

**THE INFLUENCE OF TERMINOLOGY AND SUPPORT MATERIALS IN
THE MAIN LANGUAGE ON THE CONCEPTUALISATION OF
GEOMETRY LEARNERS WITH LIMITED ENGLISH PROFICIENCY**

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ABSTRACT

Learners in South Africa underachieve in Mathematics. Amidst many other factors that influence the Mathematics scenario in South African schools, one major aspect of the Mathematics classroom culture is the Language of Learning and Teaching (LoLT). For many learners the LoLT, namely English, is not their main language. The question arises of whether Setswana learners with Limited English Proficiency (LEP) are disadvantaged because the LoLT is English and if so, what could be done about it.

The interaction between language and thought is discussed against the background of the learning theories of Piaget, Vygotsky and van Hiele, as well as the Network Theory of Learning. From this study the importance of language for conceptualisation becomes clear, especially that of the mother tongue. The circle is then narrowed down to take a look at the vital part that language plays in Mathematics and the problems that exist for the learner when negotiating meaning during the journey between natural language and the mathematical register.

Focusing on the situation of the Setswana Mathematics learner with English as LoLT, the views of parents and teachers come under scrutiny as well as government policies regarding the LoLT. The techniques and strategies of teachers in the English Second Language Mathematics classrooms (ESL-classrooms) are investigated. In this regard code-switching is of importance and is discussed extensively.

These theoretical investigations led to an empirical study. Firstly, a quantitative study was undertaken by means of a survey to investigate the language situation in schools where Setswana is the main language. Furthermore, the views of those teachers, who teach Setswana learners with English as LoLT, on how English as LoLT influences Setswana Mathematics learners' conceptualisation were investigated. A sample of 218 teachers in the North-West Province of South Africa was used in this survey. A complex language situation crystallises where no one-dimensional answer can be recommended. Code-switching has clearly made large inroads into the Mathematics classroom, but teachers' views on the expediency of

using Setswana, especially for formal notes, terminology and tests, vary considerably.

Secondly, a qualitative study was undertaken in two schools. The study investigated the possibility that notes in Setswana as well as in English, and the aid of an English/Setswana glossary of Mathematical terminology in daily tasks as well as in tests, would be of value to learners. It was clear from the sample that the new terminology is difficult for the teachers in question because they are used to the English terminology. Some learners also find the Setswana terminology difficult. However, the learners experience the use of the Setswana in the notes positively. It was clear from the interviews with the learners that by far the most of the learners in the sample felt that the Setswana/English notes as well as the glossary helped them to understand better. The learners oscillate between English and Setswana to understand the explanation given or the question asked. Most of the learners are of opinion that tests where questions are asked in both languages contribute to a better comprehension of what is asked. They also experience the glossary of English/Setswana terminology supplied in the test as an important aid.

Recommendations comprise that the Setswana Mathematics register should be expanded and final examinations set in both Setswana and English. Furthermore, teachers should be educated to use new terminology effectively as a scaffold to ensure adequate conceptualisation, as well as to manage code-switching in a structured way.

Key terms for indexing: language and thought, conceptualisation, Piaget, Vygotsky, van Hiele, the Network Theory of Learning. Limited English proficiency (LEP), English as language of Learning and Teaching (LoLT), Mathematics and language, Mathematics and second language, Geometry and second language, Mathematics register, Setswana Mathematics learners, code-switching, English/Setswana Geometry notes and tests.

OPSOMMING

**DIE INVLOED VAN TERMINOLOGIE EN
ONDERSTEUNINGSMATERIAAL IN DIE LEERDER SE HOOFTAA¹
OP DIE KONSEPSUALISERING VAN MEETKUNDELEERDERS MET
BEPERKTE VAARDIGHEID IN ENGELS**

Leerders in Suid Afrika onderpresteer in Wiskunde. Baie faktore beïnvloed die Wiskunde-scenario in Suid-Afrikaanse skole. Onder andere speel die taal van onderrig-en-leer 'n belangrike rol in die klaskamerkultuur. Vir baie leerders is die taal van onderrig-en-leer, naamlik Engels, nie hulle hooftaal nie. Die vraag ontstaan of Engels as onderrigtaal die konsepsualisering van Setswana wiskundeleerders, wat Engels nie goed magtig is nie, benadeel en indien wel wat hieraan gedoen kan word.

Die interaksie tussen taal en denke word bespreek teen die agtergrond van die leerteorieë van Piaget, Vygotsky en Van Hiele, sowel as die Netwerkteorie van Leer. Hieruit word die belangrike rol wat taal in konsepsualisering speel duidelik. Die kring word dan nouer getrek om te kyk na die belangrike rol wat taal in Wiskunde speel. Die probleme wat die leerder ervaar om te beweeg tussen die natuurlike taal en die wiskundetaalregister word onder die soeklig geplaas.

Verder word gefokus op die Setswana wiskundeleerder wat deur middel van Engels onderrig word. Die sienings van ouers en onderwysers, en die onderrig-leer-taalbeleid van regeringsinstansies word van nader beskou. Die tegnieke en strategieë wat onderwysers gebruik om Wiskunde te onderrig aan leerders met beperkte vaardigheid in Engels, kry verder aandag. Kodewisseling is die belangrikste strategie en word breedvoerig behandel.

Voortvloeiend uit die insigte wat uit bogenoemde teoretiese studie verkry is, is 'n empiriese studie aangepak. Eerstens is 'n kwantitatiewe studie geloods deur middel van 'n vraelys wat gebruik is om die taalomgewing binne die wiskundeklaskamer waar Setswana die leerders se hooftaal is, te ondersoek. Verder is die sienings van onderwysers wat Setswana wiskundeleerders deur middel van Engels onderrig, ook getoets oor hoe dit leerders beïnvloed om wiskundeonderrig te ontvang deur middel

¹ Sien "Abbreviations and notes on the text", p. viii.

van 'n tweede taal. 'n Steekproef van 218 onderwysers in die Noorwes-provinsie van Suid-Afrika is gebruik. 'n Komplekse taalsituasie tree na vore waarvoor geen eenduidige metode aanbeveel kan word nie. Kodewisseling het duidelik 'n belangrike staanplek gekry, maar onderwysers se siening oor die wenslikheid van die gebruik van Setswana in veral formele notas, terminologie en toetse verskil aansienlik.

Tweedens is 'n kwalitatiewe studie gedoen in twee skole. Die moontlikheid is ondersoek dat dit van waarde sal wees vir die konsepsualisering van leerders as meetkundeaantekeninge in Engels sowel as Setswana, asook 'n Engels/Setswana woordelys van wiskundeterminologie aan leerders beskikbaar gestel word. Dit is duidelik uit die steekproef dat nuwe terminologie in Setswana vir die betrokke onderwysers moeilik is, omdat hulle gewoon is aan Engelse terminologie. Die leerders vind ook die Setswana wiskundeterminologie moeilik. Die gebruik van Setswana in die notas en in die klas word egter as baie positief ervaar, veral deur die leerders. Die onderhoude het getoon dat verreweg die meeste van die leerders in die steekproef van mening is dat die Setswana/Engelse notas sowel as die woordelys hulle baie gehelp het om beter te verstaan. Dit leerders beweeg tussen die Engels en die Setswana om 'n duidelike begrip te kry van wat verduidelik of gevra word. Meeste van die leerders voel dat toetse waar vrae in beide tale gestel word, bydra daartoe dat hulle die vrae beter verstaan. Die betrokke leerders sien ook die lys van Setswana/Engelse wiskundeterminologie, wat in die toetse voorsien is, as belangrike hulpmiddel.

Daar word aanbeveel dat die Setswana wiskundetaalregister uitgebrei en die finale eksamens in beide tale opgestel moet word. Verder behoort onderwysers opgelei te word daarin om die nuwe Setswana terminologie effektief te gebruik as middel om konsepsualisering te fasiliteer en om kodewisseling op 'n gestruktureerde wyse aan te wend.

Trefwoorde vir indeksering: taal en denke, konsepsualisering, Piaget, Vygotsky, van Hiele, Netwerkteorie van Leer, leerders met beperkte Engelse taalvaardigheid, Engels as medium van onderrig-en-leer, wiskunde en taal, meetkunde en tweede taal, wiskunde en tweede taal, wiskunderegister, Setswana wiskundeleerders, kodewisseling, Engels/Setswana meetkundeaantekeninge en toetse.

ABBREVIATIONS AND NOTES ON THE TEXT

Language notes

- For the sake of fluency of the text *gender* is not always specified. “*He*” will be used for both “*he*” and “*she*”, and “*his*” will indicate both “*his*” and “*her*” where reference is made to learners or teachers as a general category.
- The terms mother tongue, main language and vernacular will be used alternatively as the context requires. When the learning theories are discussed the term mother tongue is preferred, because that is the earliest language that a child masters. However, when the child reaches school his mother tongue has sometimes degenerated and the main language of the region has become the language that he knows best. Therefore the term main language will be used especially when referring to teaching a group of learners. The word vernacular is well-known amongst the teachers of the region and was therefore used in the questionnaire and the discussions thereof.
- “Main language” is translated as “hooftaal” in the Afrikaans summary.

ABBREVIATIONS

ESL: English Second Language

LEP: Limited English Proficiency

LoLT: Language of Learning and Teaching

ESL-school: School with LoLT English, but where the main language of the learners is not English.

ESL-classroom: A Mathematics classroom where English is the LoLT, but where the main language of the learners is not English.

ESL-learner: A learner who is taught through medium English, but whose main language is not English.

Motswana (plural Batswana) - A person that speaks Setswana.

OBE: Outcomes Based Education

Batswana School: A school where the main language of the majority of learners is Setswana, but the LoLT is English.

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CHAPTER 1

ORIENTATION AND RESEARCH PROGRAMME

1.1 ORIENTATION

Mathematics education in South Africa is in a crisis. This cannot be disputed after the findings of the Third International Mathematics and Science Study Repeat (TIMSS-R), conducted in 1999. South Africa was again² placed last out of 38 countries (Howie, 2001:1). The pass rate in grade twelve in Mathematics in 1999 supported the findings of TIMSS-R. Only 52,5% (higher grade) and 36,50% (standard grade) of the grade twelve Mathematics learners passed Mathematics in the North-West (even after conversions had been made).

In order to contribute to science and participate in scientific discourse it is necessary to master the relevant mathematical content and skills (De Villiers, 2000:3). These skills include communication and problem solving skills, where language plays a significant role. The role of language in Mathematics teaching is therefore of the utmost importance. Howie and Hughes (1998:5, 33, 59) see the relationship between language and performance in Mathematics as complex and critical, and are of opinion that language is possibly one of the factors influencing performance in Mathematics in South Africa. Learners not only need, but also request, access to English as lingua franca in order to participate in the global reality of the twenty first century (De Villiers, 2000:3). In accordance with this, the majority of Batswana Geometry learners are enrolled in schools where English as second language is the medium of instruction (ESL-schools). Although the main language of instruction is English, many teachers use code-switching³ when teaching Mathematics, since the main languages of the vast majority of learners are indigenous languages.

² In 1995 South Africa was placed last of 41 countries in the Third International Mathematics and Science Study. The mean average of 275 out of a possible 800 marks reached in 1999, was nearly exactly the same as the 278 reached in 1995 (Howie & Hughes, 1998:47, 48, 65-70).

³ Code-switching refers to the practice of switching from the language of instruction to the main language of the group to explain a certain concept and then back to the language of instruction (Nkopodi, 1998:99).

The question arises of what the impact of English as Language of Learning and Teaching (LoLT) is on Geometry teaching in the North-West, especially where Batswana learners are concerned.

1.2 LITERATURE OVERVIEW

Both Piaget (1932) and Vygotsky (1962) stress the importance of the interaction between language and thought (logic). Vygotsky (1962:51) says that the child's intellectual growth is contingent on his mastering of language and he sees it as an indisputable fact that thought development is determined by language and the socio-cultural experience of the child. Thought underpins both conceptualisation and reasoning, which are two important building blocks of Mathematics. It follows logically that competence in language will play a role in the understanding of Mathematics as indicated by research (Roux, 2004, 101-102). Focusing on Geometry Van Hiele (1986:34-37, 77-91, 138-141, 231-236) highlights the important role language plays in the teaching and learning of Geometry. He considers the development of the relevant language in Geometry as a prerequisite for a learner to proceed to a next reasoning level (compare to "generalisation level", Vygotsky, 1962:114). Furthermore, the Network Theory of Learning stresses the importance of connecting new knowledge into networks of existing knowledge for conceptualisation (Hiebert & Carpenter, 1992:67-72). This strongly suggests the importance of any prior knowledge that may be imbedded in the mother tongue, or if the learners mother tongue has degenerated, his main language. The Geometry learner may possibly be familiar with words in his mother tongue (or main language), which he will be able to use to infer meaning into geometric terminology encountered.

