may have similar words but different in their application can cause confusion and lack of progression in application of both languages. Hughes *et al* (in Maluleka, 2019) broadens the view pointed by the author that code switchers should have clear understanding of two or more languages used during the process as the two languages may hold different meanings and culture to them

The author believes that the research outlines the challenges foreseen in the use of language as a barrier that leads to challenges of learning Mathematics and its applications. In Context of a South African School, teachers often try to explain the mathematical concepts in the language that students will find easy to understand, but this leads to misinterpretation of Mathematical terms, as ordinary English is not applied the same as Mathematical Language, and this causes confusion for students to understand the Mathematical Language. For example, Product in Mathematics means Multiplication of a certain number of digits, where else in English it means the totally opposite. Students are required to also learn the different meanings of Multiplication within the different meanings of the Mathematical language. This in my view causes confusion when students are required to attempt problem solving strategies. The objective of this study is to encourage the depth understanding of Mathematical Concepts and its artist nature.

6. Ethical Considerations

The research mainly focuses on the impact that language has in learning Mathematics by comparing performance of the three types of students (Students who require code switching to understand mathematical concepts and students who do not have to code switch to understand Mathematical concepts) who have studied Mathematics or are studying Mathematics. Thus, confidentiality will be at the core and students will be

guaranteed that they will not be made to feel less important than others. They will not be put under duress and they their participation is voluntary.

Since the truth is dependent on people's interpretation of facts, I believe that it is important to gather information from people who have studied or who are currently studying Mathematics as a Course or Module in Higher Education, There argument could help in the research as to whether language is or not a barrier to learning Mathematics. I believe that the Research Methodology should be sensitive, i.e. I will not base my research based on race or quality of education a person received before they attended any Higher Education Institutions.

I acknowledge that is it not ethically correct to conduct research only to students who directly dealt with mathematics in Higher Education as there are students who may have studied Mathematics in High School and my contribute to the study, by doing so I am advantaging the students who continued with Mathematics at Higher Education. This is because my research is based on finding out if the students in Higher Education can attest or detest to my research topic. The research did not harm or disrespect the participants as they were not be required at any point to share their Mathematics Course or Module Percentage obtained. Full consent was requested from the participants before the study commenced and there was adequate level of confidentiality of the research data that the participants have participated in. The researcher avoided gathering of any misleading information or data and the findings were not skewed to be biased.

7. Limitations of the study

The effectiveness of research which uses qualitative research methods is dependent on the skills and abilities of the researcher, while the outcomes may not be perceived as reliable as they come from the researcher's personal judgement and interpretations.

As the research sample involves 12 participants (6 Mathematics students – student A - who are currently at University majoring in Mathematics, 2 Mathematics graduates who have experienced the impact of learning Mathematics in a different language that their mother tongue and 5 Mathematics students – Student B - who have been taught Mathematics from Grade 1 to Higher Education in their mother tongue, for example,

Afrikaans Students or English Students). It is important to note how risky it is to conduct research in small samples as the results may be perceived as reflecting the opinions of a wider population.

As limitations to my study, since the research will be focused on students who were taught Mathematics in English or Afrikaans from Grade 1, the view of the researcher may be biased due to the perspectives of the researcher, the researcher was taught Mathematics in Home Language from Grade 1 to Grade 3 then had to transition to learning Mathematics from grade 4.

8. Conclusions and Recommendations

The study concluded that student who were taught Mathematics in their Home Language from Grade 1 to 3 and then had to transition to Mathematics in English from Grade 4 have difficulties with problem-solving as a skill in Mathematics which requires students to understand the mathematical language that is written in English or Afrikaans and this affects their abilities to mathematically express themselves clearly and adequately.

More research should focus closely on the relation between the application and understanding of Mathematics concepts for students who have to code switch and those who do not have to code switch - these would be students who were taught Mathematics in their Home language from Grade 1 to University and those who were taught Mathematics in a secondary language. This will lead us to understanding how these two types of students' cope in Higher Education, the challenges they face and look at the suggestions on how to overcome it.

The connection between Mathematics and Language of teaching Mathematics in Basic Educations and its impact in students understanding Mathematical proves and theories should be researched.

Mathematics language is not used in everyday English and therefore in its application, it becomes less likely to be understood by English Learning Students, there should be more research to determine whether there is positive impact when students use the Mathematical language on a regular basis.