Durkin (1991:4) emphasises the crucial role of language in Mathematics by saying: "... Mathematics education begins and proceeds in language, it advances and stumbles because of language". Olivares (1996:221) rightly sees language as a major problem for learners with Limited English Proficiency (LEP-learners). The English proficiency of the learner in day-to-day interaction is not sufficient to learn Mathematics. The learner needs to acquire the language of Mathematics encoded in English. Part of learning Mathematics is to gain control over the Mathematics

register⁴ of the relevant language (Pimm, 1991:17, 18). This presents a problem to the LEP-learner. Not only does the learner have to master everyday English as well as new mathematical concepts, but also the special English register of Mathematics.

Mathematics communication differs in three ways from everyday communication. Firstly, mathematical language and symbols are abstract. Secondly, each element of a mathematical proposition is usually fundamental for understanding the proposition. Thirdly, the elements of mathematical propositions are in most cases so specific that they cannot be re-arranged in an order that the learner may be more accustomed to in his mother tongue. These issues pose difficulties to LEP-learners who do not understand all the words and who cannot use his usual second language and social skills to infer meaning. Furthermore, communicative competence in Mathematics is a prerequisite to the development of mathematical thinking and Mathematics learning. These competencies include grammatical and discourse competence (Olivares, 1996: 219-223).

The English proficiency of subject teachers teaching Mathematics through medium English should be above suspicion if they want to be able to facilitate the development of the learners' communicative competence in Mathematics (De Villiers, 2000:2, 3). It is doubtful whether this is always the case in the ESL-schools, especially in the rural areas, where the teachers have to teach through medium English even though it is only an additional language for many of them and not their second language.

1.3 PROBLEM STATEMENT

In the North-West a vast number of the Geometry learners are LEP-learners in an immersion model,⁵ learning Geometry through medium English. Many teachers in the

⁴ By a "register" of a language in this context is meant that subject specific terminology, word meanings and expressions that are used when communicating in the domain of a specific subject or specialised field. This "register" will only be fully understood by those who have become acquainted with the specific meanings given to words in the context of the relevant specialised field.

⁵ Immersion: Learners from the same linguistic and cultural background, whose mother tongue is not the LoLT, are put together in a classroom setting in which the second language is used as

North-West are therefore confronted with a *de facto* situation that most of the learners in their classes do not have the necessary English language proficiency to cope with the Mathematics register of English (Nkopodi, 1998:15). Teachers conduct classes in English, which is most often also their second language or an additional language. Language support of some sort is needed to help the Motswana learner in the process of conceptualisation in face of this language deficiency. This raises the following research questions:

- To what extent has code-switching taken root in the Mathematics classrooms of the North-West?
- What is the language profile of Mathematics classrooms in the North-West?
- What are the views of Mathematics teachers in the North-West regarding to the influence of English as LoLT on the conceptualisation of Batswana Geometry learners?
- What are the views of Mathematics teachers in the North-West on the possibility of a Setswana/ English glossary and Setswana support materials as an aid to teaching Geometry?
- Will grade eight Batswana Geometry LEP-learners experience English/Setswana support materials as a positive aid to understanding geometric concepts better?

1.4 METHOD OF RESEARCH

1.4.1 Literature survey

A thorough literature survey was conducted by means of Nexus and Dialog searches. EBSCOhost and internet search engines were also used. The following keywords and phrases are of importance: (math* or geometry) **AND** (teaching or classroom*); (bilingual or multilingual) **AND** (teaching or classroom*); (limited English proficiency

medium of instruction. The teacher is often fluent in the main language of the learners. The other model, called submersion, is where the learner who has little or no knowledge of the school language, are taught in the same class with children already fluent in the school language (Nkopodi, 1998:14, 15).

or LEP) **AND** (math* or geometry); (vernacular or mother tongue or second language or Setswana or Tswana) **AND** (math or problem solving); (language or linguist* or communication) **AND** (math* or geometry); concept* **AND** math* **AND** (vernacular or mother tongue or second language or Setswana or Tswana); Network Theory **AND** (math* or geometry); (code-switching or code switching) **AND** Mathematics; constructivism; Van Hiele **AND** (language or terminology); information processing **AND** math*; Vygotsky **AND** language.

The results of the literature survey are integrated into the orientation of the study, the theoretical background and the research findings.

1.4.2 Empirical research

1.4.2.1 Design

Attempting to make sense of the language situation in schools where the LoLT is English, but the learners' main language mostly is Setswana, the research was based on an interpretive social research approach (Goede, 2003: 22-25, 30 -33) The study was done by means of collaborative action research, which has its roots in "an agenda for social change" (Doerr & Tinto, 2000:403-412). According to Baskerville, as quoted by Goede (2003:42), one of the major characteristics of action research is to study an existing social phenomenon of a complex nature and to assist in problem solving. This fitted in with the aim of trying to understand the language situation in schools in North-West where the LoLT is English and the main language of most of the learners is an indigenous language, and how learners could be assisted in their struggle to better their understanding of Mathematics.

Doerr and Tinto (2000:403) see the cyclic process of action research as problem identification, action and reflection. Goede (2003:42) reports five stages of action research identified by Baskerville and Pries-Heje, namely the stages of diagnosis, action planning, action taking, evaluation and lastly specifying learning. These five stages are incorporated in the study as follows:

The study was undertaken in two phases. The first phase consists of an ex post facto quantitative study. It represents diagnostic stage of action research. To make enquiries into the language situation in the schools in the North-West where English

is the LoLT, a field survey was undertaken among teachers in the North-West. The purpose was to establish the language situation in the classes, and the teachers' views on the influence of English as LoLT on learners' conceptualisation in Geometry, and the possibility of using English/Setswana support materials in the Geometry classroom. This phase investigates the first four research questions, which focussed on the language situation in Mathematics classrooms in the North-West. This diagnostic stage differs from the usual diagnostic stage in action research in the sense that the views of a wide range of teachers were studied. Teachers, as body of teachers, represent one of the main role players in the language culture in Mathematics classrooms where the LoLT is English. A diagnosis of the language situation could not be made by only concentrating on the schools where the intervention was to take place, as would usually be the case in action research. The overall language situation in the schools is too complex to make a diagnosis on such a limited basis.

The second phase was a qualitative study that involves the next three stages of the action research. The second stage of action research, namely action planning, was undertaken in view of the results of the diagnostic stage, and an intervention was planned which consisted of a Geometry programme for grade 8 learners. This programme was written in both English and Setswana.

In the third stage this programme was used to do an intervention in one rural school and one township school. At this stage the two teachers who taught the programme became partners in the research. They not only taught the geometry programme but also reflected on the process, the reactions of the learners and their own experiences as the teaching in two languages took shape. During the intervention the researcher made class visits and took fieldnotes as observer.

In the fourth stage, the influence of the programme was evaluated through collective case studies (Creswell, 1997:61-64). Semi-structured interviews were conducted with the teachers before the intervention took place and again afterwards. Semi-structured interviews were also conducted with a sample of learners at each school and the data interpreted and processed. The qualitative study attempts to answer the last research question and in doing so to contribute towards a solution for some of the problems that exist for the learners in this domain.

In the fifth and final stage, recommendations are made concerning the use of language aids to assist learners and the development of a Setswana mathematics register. Again this stage differs from ordinary action research in that the teachers at the two schools were not able to change their teaching according to these recommendations, because an input of a wider range of role players is necessary before it can be implemented. The recommendations are therefore directed at the larger education community who are stakeholders in what is happening in the language culture of Mathematics classrooms.

1.4.2.2 Study population and sample

The survey

The population consisted of teachers in the North-West Province of South Africa. It comprised a sample of 218 Mathematics teachers in two separate training programmes of the Potchefstroom Campus of the North-West University. The yeargroups 2001, 2002 and 2003 were included. Of these, 121 are primary school in-service teachers in the Nasop-ACE-programme, and 97 are secondary school in-service teachers in the Sediba-ACE-programme.

Samples of convenience were used and no random sample was selected. The samples were stratified in that the two samples represented one group of teachers from secondary schools and one group of teachers from primary schools. The results of the survey were processed separately for each group (see Leedy & Ormrod, 2001:210- 223).

The empirical study conducted in the schools

The *population* for this part of the study is the grade eight Batswana Geometry learners in the Potchefstroom and Klerksdorp regions of the North-West. Grade eight learners were chosen because important new concepts that precede formal problem solving in Geometry, are introduced in grade eight. One rural school (School A) and one township school (School B) were selected on the basis of convenience and feasibility. At school A the only grade eight class was used for the intervention. At School B the Setswana class of the participating teacher was used. As the teacher also teaches Mathematics to a class with main language Sesotho, this class was also included in the research although the intervention was only partially executed.

Five learners were selected for interviews from the rural school and six learners from the township school to form the sample for the qualitative study. Four learners from each Setswana class from the two schools respectively were selected based on their profile as reflected by their Mathematics-, Setswana- and English June yearmarks. The fifth learner at the rural school was selected based on the fact that her mother tongue was Xhosa, while two learners in the township school was selected randomly from the Sesotho class on the basis that their mother tongue and/or main language is Sesotho. Interviews were also conducted with the two teachers involved in the intervention.

1.4.2.3 Instruments

The researcher designed a questionnaire to use in the survey that was undertaken for the quantitative study. Internal validity was ensured by asking the teachers to comment on views they expressed and comparing it to their answers.

For the qualitative study the researcher designed a Geometry teaching programme for use in the intervention. The programme was translated into Setswana by The Translation World CC, who often does translations of Mathematics texts for various role players in the market of school Mathematics. This qualitative study was done by means of semi-structured interviews with learners after the intervention and semi-structured interviews with the teachers before and after the intervention. The researcher also visited the classes and took field notes.

1.4.2.4 Statistical techniques

The assistance of the Statistical Services of the Potchefstroom Campus of the University of North-West was obtained. Descriptive statistics were used in the quantitative study to process the information gathered in the survey on the views of the teachers.

1.4.2.5 Research procedure

Procedure to conduct the survey

The teachers of the Nasop- and Sediba-programmes were respectively asked to complete the questionnaire during the first session of the ACE-programmes of each relevant year (2001, 2002, and 2003). The questionnaires of the teachers in the

Nasop-programme were processed in one group since these questionnaires revealed information about the language situation in primary schools and the views of primary school teachers. The questionnaires of the teachers in Sediba-programme were processed in another separate group to get information on the language situation in the secondary schools and the views of secondary school teachers. The comments on questions referring to the teachers' views were also summarised separately for each group. Descriptive statistics were used to process the information gained from the questionnaires.

The advantage of this process was that all the questionnaires handed out were completed and could be used in the research.

Procedure followed in the empirical research in the schools

The researcher visited the principals of the selected schools and asked permission to conduct the programme at their schools.

The rationale for the research and the way in which it would be conducted were discussed with the grade eight teachers involved. The Geometry programme used for the intervention was then discussed in detail with each of the teachers, after which one teacher at each of the schools decided to participate. The teachers discussed the intervention with the learners and obtained their co-operation as participants in the research.

Each teacher was asked to complete the same questionnaire used in the survey and this was used to conduct a semi-structured interview with them to establish their background and views before the implementation of the programme. Class visits were made to monitor the programme. At the end of the programme each teacher set his/her own test in both Setswana and English.

After the programme was completed, interviews were conducted with the sample of learners at each school. The interviews were conducted in Setswana by an independent interviewer at each school. Interviews were also conducted with both the teachers after the programme was completed. The interviews were transcribed

and the interviews with the learners translated into English. All the information gained from the interviews was interpreted and documented.

1.5 CHAPTER OUTLINE

Chapter 1. Introduction and problem statement: The purpose of this chapter is to give a short overview of the problems that gave rise to the research questions of this study. The reader gets a glimpse of what to expect in the study by means of a short literature study and an outline of the research design and procedure.

Chapter 2. Language, learning theories and conceptualisation in Mathematics with specific reference to Geometry: In this chapter the researcher discusses the theories of the renowned developmental educationists, Piaget and Vygotsky with special reference to the relationship between language and thought. This forms the background to the importance of language for conceptualisation. The focus narrows down to the importance of language for the teaching of Geometry in the discussion of van Hiele's theory of reasoning levels. Lastly, the Network Theory of Learning highlights the significance of the extensive language network of the mother tongue, formed in the early stages of childhood, for integration of new concepts.

Chapter 3. The role of language in the Mathematics classroom: This chapter examines Mathematics as language, with special reference to the rigorous language of Mathematics and the problems it creates for learners when moving between natural language and the mathematical register.

Chapter 4. The interplay between language and Mathematics in the multilingual classroom with special reference to Geometry: This comprehensive chapter deals with the language policies of educational authorities and different role players' views on English as LoLT. More importantly, it focuses on bilingualism, the language techniques and strategies in the ESL-Mathematics classroom, of which the most important and most extensively covered is code-switching.

Chapter 5. Empirical investigation of the language profile of the Mathematics classrooms in the North-West, South Africa: The results of the survey among a sample

of teachers in the North-West is covered in this chapter. Information on the language situation in the classrooms of the teachers who participated in the study covers topics like code-switching, the language make-up of the classgroups, the teachers' views on the problems around the use of English as LoLT in Geometry and the possible use of Setswana notes and an English/Setswana glossary in the teaching of Geometry in the ESL-Mathematics classroom.

Chapter 6. Empirical investigation of the influence of Setswana notes and an English/ Setswana glossary on the conceptualisation of Batswana Geometry learners with Limited English Proficiency: This chapter reports on the empirical research done in one rural and one township school in the North-West. The qualitative study focussed on an intervention programme that included notes in English as well as Setswana, and an English/Setswana glossary of mathematical terminology. Code-switching was used as teaching strategy. This chapter describes the results of how learners and teachers experienced this programme.

Chapter 7. Conclusions and recommendations: The last chapter summarises the conclusions reached in the study and identifies possible subjects for future research.

1.6 SIGNIFICANCE OF THE STUDY

Mathematics educators in South Africa are confronted with a diverse and complex language situation in their classrooms. Research in this field can offer solutions to South African teachers as well as contribute to the international body of knowledge, since the South African educational system offers an excellent opportunity for researching second language learning in an immersion environment.

It is essential to find methods to support Batswana Mathematics learners with limited English proficiency in ESL-schools in the North-West. If the results in this study points to the use of support materials in Setswana as a valid support structure for the Motswana Geometry learner, it may prove a valuable and practical contribution to help Batswana Geometry learners in need.

CHAPTER 2

LANGUAGE, LEARNING THEORIES AND CONCEPTUALISATION IN MATHEMATICS WITH SPECIFIC REFERENCE TO GEOMETRY

2.1 INTRODUCTION

The development of thought in a child is a field of study that is important for the Mathematics teacher because it sheds light on how concepts are formed at different stages of the child's development. For the learners to understand Mathematics it is essential that concepts are developed adequately and are integrated into a network of concepts connected by relationships. It is therefore necessary to take cognisance of the theories of thought and language if research is undertaken on how Mathematics, and in particular Geometry understanding, is influenced by language factors.

Researchers in the fields of cognitive development and learning theory revealed the close relationship between language and thought. In this regard the views of Piaget and Vygotsky, who are renowned researchers in this field, will be discussed. In the specialised field of Geometry, which is the focus of this study, attention will be paid to van Hiele's learning theory. The mother tongue, or if this has degenerated, the main language of the learner, develops early in his life and constitutes a major network of knowledge. Chapter 2 will in the last instance consider the Network Theory of Learning and give a cursory overview of recent research on the relationship between language and thought.

In chapter 3 the important role that language plays in Mathematics and the special language-like character of Mathematics will come under scrutiny and it must be read against the background of these language and learning theories. In chapter 4 the circle is narrowed to second language learners and their language scenario. The last two chapters will then zoom in on the situation in the North-West and the empirical study and findings will be described.

2.2 PIAGET (1896-1980)

Piaget made a major contribution to the theory of the development and learning of children. He furthermore studied the development of thought in depth. Piaget has elaborated his theory over sixty years. His theory is complex and the different concepts he works with cannot be understood in isolation. This cursory overview therefore depends heavily on secondary sources written by researchers who have studied his work in depth. It is not the aim of this study to cover Piaget's extensive research, but rather to trace his views pertaining to the interaction of language and thought.

During his undergraduate and graduate studies Piaget focussed on biology. He also had a keen interest in philosophy, especially epistemology. McNally (1974:1, 2) is of opinion that it was this early interest that gave Piaget his biological conception of knowledge and the development of intelligence (also see Atkinson, 1983:3). The clinical method that Piaget applied involved observation of play and speech, as well as questioning children. The aim was to follow the child's thought. Piaget believed in universal order and subsequently sought to understand the thinking processes common to humankind, through the study of individuals.

2.2.1 Piaget's theory of stages in cognitive development

Piaget (1974b:117; 1974:57-59) postulates four major stages in development, namely the sensorimotor, pre-operational, concrete operational and formal operational stages.⁶

The sensorimotor stage is the stage before language has started. It includes the time from birth to two years. The "sensorimotor intelligence" of this stage is characterised by "the organization of spatial relationships, the organization of objects and a notion of their permanence, the organization of causal relationships, etc." (Piaget,

⁶ Depending on the translation from French, the stages are sometimes called periods. For the sake of consistency the terms "stages" and "sub-stages" will be used, although some of the sources use the term "periods" and divide the periods into "stages".

1974b:117). *The sensorimotor stage* is divided into six sub-stages of which the last stage is the “beginnings of thought” which forms the transition to the stage of pre-operational thought. Piaget (1974a:58) views the series of structures that are formed in the sensorimotor stage as indispensable for structures of representational thought that have to be formed later.

The *stage of pre-operational thought* is called such because the child cannot yet perform internalised actions that are reversible. This stage starts around the age of two years and continues up to the age of approximately seven. Reconstruction of the structures formed in the sensorimotor period takes place. Representation starts as the symbolic function develops, which includes language, mental images and symbolic gestures (Piaget, 1974b:117 & 1974:58). The symbolic function will be discussed further in 2.2.2.3.

The third major stage advances from about seven to eight years. The *concrete operational stage* is characterised by the inception of operations. Piaget (1974b:117 & 1974a:57) defines operations as internalised actions that are reversible and are co-ordinated into overall structures. He views an operation as the essence of knowledge. An operation modifies an object through a set of actions, e.g. ordering, constructing a classification, etc. It is always linked to other operations and thus part of a logical structure. The operations are concrete, in other words, the child can establish relationships between concrete objects.

The fourth stage, the *formal operational stage*, starts around the age of eleven to twelve years. The child's thinking is now “hypothetic-deductive”. This stage is characterised by formal propositional operations that the child can use to establish a hypothesis, from which he can reach deductions by formal or logical means in order to classify his hypothesis as right or wrong. He is able to isolate variables in a problem and to examine the relational effects between them (McNally, 1974:51, Piaget, 1974b:117).

In an overview of the stages one can see that with development, the structures of the earlier stages become integrated into higher-level structures. The child is not conscious of the structures, but uses them nonetheless. Piaget (1974b:120, 122)

says that a feeling of necessity, where the child will say "but this is obvious", indicates the closure of a structure of a certain stage. The stages have essentially a biological meaning. The order of stages is constant and sequential, and the sequence never differs. The ages when children reach the different stages vary quite significantly according to the interaction between the maturation of the nervous system of the child, the social environment and experience in general. Piaget (1974a:59, 62, 63) stresses the necessity of equilibration or self-regulation, which he views as a fundamental factor. Equilibration is in essence the ability to understand conservation and reversibility. Piaget gives the example of a plasticene ball that is transformed into a sausage. The child will first concentrate on the length, then on the thickness, and in the end see that there is a relationship between the two. The child will come to understand that when the plasticene gets longer it gets thinner and vice versa. He will finally understand that the amount of plasticene stays the same.

The different stages described here refer to the development of intelligence, more particularly "logico-mathematical" operations. Other stages can be identified, for example for mental imagery, memory and the notion of causality.

Piaget (1974b:125) identifies a problem, not yet solved, relevant to the theory of stages, namely that of time lags. A time lag of several months up to two years may exist in the understanding of problems that seem closely related, but where other material is used in another context. An example of this may be found in the development of the child concerning conservation. Conservation of substance precedes conservation of weight, which precedes conservation of volume (McNally, 1974:40).

2.2.2 Piaget's theory of thought and language acquisition

2.2.2.1 *The development of language*

Piaget (1932:9-19, 33) divides the language of a child into two main groups, namely egocentric and socialised speech.

Egocentric speech is subdivided into:

Repetition of echolalia: The repetition of words with no social character and words that do not even always make sense.

Monologue: The child talks to himself. This type of talk often accompanies action. The monologue gradually disappears towards adulthood.

Dual or collective dialogue: Children that play side by side and talk aloud but without giving real information.

Socialised speech is subdivided into:

Adapted information: The child really exchanges thoughts with others, but causal relations remain unexpressed.

Criticism and derision: Directed at an audience, but is affective in nature. The child sees himself as superior and depreciates others.

Commands, requests and threats that are interaction aimed at assisting action.

Questions: It calls for an answer and is socialised speech. Piaget found questions of child to child to be mostly about actions, intentions and classification. Children very seldom ask for causal explanation.

Answers to questions.

Piaget (1932:38-47) comes to the conclusion that children up to more or less seven years of age, think and act more egocentrically than adults. The child has no verbal continence and speaks aloud the thoughts that come into his mind, but he often speaks to himself. The speech accompanies and reinforces individual activity. In play the child uses gestures, movement and mimicry as much as words. Language, such

as commands that accompany action, tends to become more socialised, while intellectual processes remain egocentric.

2.2.2.2 Beginnings of thought

As mentioned before, Piaget divides the sensorimotor stage into six sub-stages. Although Piaget already sees intelligent behaviour in the fourth sub-stage (8-12 months), it is only in the sixth sub-stage that Piaget really identifies thought. The child can now represent objects mentally and use these representations to solve problems. The child is able to solve a problem by "thinking" about it, without external random experimentation. He arrives at the solution internally. The child has an understanding of cause and effect (McNally, 1974:18, 19). Language plays no role in the development of thought up to this stage.

2.2.2.3 Thought in the pre-operational stage

The pre-operational stage is divided into two phases, namely the pre-conceptual or symbolic sub-stage (2-4 years), and the intuitive or perceptual sub-stage (4-7 years). Other classifications to divide the pre-operational stage also exist. This study follows McNally (1974) in his choice of the possible classifications.

Thought in the pre-conceptual sub-stage

As mentioned earlier, the symbolic function develops in the pre-operational stage. McNally (1974:20, 21) describes the symbolic function as "the ability to represent something such as an object, event or conceptual schema by what Piaget refers to as a signifier". Language is one of those signifiers, together with mental images and symbolic gestures. Internalised imitation is used to form mental images, which includes visual imagery. The mental symbol is formed through accommodation and assimilation, therefore, the existing structures have to be modified to be able to include the new signifier. The way in which the mental image is represented is personal and unique for the individual. The signifier, e.g., a word, cannot stand for the real object, but stands for the way in which the child has represented and understands it. This insight of Piaget is particularly important in teaching. Whenever

teachers try to facilitate the learners' construction of concepts, they have to take into account that the learners each construct the concept in his own way. Each learner will have his own personalised understanding of the concept.

Words or signifiers, are external imitations and the meaning of the words is dependent on the child's culture. A shared signification makes communication possible. Among the symbolic functions, language becomes especially important to facilitate thought. Through the signifier, or word, the child can recall something that is not present. The child's thinking is accelerated and his thinking becomes more efficient. As the child grows older, the symbolic function includes both symbol (meaning) and signifier (word). Language helps to detach thought from physical action and brings with it a socially elaborated meaning (McNally, 1974:20 -22, 25).

At this stage the child reasons *transductively*. The child is going from one particular to another without a clear logical connection. He may for example select blocks according to form and the next moment add an object that has the same colour as the previous one, with no regard for the form of the object. The child is only forming pre-concepts and not real concepts (McNally, 1974:20 -22, 25; compare paragraph 2.3.2 on Vygotsky's thinking in complexes).

Thought in the intuitive (perceptual) sub-stage (4-7 years)

During this phase the child develops the ability to give reasons for his actions and is able to sort consistently by one attribute. Thought is restricted by the fact that the child can only think about one relation at a time and also because his thoughts are dominated by the aspect that is attended to at the time. For example, if water is poured from a jug into a high thin container the child would say there is more water. He cannot attend to the fact that the container is thinner *and* higher simultaneously, but will only attend to the height. There is no understanding of reversibility. The child will not pay attention to the fact that the water can be poured back into the jug and that the situation will be restored to its original status. Language progresses quickly and assists internalisation. This speeds up the rate at which experience takes place (McNally, 1974:27-32).