It is crucial that the challenges that hinder students from learning Mathematics are addressed so that more students could take up Mathematics throughout Higher Education level, this is because students in Higher education who are studying Mathematics are taught to understand the importance of applying Mathematical Language at more complex cognitive levels, thus interference of other languages should be addressed earlier in their stages of learning to address the challenges that hinder their understanding of Mathematics Theories and Proves.

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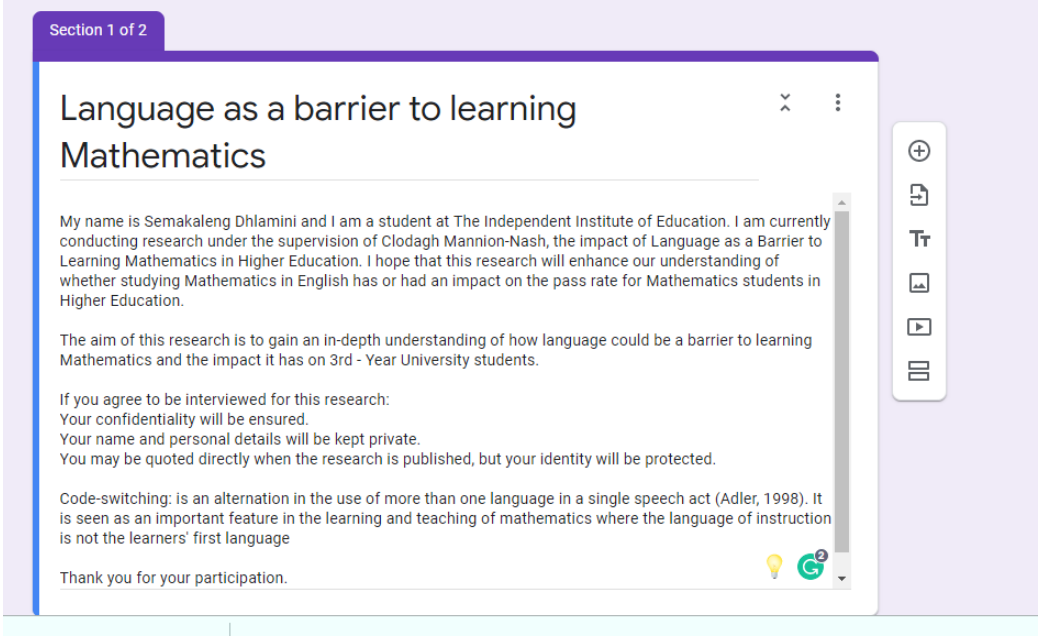
10. Appendices

10.1. Questionnaire- Online Instrument (Google Form)

Due to the nature of the research and the geographical positions of the participants, the interviews will be conducted either through a link that will direct them to the questions.

Link for the Online questionnaire:

https://docs.google.com/forms/d/e/1FAIpQLScX4pyOPdBfXLlh9p8nw6pfHEgmh1Hgg-2Z-OdMwjnQ-TIY-Q/viewform?usp=sf_link



I agree to participate in the research conducted by Semakaleng Dhlamini about the impact of language as a barrier to learning Mathematics in Higher Education *