The curves of the development of thought and that of language do not, according to the theories of Piaget, coincide or develop parallelly, each has its own rate of development.

Two categories of thought are distinguished namely *autistic thought* and *directed or intelligent thought*. *Autistic thought* is subconscious, individual, operates chiefly through images and is incommunicable in language. *Directed thought* is subdivided into egocentric thought and communicated intelligence. A great part of the child's thoughts during the intuitive stage is egocentric (Piaget, 1932:38-47). Egocentric thought is more intuitive than deductive. Little value is attached to proof. The child uses personal schemas of analogy and earlier; visual schemas play an important part, and values influence egocentric thought greatly. Communicated intelligence on the other hand uses deduction. Greater emphasis is placed on proof, while schemas of analogy and visual schemas are mostly eliminated. Collective judgement takes the place of personal judgements.

Early thought processes constitute the following:

Verbal syncretism (Piaget, 1932:131-136). Schemas play an important role in children's thinking. Schemas develop long before the perception of detail. Syncretistic perception is perception of the whole rather than the part. It excludes analysis, but it is richer and more confused than the general schemas of adults. Syncretistic perception is used where children are taught to read whole words instead of spelling the letters. The development of language, as in perception, is from the whole to the part.

Syncretistic reasoning (Piaget, 1932:136-150). Syncretistic reasoning is a subjective synthesis where a schema is added onto propositions and not derived from it analytically. Syncretistic reasoning therefore serves to create relations between two propositions that are not objective and not logical to the adult mind. The propositions are assimilated because they have a general schema in common. A enters somewhere into the same schema as B, therefore A implies B. Syncretistic reasoning is pseudo-logical. Piaget illustrates this with the example of a child that reasons, "the moon doesn't fall down because there is no sun, because it is very high up." The

child has taken three separate things that he knew about the moon, namely "the moon doesn't fall down" and "the sun goes out when the moon appears" and "the moon is high up" and constructed a causal relationship from it. The egocentric thought is driven by a need for justification at any price, therefore the three properties of the moon that form a single schema because it describes the moon, were then linked together.

Syncretism of understanding (Piaget, 1932:151-161). When a child listens to someone he thinks that he understands everything. This originates from his egocentric viewpoint. The child reasons from the whole and does not analyse what he hears. Comprehension of the details takes place only as a function of the whole. To understand a sentence the child ignores the words that he doesn't understand, fits the ones that he does understand into a general schema and then interprets the words he did not understand. Although this may sometimes give rise to mistakes and gross misunderstandings, it more often helps the child to make sense of the world around him.

2.2.2.4 *Thought in the concrete operational stage (7-12 years)*

The most important development in this stage is the gradual development of conservation. Conservation includes the ability to reverse internally, to take into account more than one feature at a time, and to focus on transformation of one state to another. There is a progression in conservation. Conservation of quantity appears first, then mass and then volume. A general logical structure exists, namely the structure of groupings, and there is a wide generality of application. The structure available to the child now enables him to see past the fact that the water in the thin holder is at a higher level than that of the jug, because he can see the logic of the situation. The operations still relate directly to objects. If all the objects or data that form the basis of thought are present, concrete reasoning can proceed (McNally, 1974:32-34).

2.2.2.5 *Thought in the formal operational stage (12-15 years)*

The formal thinker is not concerned with concrete materials and data only, but thinks about different possible relations. These possible relations are judged as false or true by enquiry and attempted logical analysis. Piaget identifies three modes of thinking during the formal operational stage:

- *The hypothetic – deductive mode:* It is the ability to see the real as subset of the possible. A hypothesis is set up, tested and then confirmed or denied.
- *The propositional mode:* The child manipulates propositions about the data. Content does not change the form of the argument and he can manipulate relations that might exist.
- *The combinatorial mode:* This is the ability to isolate variables and consider their influence on possible relational effects, either alone or in combination (McNally, 1974:51).

2.2.3 **The figurative and operative aspects of knowing**

A concept can be developed more or less extensively. Piaget calls it figurative or operative knowing. Figurative knowing is when something is known, but as a whole. The more attributes and relations between the attributes of a concept are known, the higher the level of operative knowing. McNally (1974:67) defines it as follows: "Operative knowing refers to transformation of objects and events so that they can be assimilated to current general structure, while figurative knowing relates to the configuration of this specific knowledge." Operative knowing is linked to other knowledge and is available for use when the child is thinking. More operative knowing and operative activity will constitute higher intelligence. In teaching it will mean that a symbol or signifier like a word, will not be of value if operative knowing is not present. This highlights the importance of action-based operative aspects of knowing in teaching (McNally, 1974:367, 368).

2.2.4 The role of language in thinking

Does language influence development of thought or does thought influence the development of language? Piaget's position is that the development of language does not contribute primarily to the development of thought in the early stages, but only contributes effectively to thought when formal operations begin to appear. Language is structured by thought, rather than thought by language and "only follows and mirrors intellectual structures" (Atkinson, 1983:186). Language is part of the general capacity of the symbolic function, but differs from the forming of mental images and delayed imitation in that language deals with signs. These signs have no resemblance to the objects or events they symbolise (Sinclair, 1974:103). It could therefore be deduced that these signs will only have meaning if it is mentally connected to the physical object or a mental image of that object.

Piaget does not negate the fact that language does play a role in the development of thought even in the earlier stages, as was noted before. However, language is *only one aspect* of the symbolic function. The child constructs representation of deferred imitation himself, while language is borrowed from society. Symbols (e.g. words) should get their meaning from operative structures, otherwise symbols only constitute figurative knowing. Therefore Piaget's point of view is that operative knowing contributes to the effective development of language. This view is sustained by research on deaf and blind children. The development of operational structures is delayed only two years in deaf children and in blind children about four years, although their language development is normal. Piaget ascribes this to sensorimotor disturbance peculiar to blind children. This interferes with the development of sensorimotor schemes and cause a lack of activity, which is necessary to develop conservation (McNally, 1974:69, 77, 141-142).

In the formal stage language plays an important role in the growth and development of logical structures. McNally (1974:145) comments on this as follows: "Therefore along with the emphasis on providing concrete and practical experiences should be adequate provision for discussion and disputation as the adolescent subjects his own ideas and thoughts to the critical scrutiny of teacher and peers."

2.2.5 Conclusions

According to Piaget:

- language must be seen as one of the symbolic functions;
- development of the structures of thought makes it possible for language to develop;
- language does not contribute primarily to the development of thought in the early stages;
- in the formal operations stage language is of major importance;
- symbols or signifiers like words must get their meaning from operative structures and therefore operative knowing is necessary for the development of language;
- the mental image, and therefore the meaning of a word, is personal;
- words, and therefore language, are culturally determined.

2.3 VYGOTSKY (1896-1934)

Vygotsky's (1962) theories greatly influenced the learning theories of the twentieth century. His study of the relationship between language and thought and on concept formation is very important for this study. These aspects of his theories will therefore receive special attention.

2.3.1 The relationship between language and thought

2.3.1.1 *Word meaning*

When studying speech and thought word meaning is an important aspect. Through *word meaning*, speech and thought unite into verbal thought. A word does not refer to a single object but to a group or class of objects. Each word is therefore a generalisation that is a verbal act of thought. Thought is present in generalised reflection on reality, which is the essence of word meaning. Meaning is an inalienable

part of words as such, and therefore belongs to both the realms of thought and language. Speech has an intellectual function as well as a communicational function. Word meaning is a unit of both these functions, namely generalising thought and social interchange. An individual's experience that resides in his consciousness only becomes communicable if generalisation has taken place and word meaning can be developed. In higher forms of intercourse thoughts reflect conceptualised actuality. This is why someone cannot really understand a word if he has not adequately generalised the concept that the word stands for (Vygotsky, 1962:5-7).

This view of Vygotsky has important consequences for teaching and for this study. A learner may know a word, e.g. a geometric term, but if adequate generalisation has not taken place the term will have no meaning for the learner. The learner will not be able use the term to facilitate his thoughts and reasoning. The teacher should verify that learners, especially second language learners, have adequately generalised the concepts that give meaning to terminology used in teaching Geometry.

While the bond between word and meaning was previously seen as an associative bond, Vygotsky (1962:121) perceives it as dynamic. Word meaning changes as the child develops and it also changes according to the different ways in which thought functions.

2.3.1.2 The development of speech and thought in a child

Vygotsky (1962:19, 20) sees the order of development of speech in a child as first social, then egocentric and then inner speech. The direction of the development of thought is therefore from the social to the individual. This is opposite to Piaget's view who perceives the development from egocentric to social (Vygotsky, 1986:34). The primary function of speech is social contact and the children's earliest speech is essentially social. Later the functions become differentiated and the child's speech is divided between egocentric and communicative speech. Egocentric speech leads to inner speech, which serves both autistic and logical thinking and is directly related to the child's interaction with the real world.

According to Vygotsky (1962:28, 41, 42, 50) thought and speech have different roots in their ontogenetic development and the two functions develop independently of each other and along different lines. Although there is no clear-cut and constant correlation between them, there is a close correspondence. Two phases are clearly discernible in the development of thought and speech, namely a pre-linguistic phase in the development of thought and pre-intellectual phase in the development of speech. The crying and babbling of a child, which has a social function, is an example of the pre-intellectual phase.

A critical change takes place in the child's language development when the child inquires about the names of objects with a resulting sharp increase in the child's vocabulary. The child seems to discover the symbolic function of words. Speech begins to serve intellect and thoughts are being vocalised. The relationship between speech and thought undergoes many changes. Progress in thought and speech does not develop parallelly. Their growth curves may cross and even merge for a time but will always diverge again.

2.3.2 Speech development

Speech development follows the same course as the development of other mental operations e.g. counting. Four stages can be distinguished. Firstly, the *natural stage* corresponds to pre-intellectual speech and pre-verbal thought. The second stage is the stage of *naïve psychology*. The child becomes aware of the features of his body and the objects around him and starts to use tools. In speech development it can be observed in the correct use of grammatical forms without really understanding why. The child uses words that are causal or conditional words before he really understands such relationships. The *third stage* is distinguished through external signs and operations used as aids in the solution of inner problems, for example, the child counts on his fingers. In speech the third stage is characterised by egocentric speech. The fourth stage is the *in-growth stage*. External operation turns inward. The child begins to operate with inherent relationships and inner signs, for example, to count in his head. Inner and outer operations frequently change from the one form to the other and back again. Inner speech can become very close to external speech,

especially when in preparation for outer speech. Inner and external behaviour influences each other.

Schematically Vygotsky (1962:47, 48) represents thought and speech as two intersecting circles. It can be depicted as follows:

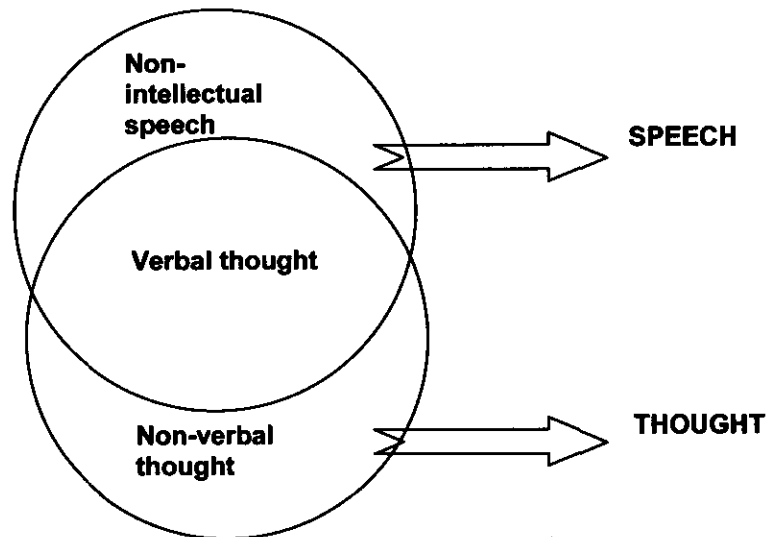


Figure 2.3.2 Speech and thought

Verbal thought is found where the areas of the two circles overlap. Thought and speech produce verbal thoughts. Verbal thought includes neither all forms of thought nor all forms of speech. There also exists non-verbal thought as manifested e.g. in the use of tools. Thought can function without words. Non-intellectual speech can be seen when a poem is recited that has been learned by heart. Fusion of speech and thought is limited to a circumscribed area where the processes of verbal thought take place. Although non-verbal thought and non-intellectual speech exist, Vygotsky (1962:50, 51) comments that the speech structures mastered by the child finally become the basic structures of his thinking. He concludes: "This brings us to another indisputable fact of great importance: Thought development is determined by language, i.e., by the linguistic tools of thought and by the socio-cultural experience of the child". And furthermore: *"The child's intellectual growth is contingent on his mastering the social means of thought, namely language."*

When studying the impact of learning in a second language Vygotsky's insights may possibly be a directive. The question arises how the thought processes of a learner

are influenced when he is taught in a language that he has not properly mastered. Furthermore, thought is co-determined by the social-cultural experience of the child, which is intermingled with his language. In the townships the informal language of the learners is a mixture of different languages and this is combined with the situation of teaching-and-learning where the learners are often exposed to code-switching between the LoLT, which is English, and the main language of the school (See 5.4, 5.5 & 6.6.1). This situation gives rise to a second question, namely, how does the intercultural situation in townships impact on the thought processes of the learner? To answer these very difficult questions is not in the scope of this study, but are questions for further research.

2.3.2.1 Inner speech

Vygotsky (1962:46-47, 135-145) sees a close connection between egocentric speech and inner speech. He describes egocentric speech as "speech on its way inward". Egocentric speech has a social function. If a child is alone or between children that cannot understand him, the egocentric speech diminishes drastically. As the child grows older the he uses egocentric speech less often, it becomes harder to follow and the structure more and more resembles that of inner speech. The main trait of inner speech is its syntax which, compared to external speech, seems incomplete and with a tendency to predication. Vygotsky (1962:145) ascribes this syntax to the fact that a person who is thinking always knows the subject and the situation. In the beginning the syntax of egocentric speech is almost identical to that of social speech, but during the process of the transformation of egocentric speech to inner speech, the syntax becomes almost entirely predicative.

With syntax and sound reduced, the emphasis is on meaning. Vygotsky (1962:146-148) distinguishes three important features of inner speech, namely word sense, combination of words and influx of sense. The "sense" of a word is understood to be all that a word arouses in our consciousness. Meaning is only one of the zones activated and is the most stable one. Context, for example, may change the word sense. Word and sense are therefore more independent from each other than word and meaning.

The feature of word sense is central to this study. Although the second language learner may grasp word meaning from a dictionary, word sense is not easy to attain. Word sense grows from an intimate relationship between the speaker, his thoughts and experiences, the relevant context and the language he is using.

The second feature of inner speech is that several words can be combined to form one word that expresses a complex concept and contains all the elements of the separate words. Vygotsky (1962:147) mentions that some languages use this feature more than others. It is interesting that this feature is sometimes used in Setswana. This is one of the ways used to create new terminology in Mathematics; examples of this will be discussed in chapter 4. The third feature is the influx of sense. Influx of sense refers to the way in which the sense of different words influences each other. The sense of a word can become so complicated that it would require many words to explain it in external speech. The sense of the word "love" for example would be very different if used as "maternal love" or "love for alcohol". Inner speech is not an interior aspect of external speech - it is thought connected with words.

2.3.2.2 *Thought*

The next plane of verbal thought is thought itself. Thought is not automatically accompanied by speech. It has its own structure and the transition to speech may not always be easy. Thought does not consist of different units. A whole situation can be one thought and will need more than one sentence to express. Meaning of words becomes important when a thought has to be expressed in words. Vygotsky (1962: 159, 151) comes to the conclusion that direct communication between minds is impossible because thoughts, driven by our desires, needs, interests and emotions, first have to pass through meaning and then through words.

2.3.3 *Concept formation*

Vygotsky (1962:58-81, 82-118) distinguishes between the child's development of everyday (spontaneous) concepts and scientific (non-spontaneous) concepts formed under classroom instruction. Although some traits of concept formation can be seen

at an early age, real concept formation is not reached until puberty. Vygotsky (1962:58) likens these intellectual formations that perform functions similar to concepts, to an embryo that will develop to a fully formed organism.

The environment should present the child with problems that demand the forming of new concepts. However, concept formation is a function of the child's total social and cultural growth. Instruction plays an important role to mould and direct the child's mental functions so that true concept formation is possible.

2.3.3.1 Development towards concept formation

Vygotsky's view of the development of a child's thought processes up to the stage of real concept formation, may be depicted in the following scheme:

First phase Syncretic images Word meaning is constructed from a "heap" of unorganised, diverse objects that somehow form an image in the child's mind. The image is highly unstable. Many words have partially the same meaning to adults and children, which ensures mutual understanding (Vygotsky, 1962:59-61).
Second phase Thinking in complexes Thinking in complexes is coherent and objective, but does not reflect objective relationships in the same way as conceptual thinking. The bonds between the components are concrete and factual and are discovered through direct experience. Any factually present connection may lead to the inclusion of an element. A unique property (or set of properties) does not have a major role when forming complexes, as is the case in concept formation. An object may for instance enter a collection not because of a common property with all the elements in the collection, but because of a common property with one or a few of the elements.

Five variations of thinking in complexes are distinguished.

Associative complex

An object is included through any bond the child may notice, for example, similarity, contrast, proximity in space, etc. If the child is given a first object he may add one object because of its shape, another because it is near, another because of the contrast in colour. A word becomes a family name of a group of objects related in various ways.

Collective complex

Objects are selected based on some trait on which they differ and complement each other, e.g. a group of different colours. Associative and collective complexes may sometimes be mixed.

Chain complex

Objects are selected on the basis of one attribute, e.g., round blocks. The basis on which the objects are selected is still not totally stable. Another property may catch the attention of the child, e.g. that the block is red and then red blocks may be added, etc. Vygotsky (1962:64) sees chain complexes as the purest form of thinking in complexes.

Diffuse complex

Attributes are sometimes considered similar because a child has an unqualified feeling that those two specifics have something in common. Complexes formed like this are limitless. These complexes are often used when a child ventures beyond his own experience and he may form unexpected associations and generalisations (Vygotsky, 1962:66, 67).

Pseudo concept

According to Vygotsky, (1962:67) this type of complex plays, a predominant role in the child's real life thinking and forms a bridge to true concept formation.

In true concept formation, the learner distinguishes a common set of characteristics by which a specific is classified as being an example of a concept (Cangelosi, 2003:80). In the formation of a pseudo concept the child is still guided by a concrete visible likeness and forms a complex, although the result may be the same as if he has formed a true concept. The complexes formed are not spontaneous, but influenced by the language environment where the word has a stable meaning. The manner in which the pseudo concept is formed, however, differs from the way true concept formation takes place. The adult supplies a meaning to a word around which the child forms a complex, but an adult cannot transfer his mode of thinking to the child. Vygotsky (1962:68) sees this as a major obstacle in the analysis of thought.

The congruency between the product of the pseudo concept and the concept represented by the word around which the pseudo concept was formed, facilitates understanding between the child and the adult. The intercourse with adults becomes an important factor in the transition from thinking in complexes to true conceptual thinking (Vygotsky, 1962:66-69).

Third phase

Real concept formation

While complex thinking concentrates on connections, both analysis and synthesis are necessary for real concept formation. An attribute has to be singled out as necessary and be united with the other necessary attributes to form a concept. The following developmental processes take place:

Maximally similar objects

The child abstracts a whole group of traits without paying attention to each attribute as such. It is the start of a positive and negative abstraction of attributes.

One attribute

The grouping of objects takes place on the basis of one attribute, e.g. round objects or green objects. These are still not real concepts but only potential concepts. This type of abstraction is already present in complex thinking, but is unstable and the child can be distracted and change the attribute he was using to focus on another attribute. In the pre-conceptual thinking, however, one attribute becomes the main instrument of thought.

Real concept

Vygotsky (1962:80) sees concept formation as a multifaceted process: "a movement of thought within the pyramid of concepts". As mentioned before, to learn a new word is an act of generalisation. The meaning of the word develops and is replaced at different stages by higher and higher generalisations where more attributes are added. It finally leads to the forming of a true concept where all the necessary attributes are distinguished. In adolescence there is a transitional stage where the adolescent forms concepts but has difficulty in defining it in words (Vygotsky, 1962:76-81).

2.3.3.2 The development of scientific concepts

Different intellectual functions are involved and the child's mental development has to reach a certain level before true concept formation is possible. When facilitating the forming of non-spontaneous concepts, the teacher should take into account the features of child-thought at each developmental level (Vygotsky, 1962:82-85).

Spontaneous and non-spontaneous concept formations develop along different lines. They differ in relation to the child's experience and attitude. The mental processes involved in non-spontaneous and spontaneous concept formation influence each other. It is part of a single process. Spontaneous and scientific concept formation interact to develop the semantic aspect of verbal thought and to unite into a system of concepts.

Vygotsky (1962:85, 92, 93) sees instruction as a principle source that directs the evolution of concepts. School instruction develops the child's consciousness of his own mental processes (meta-cognition). As scientific concepts grow into a hierarchical system the child becomes conscious of his own thoughts. In this system of concepts some concepts are super-ordinate and other sub-ordinate. New concepts fit somewhere into this system. This systematisation is transferred to spontaneous concepts. Thus spontaneous concepts that are already formed may be modified and become part of the system of concepts. Scientific concepts, on the other hand, have to be filled with real life experiences to develop fully. "One might say that the development of the child's spontaneous concepts proceed upward and the development of his scientific concepts downward to a more elementary and concrete level" (Vygotsky, 1962:108, also see p. 116).

Concept formation is a complex process that involves many different functions. Language, however, plays an important role. Words are used as the means to centre attention, to abstract traits, synthesise them and symbolise them by a sign. Vygotsky (1962:82) sees the word as an integral part of the development of concepts.

2.3.4 Conclusions

According to Vygotsky:

- language is an integral part of thought;
- word meaning, word sense, the combination of words and influx of sense play an important role in the structure of inner speech and thought;
- word meaning and word sense are dependent on the cultural context of the child;
- words play an important role in generalisation and concept formation;
- scientific concepts are facilitated through instruction and filled with meaning by true life experiences and experiences with concrete objects;
- previously formed spontaneous concepts are integrated into the system of concepts when new scientific concepts are formed.

The following theory on the development of thought is of importance because it is specifically applied to Geometry, which is the focus of this study.

2.4 THE VAN HIELE THEORY OF COGNITIVE LEVELS

Pierre M. van Hiele and Dina van Hiele-Geldof made an important contribution to Geometry teaching with their Theory of Cognitive Levels in Geometry. This study focuses on the role that language plays in this theory. Van Hiele (1986:viii, 5, 6) acknowledges that his theory of cognitive levels originated with the Piaget's theories, although he is critical of certain aspects of Piaget's theory. Firstly, an important difference between Van Hiele and Piaget is that Piaget stressed that development is necessary to reach the different levels, while Van Hiele is concerned with learning as instrument to facilitate development from one level to another. This is a major difference. Van Hiele (1986:65) expresses himself in no uncertain terms: "It would, however, be a deplorable error to suppose a level is attained as the result of a biological maturation the teacher is helpless to influence." And: "The inability of children to think logically does not proceed from deficit of maturation but from ignorance of the rules of the game of logic. The child does not have at his disposal the structures from which the questions originate. He cannot understand the questions because he has not finished the learning process leading to the required level of thinking. The age of the children is important, in so far as they must have sufficient time to go through the necessary learning processes."

Secondly, while Piaget only distinguishes two levels, Van Hiele is convinced that more levels exist. Van Hiele emphasises the role of language in moving from one level to another. This is a logical result of the fact that teaching, learning, and thought are necessary to develop from one level to another. He (Van Hiele, 1986:4, 5) is convinced that the development of insight is the main purpose of learning. Influenced by the "gestalt theory" he became aware of the importance of the perception of structure.

2.4.1 Van Hiele's concept of structure

Van Hiele (1986:9-10, 33-37) distinguishes between five media in which structures can be found:

- The physical world with its perceivable structures (world 1).
- The human mind with mental structures (world 2).
- Common human thought - the mind of humanity (world 3). Common human thought can be accessed through asking, reading books, etc. It is highly structured and a major part of individual thought is acquired through talking, hearing and reading about common human thought. Language is very important for communication with common human thought.
- Language has its own structure. Language is necessary for the construction of many structures in all the previous media, especially in world 2 and 3. Insight includes that a person sometimes communicate directly with structures in world 1, without the intervention of language.
- Human action. Automatic action has its own structure that is not governed by thought and where language plays no role.