- [ ] Yes
- [ ] No

Name *

Short answer text

Surname *

Short answer text

Home Language *

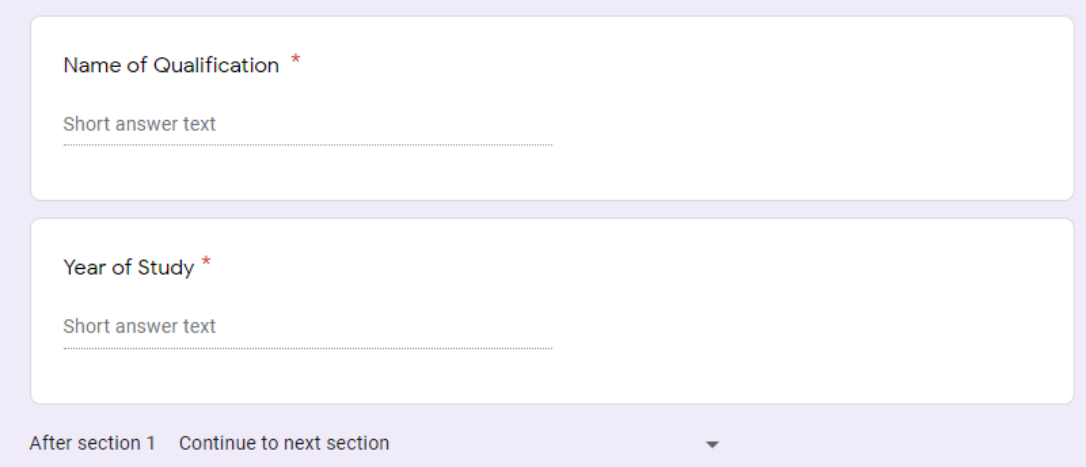
Short answer text

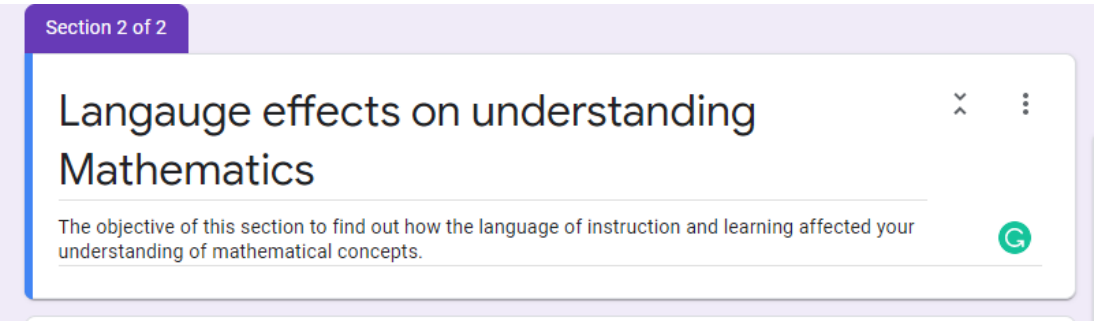
Where is the location/town of the High School you attended? *

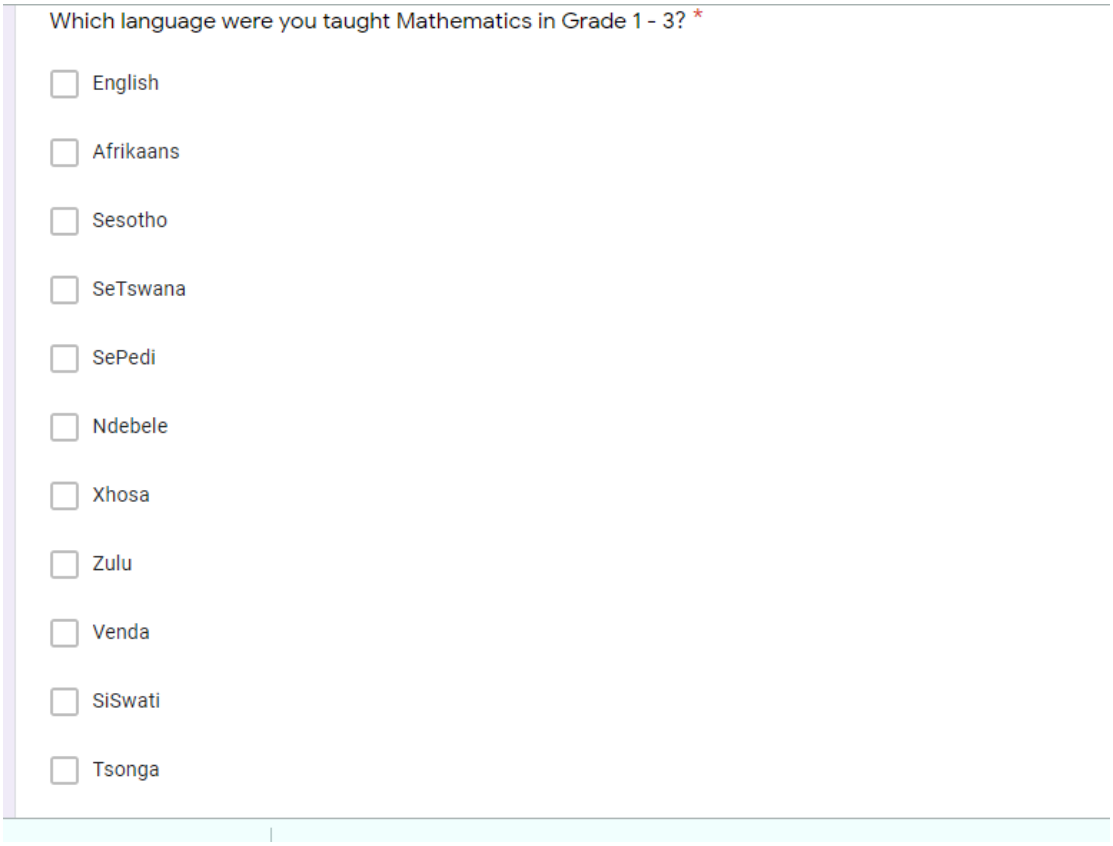
Short answer text

Name of Institute Studying or Studied at* *

Short answer text


Name of Qualification *
Short answer text
Year of Study *
Short answer text
After section 1
Continue to next section