Structures are important phenomena. If a person recognises the structure it enables him to act in a situation, although the situation may not be exactly the same as situations he has been in before. If a person can thus with intention act adequately in a new situation, it shows that insight exists. The structure can be rigid or feeble. If a structure is rigid, it can be extended without making mistakes, although it may be extended in different ways. If it is feeble you have to see many examples to recognise the structure (Van Hiele, 1986:19-24). "The most important property of a structure is that it can be extended because of its composition" and the second property is that "structures have an objectivity, different people will continue it in the same way" (Van Hiele, 1986:23).

Van Hiele (1986:28) identifies four properties governing structure from the "Gestalt" psychology. He illustrates it with the example of the human skeleton:

- *A structure may be extended.* By looking at a human skeleton a person can realise that he also has a skeleton. No new elements are necessary for such a thought process.
- *A structure may be seen as part of a finer structure.* A finer structure can be named through language and parts of the skeleton can be recognised.
- *A structure may be seen as part of a more inclusive structure.* This may be illustrated when the skeletons of humans and animals are compared and studied.
- *A structure may be isomorphic with another structure.* Two structures are defined by rules that correspond with each other. An example of this is when someone refers to the skeleton of a building, in analogy of the skeleton of a human being. Isomorphism is facilitated by language, sometimes by only one symbol of language.

Language is both medium of communication and tool to think. Language creates possibilities to constitute new structures. From this explanation of Van Hiele it is clear that language plays an important role in the teaching-learning situation and in the process of attaining insight.

2.4.2 Levels of reasoning

Van Hiele focuses in his explanation of his theory of cognitive levels on Geometry and postulates five levels of geometric reasoning from basic recognition through to mathematical rigor.

Level 0. *Visualization/Recognition* The learner works with the geometric figure as a whole. Individual properties are not perceived.

Level 1. *Analysis.* The learner recognizes properties of a figure and forms classes of figures, e.g. rectangles. Size and orientation is no longer important. Learners are not yet able to order or relate these properties within larger relationships.

Level 2. *Explanation and informal deduction (ordering)*. The learners can order and relate properties, for example a square is also a rectangle. Definitions are meaningful and informal proof (reasoning) can be constructed during exploration.

Level 3. *Deduction*. The learner can work with postulates, theorems, proofs, and other aspects of an axiomatic system. He can do a formal proof and see the larger picture.

Level 4. *Rigor*. The learner understands formal aspects of deductions. Alternate axiomatic systems can be constructed, for example an axiomatic system for spherical Geometry.

Van de Walle (2001b:T-69) effectively illustrates the cognitive levels in the Van Hiele Theory with the following diagram:

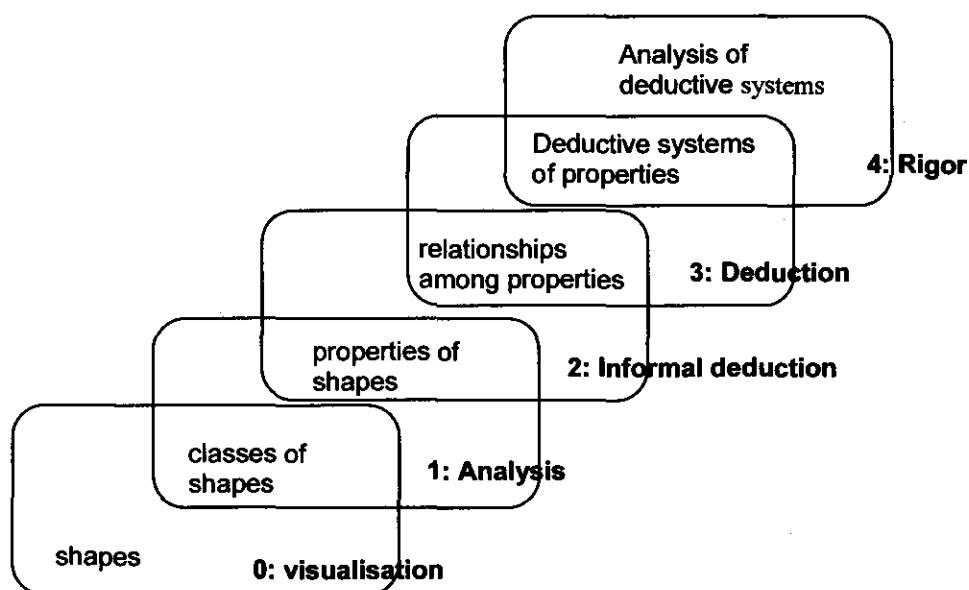


Figure 2.4.2 – Cognitive levels

Van de Walle (2001b:T-69) describes the characteristics of the levels as follows:

The levels are sequential. To arrive at a higher level, one will first experience each earlier level.

The levels are not age-dependent. Maturation in itself does not contribute to growth from level to level. Adults can still be at level 0".

Geometric experience is the most important factor that contributes to growth in geometric thinking. Reflective activities appropriate to the current level and which lead to the next have the best chance of influencing progress.

Instruction must match the child's level of thought. Activities above a child's current level of thought will be addressed only superficially.

Van Hiele (1986:50, 79) stresses the importance of the correct language for each level. The transition from one level to another is facilitated by a teaching-learning program and is, according to Van Hiele, not possible without acquiring new language. If a teacher for instance uses language appropriate to level three, learners on level two will not understand the teacher.

2.4.2.1 Stages of instruction to reach a next level

In the learning process necessary to progress from one level to another Van Hiele (1986:53, 54) discerns five stages, namely:

- In the first stage, that of *information*, pupils get acquainted with the working domain.
- In the second stage, that of *guided orientation*, they are guided by tasks (given by the teacher or made by themselves) with different relationships of the network that has to be formed.
- In the third stage, that of *explicitation*, they become conscious of the relationships, they try to express them in words, they learn the technical language accompanying the subject matter.
- In the fourth stage, that of *free orientation*, they learn by general tasks to find their own way in the network of relationships.

- In the fifth stage, that of *integration*, they build an overview of all they have learned of the subject, of the newly formed network of relationships now at their disposal.

2.4.2.2 *The role of language in the different stages*

In the first stage of *information* the teacher converses with the learners in well-known language to clarify the context he wants to use. In the second stage of *guided orientation* the relevant relationships must be discussed with the learners to help them to trace the relations, while doing appropriate activities.

The third stage, *explicitation*, comprises the teaching of mathematical terminology and expressions relevant to the level and the need for learners to formulate their new insight. During this stage, the learners try to express relations in words. The learner understands the structure, but must learn the language to communicate with others about the structure. Language can be used to extend structures (Van Hiele, 1986; 77-79, 97). According to Van Hiele (1986:57) this stage is too often neglected in the teaching process. Not enough time is spent on the explicitation process.

Learners need mathematical language to express themselves. This language is an informal mathematical language that will develop further to include the correct technical language relevant to the level that has to be attained. The need for the teacher to teach Mathematics-specific language in the Mathematics class is implicit in the levels-theory. It is important for the teacher to realise that new technical language can only be fully understood if enough examples underscore its meaning, in other words, if conceptual understanding has really taken place.

In the fourth stage of *free orientation*, learners become acquainted with the relevant field of thought. Through various tasks they become enabled to choose from different possibilities and ideally perceive the whole field of thought.

In the fifth stage, namely *integration*, language again plays a major role. In this stage an overview of the structure of concepts and relationships is done and the structure of the level is described in words. Objectification takes place and leads to a reduction

in level. The learners are now able to apply rules relevant to the topic taught, without losing the ability to return to the original higher level of understanding that has been attained (Van Hiele, 1986:57, 96-98).

2.4.2.3 Language and the structures at the different levels

Through the reduction of levels, Van Hiele (1986:53) reaches a simplified classification on which he comments as follows: "The above classification is suitable to a structure of Mathematics and perhaps mathematicians will be able to work with it." The first three levels of this model are especially suitable to apply in the school environment and therefore the discussion of language at the different levels pays attention only to the first three levels of simplified model. The levels are:

Visual (level 1). Learners recognise shapes as a whole.

Descriptive (level 2). Learners distinguish shapes on the basis of their properties.

Theoretical (level 3). Learners are able to devise a formal geometric proof and to understand the process employed (Teppo, 1991:210).

At the first level, the visual level, language supports visual observation, serves to communicate knowledge about structures and supports thinking about the structures. At the second level, the descriptive level, the child thinks about the nature of the structures of the first level and discerns the properties. New language has to be introduced to discuss the relations between figures. Discursive thinking and explanation, for the most part, uses the language of the second level. This language has to be developed during the five teaching-learning stages necessary to proceed from level 1 to level 2.

To prove, for example, that two triangles are similar, the language of the theoretical level (level 3), such as the word 'definition', has to be introduced. The language of the third level has a much more abstract character than the language of the second level. This language will be introduced in the time it takes to develop from level two to level three, especially in the explication stage. Van Hiele (1986:83-91) concludes his

discussion on the language of the levels by warning teachers and authors of textbooks not to introduce language that is not appropriate to the relevant level of reasoning, because learners will not understand the discussions.

2.4.3 Intuitive foundation of Mathematics

According to Van Hiele (1986:122) the construction of a concept starts with intuition, and it is important that the teacher selects the correct intuitive starting point. The teacher has to aim for the correct language suited to this intuitive starting point to enable the learner to communicate. He also warns that if the learner has a deficiency in vocabulary or verbal conception, the teacher should take steps to overcome the deficiency. Furthermore, van Hiele (1986:178) finds that pre-school children seldom pass the second level with their skills and "only the control of the mother tongue continues a good distance in the direction of the third level...". In view of these findings great care has to be taken when teaching Mathematics learners who are not taught in their mother tongue, because their LoLT has not nearly reached the third level and therefore misconceptions can develop easily.

Intuitive knowledge is entangled in mother tongue and when intuitive starting points are chosen for the development of new concepts and the relevant accompanying language is selected, the teacher should take great care that any verbal conception or vocabulary deficiency has been overcome. This does not only apply to the primary school. Many new concepts are introduced during the senior phase and at high school level. At this stage there will also be new concepts that have to be introduced by starting at the intuitive level where the verbal conception and vocabulary play an important role. In the Setswana class it may be possible that code-switching and an English/Setswana glossary may be useful aids to bring about real understanding.

2.4.4 Conclusions

- Van Hiele assigns a major role to language in his Theory of Cognitive Levels in Geometry.

- Conceptual development starts at an intuitive level. The correct language should be selected to accompany this intuitive starting point. Verbal conception and vocabulary is important. The role of the main language has to be considered in the teaching process.
- Language is important during all the learning stages between the levels.
- Language is especially important during the explicitation stage, when discussions take place to clarify relations. Informal mathematical language develops into the correct scientific mathematical language for the relevant stage.
- When the stage of integration has been reached, language again plays a very important part.
- If the language of a higher level of reasoning is used when the learner is still at a lower level of reasoning for the specific topic, the learner will not understand the teacher.

2.5 THE NETWORK THEORY

The network theory of information processing renders it possible to explain some phenomena in the understanding of Mathematics. The framework used to study meaningful learning by means of this theory, departs from the viewpoint that it is possible to represent knowledge internally and that this representation is structured. The form of the external object with which the learner is interacting will have an impact on the way in which the learner will represent it internally. Vice versa, the way in which the learner handles the external object would throw light on how the internal representation is structured (Hiebert & Carpenter, 1992:66).

2.5.1 The establishment of networks

2.5.1.1 Internal connections

The network theory postulates that networks of knowledge are produced when relationships are formed between internal mental representations of knowledge. Two metaphors are offered to describe these networks:

A vertical hierarchical structure. Some representations may be arranged beneath or within other more general representations. A generalisation forms an umbrella for specific examples (Hiebert & Carpenter, 1992:67).

A network that is structured like a spider's web. Such a network will consist of

- *Propositions:* Propositions is the smallest unit that can be described as true or false. Propositions consist of nodes. Nodes are pieces of represented information that are connected with each other through relationships. These connections can be compared to the threads of the spider's web. The nodes are connected to various other nodes. It will therefore be possible to travel between the nodes to reach a certain piece of information.
- *Propositional networks:* A set of related propositions will form a network (Shunk, 1996:171, 172; also compare Hiebert & Carpenter, 1992:67).
- *Schemata:* Schemata are larger internal networks on a relatively high level of abstraction. These schemata represent, for example, structures of objects, persons and situations. The schemata form structures where new knowledge with certain properties can fit in. It is hierarchical. Schemata are especially important for teaching. They can be activated every time new knowledge with certain given properties has to be learned (Shunk, 1996: 168-176; Hiebert & Carpenter, 1992:69).