Section 2 of 2
Langauge effects on understanding Mathematics
The objective of this section to find out how the language of instruction and learning affected your understanding of mathematical concepts.


Which language were you taught Mathematics in Grade 1 - 3? *
English
Afrikaans
Sesotho
SeTswana
SePedi
Ndebele
Xhosa
Zulu
Venda
SiSwati
Tsonga

Which language were you taught Mathematics in Grade 4 - 12? *

- [ ] English
- [ ] Afrikaans
- [ ] Sesotho
- [ ] SeTswana
- [ ] SePedi
- [ ] Ndebele
- [ ] Xhosa
- [ ] Zulu
- [ ] Venda
- [ ] SiSwati
- [ ] Tsonga

Which language are you taught Mathematics at University? *

- English
- Afrikaans
- Sesotho
- SeTswana
- SePedi
- Ndebele
- Xhosa
- Zulu
- Venda
- SiSwati
- Tsonga

Are you studying a Mathematics as a Qualification or Subject/Module at University? *

- Qualification
- Subject/Module

What was your range (on average) for Mathematics Subject in Primary and Secondary School *

- below 20%
- 20% - 30%
- 31% - 40%
- 41% - 50%
- 51% - 60%
- 61% - 70%
- 71% - 80%
- 81% - 90%
- 91% -100%

What was your range (on average) for Mathematics Modules at University or College? *

- below 20%
- 20% - 30%
- 31% - 40%
- 41% - 50%
- 51% - 60%
- 61% - 70%
- 71% - 80%
- 81% - 90%
- 91% -100%

At a scale of 1 to 5, rate the complexity of understanding Mathematics due to the language it was taught in at school (Grade 1 to 12)? *

	1	2	3	4	5	
Easy	○	○	○	○	○	Difficult

At a scale of 1 to 5, rate the complexity of understanding Mathematics due to the language it was taught in University? *

	1	2	3	4	5	
Easy	○	○	○	○	○	Difficult

Did your Mathematics Teachers (Grade 1 - 12) code switch to help you understand mathematical concepts? *

- ○ Yes
- ○ No

Did your Mathematics Lecturers (1st year - 3rd year/final year) code switch to help you understand mathematical concepts? *

- ○ Yes
- ○ No

What are or Were the challenges experienced in understanding Mathematical Concepts? *

Long answer text

What are or Were the challenges experienced when your teacher/ lecturer code switched? *

Long answer text

Are you attending tutoring sessions in your 3rd year to increase the understanding of Mathematical Concepts? *

- ○ Yes
- ○ No

Which textbook written in the following languages is easy to understand? *

- ☐ English
- ☐ Afrikaans
- ☐ Other...

Reflecting on your experiences, which language of learning and teaching Mathematics subject do you think would make it easier to understand mathematical concepts? *

- ☐ English
- ☐ Afrikaans
- ☐ Sesotho
- ☐ SeTswana
- ☐ SePedi
- ☐ Ndebele
- ☐ Xhosa
- ☐ Zulu
- ☐ Venda
- ☐ SiSwati
- ☐ Tsonga

Which language of instruction is easy to understand in a Mathematics Lecture *

- [ ] English
- [ ] Afrikaans
- [ ] Sesotho
- [ ] SeTswana
- [ ] SePedi
- [ ] Ndebele
- [ ] Xhosa
- [ ] Zulu
- [ ] Venda
- [ ] SiSwati
- [ ] Tsonga
- [ ] Other...

Reason why you selected Yes/No/Other on the above question

Long answer text

In your view, do you believe that language in which you were taught Mathematics played a huge role in understanding Mathematics? *

Long answer text

How has language affected the way you understand Mathematical concepts in Higher Education (University or College) ? *

Long answer text

Any recommendations on which language do you think learners should be taught Mathematics in from Grade 1. *

Long answer text