The two metaphors may also be mixed. This type of representation will be a hierarchical structure, with a spider's web of information on each level (Hiebert & Carpenter, 1992:66)

2.5.1.2 *Types of knowledge*

The following different kinds of knowledge can be integrated into a network:

Declarative knowledge. Declarative knowledge includes facts, opinions, generalisations, theories, hypotheses and attitudes. It is acquired when a new proposition is stored. Propositions can be associated with other related propositions to form a network. The learner might generate additional propositions. The acquired new proposition, as well as additionally generated ones, is stored together. The network is consequently restructured. A problem arises when the new knowledge cannot be connected to any existing propositions. By implication it is necessary for teachers to remind the learners of related material, do revision and organise the materials. Links have to be made explicit to learners.

Procedural knowledge. Procedural knowledge is the "how" of cognitive activities. A network of condition-action sequences is formed, called productive systems. A certain set of conditions activates a sequence of activities, or procedure. A production is procedural knowledge that includes the conditions under which a procedure will be followed. Productions can be represented as propositions, and networks may be formed. These productions are of major importance in problem solving (Shunk, 1996:173-177).

2.5.1.3 *The influence of external associations*

According to Hiebert and Carpenter (1992:66-67), external activities influence the construction of internal connections. When new information is added to an existing structure, the whole structure changes. Noticing the differences or similarities between the two relevant external representations may stimulate connections between two internal representations.

Connections between external representations based on differences or similarities

These connections can be formed between:

- *two different mediums of representation of the same mathematical concept*, for example, a ratio of 1:4 may be represented externally by the spoken word, it may be written in words or symbols. It may also be represented by comparing one block to four blocks or two glasses of water, one filled only to one quarter of its capacity and the other filled to capacity, etc. Similarities and differences can be observed to form connections.
- *two related procedures or ideas in the same medium*, for example, the associative property is not generally applicable for subtraction $(a - b) - c \neq a - (b - c)$, and also not for division $(a \div b) \div c \neq a \div (b \div c)$. Both subtraction and division are inverse operations. The two expressions are not the same, but strong connections exist.

The connections based on similarities and differences are likely to form web type networks, because the information is usually at the same level of generality.

Inclusion and subsumption

When one fact or procedure is a special case of another, hierarchical networks may be the result. An example of this would be the rectangle that may be seen as a special case of the parallelogram and the square, which is a special case of the rectangle (Hiebert & Carpenter, 1992:67-69).

2.5.1.4 Learning Mathematics with understanding

Hiebert and Carpenter (1992:67) define the understanding of Mathematics as follows: "A mathematical concept or procedure or fact is understood if it is part of an internal network. The degree of understanding is determined by the number and the strength of the connections".

This has the following implications for teaching and the language of instruction:

- *Meaningful information* is more likely to be retained because it activates information in the long term memory. Knowledge will make more sense to learners if it is connected to pre-knowledge, because the information may be subsumed in an existing proposition network. Thus, it is important that new knowledge will be connected to pre-knowledge. The pre-knowledge may originate from real life or the new knowledge may fit into a previously established network of mathematical propositions.
- *Organisation of knowledge*: New networks will be formed more easily if the knowledge is well organised and new knowledge will be assimilated easier and more permanently if it fits into an already existing network.
- *Elaboration*: Elaboration takes place when more information is added to an existing network by means of examples, more detail, etc. Elaboration is a form of rehearsal and keeps the information active in the short-term memory. This facilitates learning and the permanent storage of information in the long-term memory (Shunk, 1996:178-180).

It can be inferred from the Network Theory of Learning that there are more proposition networks available to assimilate new concepts if the learner is taught in his mother tongue (or main language). When the learner arrives at the pre-school class, or in grade one, a myriad of concepts has already been formed. A word may represent a specific concept, but is used in different ways. A network of related concepts may be formed, some abstract, others concrete. Such a network will result in a rich and elaborated understanding of the word. A new mathematical meaning can also be assimilated into that network.

The concepts *acute* angle and *obtuse* angle serves as an example. While teaching these concepts to a class where English first and second (or third) language speakers were present, the researcher observed that the first language speakers caught on to the terminology for the concepts much easier than the ESL-learners. Even those first language speakers that were weaker in their Mathematics than some of the ESL-learners had less difficulty with the terminology.

The first language learner knows that the word "acute" means "sharp", even though it may be an "acute" pain, or "acute" awareness. The connection with the concept "acute" is that of something sharp and piercing. *Obtuse* is also used in connection with somebody that is dumb not "sharp". Although the connection may not be obvious, the result is that first language learners are less inclined than ESL-learners to confuse "*obtuse angles*" and "*acute angles*", especially if the teacher activates the learners' pre-knowledge.

The words "*acute*" and "*obtuse*" are often meaningless to the ESL-learners. Many ESL-learners encounter these words for the first time when they learn about "*obtuse angles*" and "*acute angles*". Although they are usually introduced with the diagrams of the respective angles, it is mostly introduced simultaneously. Because the words "*obtuse*" and "*acute*" may be meaningless to these learners, they will be inclined to confuse the two terms after a time lapse if it is not revised enough. In view of the Network Theory of Learning a possible explanation is that the ESL-learner has to set up a new network, while the first language learner fits the new concept into an existing network.

2.6 RECENT RESEARCH ON LANGUAGE AND THOUGHT

The Whorfian hypothesis that states: (1) languages vary in their semantic partitioning of the world; (2) the structures of one's language influences the manner in which one perceives and understands the world; (3) therefore, speakers of different languages will perceive the world differently, was popular in the 1950's and 1960's (Gentner & Goldin-Meadow, 2003:4). Following critique on this hypothesis, a time of scepticism about a significant relationship between language and cognition was ushered in, and research in this field was at an ebb. According to Gentner and Goldin-Meadow (2003:6-7) things have changed recently and the relationship between language and cognition has come under scrutiny again. Gentner and Goldin-Meadow discern three important trends, namely:

- Evidence of substantial variability in how languages partition the world, e.g. a videocassette and an apple are both placed *in* a recorder and a bowl

respectively in English, but in Korean use two different words, **kkita** and **nehta**, because the cassette *fits tightly* into its container and the apple *loosely*. The same word **kkita** is used to describe the action of putting a ring **on** a finger and the finger **in** the ring, because the *tight fitting* is the important feature.

- Theoretical arguments from different fields make a case for an important link between language and cognition.
- There is a shift away from studying the link between language and cognition through means of colour, to domains such as space.

Two books particularly illustrate the current interest in the field of the interaction between language and cognition. Research originating from a wide cross-section of disciplines such as linguistics, anthropology, cognitive psychology, cognitive development, philosophy and animal cognition, represented in these books indicate the extent of the research being done in this field at present. These books are *Language in mind: Advances in the study of language and thought*, edited by Gentner and Goldin-Meadow (2003) and *Language and conceptualisation*, edited by Nuyts and Pederson (1997).

The interaction between language and the development of spatial concepts is one of the focal points of research. An example of this research is the interesting study of Bowerman and Choi (2003), who compared the different spatial words and the concepts in Korean and English. They come to the conclusion that language sensitises infants for certain spatial properties and that sensitivity for other spatial properties may diminish if they are not needed for the local language (Bowerman & Choi, 2003:417). In contrast, Munich and Landau (2003) comes to the conclusion that "language-specific experience does not appear to affect non-linguistic representations" but also maintains that the potential of language to mediate understanding as well as misunderstanding, must be considered.

2.7 CONCLUSIONS

In view of Piaget and Vygotsky's theories, the question arises whether the majority of Batswana LEP-learners are negotiating the meaning of the English words necessary

to form concepts in Geometry in such a way that their competence in English can adequately facilitate thought and true concept formation.

Van Hiele places much value on the development of the correct language for the reasoning level that the Geometry learner is aiming to reach. This language not only includes the names of shapes, but also causal words, phrases like “if and only if”, technical mathematical words, etc. However, explanations start on the intuitive level and the correct language to start with has to be found in the learner’s existing vocabulary or in descriptive informal “mathematical language” that will link with the existing vocabulary of the learners.

Language facilitates the establishment of networks. In the mother tongue words are placed in an elaborated network, where one word may be linked to different meanings or nuances of meanings in different contexts. This could be related to what Vygotsky calls *word sense*. Often, new mathematical terminology in the main language could be linked into a network, while new terminology used in the second language may sometimes be propositions that are not adequately linked.

At present a lively debate exists among researchers from a wide range of disciplines about the relationship “language and thought”. The influence of language on the formation of spatial concepts is one of the focal points of this research. The importance of language as one of the factors that influences conceptual development seems to be undisputable.

In the next chapter the intimate relationship between language and Mathematics is examined.

THE ROLE OF LANGUAGE IN THE MATHEMATICS CLASSROOM

3.1 INTRODUCTION

The topic of language and Mathematics has become increasingly relevant in recent years. In their historical perspective Ellerton and Clarkson (1996:989-991) indicate that a number of books have been published since the late eighties and during the nineties on the interaction between Mathematics and language. The Standards Document in the United States (NCTM, 2000:60-63) stresses the role of language and communication.⁷ In Australia language factors in Mathematics learning also have been recognised as important in both research and curriculum documents. Ellerton and Clarkson (1996:1017) express the importance of language as follows: "It should be of serious concern that so many Mathematics education researchers appear to have paid little more than lip service to the centrality of language factors in all aspects of Mathematics teaching and learning".

After the publication of the article by Ellerton and Clarkson in 1996, the interest in Mathematics and language continued. Much has been published specifically in the field of teaching in multilingual classrooms (De Villiers, 2000:3). As a result, different new phenomena of language are being studied. Classroom discourse is becoming more and more important and the use of natural language in the Mathematics class is claiming its ground. Discussions between learners increasingly take place in small groups. More written explanations are required from learners and they have to communicate their ideas in an informal style (Mitchell, 2001: 29, 30).

In South Africa the teaching and assessment strategies incorporated in Outcomes Based Education, such as journal writing, reports on investigations and group work, call for the learner's written as well as oral communication skills in the Mathematics register.

⁷ NCTM (2000:60) states that learners should be able to:

- organise and consolidate their mathematical thinking through communication;
- communicate their mathematical thinking coherently and clearly to peers, teachers and others;
- analyse and evaluate the mathematical thinking and strategies of others; and
- use the language of Mathematics to express mathematical ideas precisely.

3.2 MATHEMATICS AS LANGUAGE

In literature dealing with Mathematics teaching and learning, Mathematics is often described as a special language that a learner has to learn. Usiskin (1996:232) expresses his view in no uncertain terms: "Mathematics is *like* a language because it *is* a language like any other". To argue his view Usiskin compares Mathematics to language with regard to the following aspects, Mathematics:

- is both oral and written;
- can be either formal or informal;
- not only describes but helps to format concepts;
- has communication as a major purpose;
- has a well constructed syntax.

Usiskin (1996:232) is of opinion that mathematicians should look at how languages are taught and learned for clues on how to guide the teaching and learning of Mathematics. Although the view that Mathematics is a language "just like other languages" is perhaps a little forced and may be disputed, Usiskin (1996:233, 236; 237) makes a very valid and important point: "Recognising that Mathematics is a language forces one to rethink its teaching." For too long, silence in the Mathematics classroom was the ideal and communication between learners in the classroom was discouraged (also see Costello, 1991:171).

Costello (1991:167, 170) rightly argues that to describe Mathematics as a language narrows it down, because it is not only a means of communication, but also an activity and a body of knowledge. In addition, Mathematics has the function of making manipulative operations and calculations easier and is often a solitary activity. Costello (1991:167; 171, also see Pimm, 1987:xiv) sees some value in describing Mathematics as a language if used in a metaphorical sense, because it can be used to describe patterns, relationships, structures and properties that cannot be communicated in any other way. Language and Mathematics furthermore share the function of being a vehicle for logical thinking. The pleasure derived from

mathematical activities can be compared to the pleasure derived from writing poetry or short stories.

It therefore seems valuable to discuss the linguistic features of Mathematics and the role that language plays in it. It should however be kept in mind that it is the communicative role of Mathematics to and from the learner that is under discussion and not all the features and activities which the subject of Mathematics encompasses.

3.2.1 Mathematics as spoken language

The oral language of Mathematics is important for the understanding of mathematical concepts, especially where interpretation is needed. Usiskin (1996:236-241) stresses that oral communication, both formal and informal, is important for the learning of Mathematics. The constructivist view of learning Mathematics emphasises the need that learners should speak about Mathematics. By articulating their mathematical ideas and discussing it with peers, learners negotiate mathematical meaning for themselves (Costello, 1991:174, Pimm, 1987:23-24, Sai, 1994:15-17). Discussion gives learners the opportunity to modify and develop their ideas and to integrate new knowledge into existing schemes. It fosters relational understanding. Learners think more clearly when they speak out loudly. When learners formulate a problem, they often resolve it for themselves (see Orton, 1987:135-137, Orton & Frobisher, 1996:59).

This is particularly true for Geometry. Oral communication enables the learner to make knowledge his own and to make connections between different concepts and ideas. The correct terminology and appropriate language is necessary to describe properties of figures and to understand and discuss geometric principles. The learners therefore have to internalise the vocabulary that will enable them to develop their sense of space and to solve problems and write proofs (Swindal, 2000:246).

In Curriculum 2005 one of the major changes in the teaching approach is the importance of learner participation and group work, also in Mathematics (Department

of Education, 1997b:MMLS, SO9,⁸ p. 29). In line with Usiskins' suggestion, the South African Mathematics educators realise that learners should communicate about Mathematics much more, both amongst each other and with the teachers. Additionally, more attention is paid to how learners think. Learners should be able to communicate their thoughts clearly and precisely to a teacher. It follows that the learners' skill in using Mathematics as oral language should be developed to supply the learners with the language tools to communicate orally in Mathematics. Brainstorming, group work, reporting on investigations and even the ordinary question-and-answer method could be developed to encourage learners to speak about what and how they think, to formulate their thoughts and to express themselves clearly (also see Orton & Frobisher, 1996:60).

Pimm (1987:24, 25) describes the value of "self-talk". Sometimes this self-talk can be sub-vocal and by times a learner would speak aloud. "Self-talk" forces a learner to find words for his thoughts and helps the learner to explore and guide his thoughts on a problem. Pimm concludes: "Articulation can aid the process of reflection by affording better access to thought itself." In the traditional South African classroom this essential part of a learner's struggle to find solutions to problems was inadvertently discouraged as the learners were encouraged to work in silence.

Another issue that Usiskin (1996:238) touches on, but does not investigate in depth, is that a child learns to speak a language at a very young age. He argues that if an oral language is not learned before a certain age, it becomes more difficult to learn. He suggests that the delay in confronting learners with for instance Geometry, may make it more difficult for learners to learn it at a later stage.

Orton (1987:133) is of opinion that oral language should be used for a longer period of time. In his view symbolism should only be introduced after the learners have mastered transitional notations such as "area=length x breadth" and have reached a real understanding of the structures. When they discuss the need for learners to learn to use the precise language of Mathematics, the NCTM (2000:63) is of opinion that learners should first start to communicate in their own words and cautions that:

⁸ SO9: Use mathematical language to communicate mathematical ideas, concepts, generalizations and thought processes.

“it is important to avoid a premature rush to impose formal mathematical language”. Van de Walle (2001a:214, 209-213) propagates that fraction symbolism should be delayed as long as possible and that words like, for example, two-thirds or one-half should be used for a longer time before numerical symbols like $\frac{2}{3}$ or $\frac{1}{2}$ are introduced. The emphasis is on conceptual development, which is on par with new developments in the teaching of Mathematics.

To conclude one can say that the ability to formulate problems in Mathematics, to talk about Mathematics using informal but also more formal and precise terminology, should be fostered and should be one of the outcomes of Mathematics teaching.

3.2.2 Mathematics as written language

In the traditional classroom culture the emphasis falls on the reading and interpretation of written Mathematics and not so much on writing down mathematical ideas and explanations. Written Mathematics is mostly confined to writing down calculations, mathematical manipulations, geometrical proofs, memorised definitions and graphical representations, etc. The use of the language of communication, e.g. English, is mostly confined to word sums and a few expressions or a short sentence here and there. Symbolism plays a major role in written Mathematics.

Although the use of symbols and the syntax of calculations and manipulations certainly are of major importance, it is only one section of the language of Mathematics and it is not the focus of this study. The focus is on the mathematical register of the language⁹ of instruction. In the traditional Mathematics classroom the learner has little occasion to practise to write the mathematical register of the language of instruction. The learner more often experiences only the formal written language of Mathematics in the textbook and he is only required to read, interpret

⁹ A “register” of a language in this context refers to those subject specific terminology, word meanings and expressions that are used when communicating in the domain of a specific subject or specialised field. This “register” will only be fully understood by those who have become acquainted with the specific meanings given to words in the context of the relevant specialised field.

and perhaps memorise it. The informal use of Mathematics as language to write, express and explain thoughts and processes is seldom required of the learner.

This has changed in the wake of the new methods of teaching that have been introduced since the constructivist view of teaching Mathematics has gained momentum. Teaching methods such as the investigative approach (James:1990), the conceptual development method (Gunter, Estes & Schwab, 1999:100-121) and the importance placed on group work and discussions with peers have changed the scene. Costello (1991:173, 176) identifies growing demands on the learners' linguistic skills when he describes the writing that arises from an investigation: "It is commonly considered worthwhile that such writing should include not only the mathematical structures and relationships discovered but also a description of the process of thinking, exploring and discussing which led to the discovery." To communicate these processes and thoughts on Mathematics, the learner will have to be able to use an informal written mathematical register of the language of instruction. When a learner has to write down mathematical processes and reasoning, he has to reflect on the Mathematics involved to be able to formulate his thoughts and to communicate clearly. Therefore, "written communication should be nurtured" (NCTM, 2000:61, 62). Informal writing should lead to the development of the ability to write also in the more formal register of the language of Mathematics.

3.2.3 Reading Mathematics

Orton and Frobisher (1996:57) expressed concern regarding the fact that learners were not being educated to read Mathematics and that they were seldom required to read passages from their textbooks. In South African schools the situation was much the same. The question may be asked whether the introduction of the new Mathematics curriculum in South Africa is bringing about an improvement in the situation. Teachers should apply measures for readability in selecting new teaching materials. The teaching materials have to be accessible within the reading level of the learners. Orton and Frobisher (1996:57) also pointed out that applying measures for readability is no easy task because of the mixture of everyday language, specialist terminology and mathematical symbols used in mathematical

text. It could be added that the learner should experience text where the formal mathematical register is used correctly, but where terminology and concepts are explained in informal language on his own level. Writing and selecting teaching/learning material that uses the formal and informal mathematical registers of the language of instruction in a balanced and accessible way, is no easy task. Teachers should be trained to apply the correct measures of readability and practice in the selection of materials for learners at different levels should be included in teacher training.

More attention should be paid to motivate learners to read Mathematics and about Mathematics. It is obvious that to achieve this goal, interesting reading material, as well as interesting textbooks should be available. For many learners a change in belief will have to take place - the belief that a new topic in Mathematics can only be tackled if some expert has introduced you to it. Much more attention should be paid to history, interesting details about the lives of great mathematicians, interesting links to nature, and other fields of Mathematics that exist, e.g. spherical Geometry. Learners in middle school are fascinated with "magician's" Mathematics, where he can learn to tell someone which number he thought of or to prove impossible things by multiplying with zero, riddles, etc. However, reading material have to be available and the learner has to be motivated to read it in his own time (see Cangelosi, 2003:237 for names of "trade books" for interesting popular reading on Mathematics).

3.2.4 Symbolism as part of the Mathematics language

The language of Mathematics furthermore consists of mathematical symbols used in the different mathematical disciplines, pictorial Mathematics such as graphs, Venn diagrams, geometrical diagrams and pictograms (Usiskin, 1996:237). Much can be said on this topic. However, this is not the focus of this study. It is enough to say that the learner has to master symbolism as a major part of the language of Mathematics. Learners should be able to translate words into symbols and vice versa.

Often, as in word sums in different topics, e.g. sequences and series, the learner should be able to translate the syntax of the words into an expression or equation

with the correct mathematical syntax. In these instances the learner has to be master of both the mathematical register of the language of instruction and symbolism, as well as the concepts involved. This could become very difficult for a learner, especially for the LEP-learner.

3.2.5 Mathematics as special register of language

As in other subjects, Mathematics is expressed in a special register peculiar to the subject. Cangelosi (2003:233) describes the use of mathematical language as the "power to communicate precisely". He continues by saying that this power comes at a price. Mathematicians have to learn to shift between figurative interpretations of ordinary English and literal interpretations of mathematical English. These "literal interpretations" form the register of Mathematics not only includes subject specific terminology, for example "parallelogram", but also certain phrases and modes of arguing (Pimm, 1987:76). The Mathematics register includes ordinary words that would have a different meaning in Mathematics than in the everyday language. The term "function" could be used as an example. In Mathematics "function" has a very rigorous definition, which differs from the general use of the word in natural English. Many such words exist and have been reported in research. Learners sometimes struggle to understand a topic because they decode a word that represents a mathematical concept in the everyday sense of the word. Sometimes the difference in meaning could be quite subtle. Orton and Frobisher (1996) use the example of the word "similar", which is used with two meanings within Mathematics itself. Two Geometry problems could be solved in a similar way, which would imply that the same method could be applied to solve the problems, but it would not be exactly the same. In another instance, two triangles could be similar and it would have a very specific meaning, the sides would be in the same proportions and the angles respectively equal (also see Durkin & Shire, 1991:74 for examples of words causing problems).

Pimm (1987:79, 86) highlights another problem area namely the specific use of prepositions in the Mathematics register of English, e.g., the square *on* the hypotenuse (geometrical) and the square *of* the hypotenuse (numerical).

Connectives such as "and" and "or" sometimes have a specific meaning, e.g. in sets where "and" would indicate the intersection of sets, and "or" the union of sets. Expressions such as for example "if and only if", "if ... then", "greatest common divisor", form structural units that are always used as such and are important in the mathematical register.

Costello (1991:178) expresses concern about the phenomenon that words can sometimes act as barriers to the recognition of mathematical ideas. Learners that understand a mathematical property may not relate the term used for that property to the question asked, for example, it may be asked that the learner apply the distributive property to $a(b+c)$. The learner may be very well acquainted with the fact that $a(b+c) = ab + ac$, but may have no clue to what the distributive property may be.

The learner has to be aware that he cannot always use everyday strategies to decode the meaning of the combination of mathematical words that form an expression, e.g. red flowers would be flowers that are red, an example of a rectangular prism may be a cylinder with nothing obviously rectangular about it. Pimm (1987:101, 102) gives the example of a circular triangle. Specific knowledge of spherical Geometry has to be applied to understand that this is a triangle on the surface of a sphere. Again no circular property would be obvious.

According to Ellerton and Clarkson (1996:1000-1004) the "Newman research" has been used widely in the Asian Pacific region. The "Newman method" is a procedure where learners who have attempted word problems are asked a sequence of questions. Through this evidence was found that indicates that learners experience difficulty with semantic structures, the vocabulary and the symbolism of Mathematics. Most of the errors were found in the "comprehension and transformation" stages of the word problems. Furthermore, semantic structures were found to be of utmost importance in learning and in classroom discourse.

Semantics especially poses a problem for second or third language speakers. The following two word problems were presented to about seventy in-service primary school teachers in an upgrading programme. A discussion of about three quarters of

an hour followed, first in groups and then in a whole class discussion, before all the teachers could really comprehend the difference between the two problems:

- (a) Peter painted half of a hedge in the morning and a *third* in the afternoon. What part of the hedge was left unpainted?
- (b) John painted half of a hedge in the morning, a *third of what was left* in the afternoon. What part of the hedge was left unpainted?

Word meaning, context, semantic structure and syntax are very important in especially written Mathematics. It may sometimes be very rigid. Ultimately, the learner should be able to use the mathematical register and symbols to express mathematical ideas and content precisely.

3.2.5.1 *The development of a Mathematics register in indigenous languages*

It is clear that Mathematics as language needs the language of instruction as vehicle. To provide this vehicle, each language has to develop its own mathematical register to enable the speakers of the language to communicate mathematical concepts and procedures effectively in their own language. The learner has to master the vocabulary and structure of this register to be able to express, speak, write and think in "the language of Mathematics".

In Setswana the mathematical register is not fully developed. This is of importance in the debate concerning the preferred language of instruction for Mathematics in schools and such practices as the use of code-switching in the classroom. These features will be discussed more extensively in the next chapter.

3.3 TEACHING LANGUAGE IN THE MATHEMATICS CLASSROOM

Explicit teaching of the subject specific language registers in the classroom is gaining momentum. "Many subject lecturers have realised that they need to become teachers of the language of their discipline. Language lecturers are familiarising themselves with enough content to ensure they are teaching communication skills in

a context which is relevant to students within particular disciplines" (Jacobs, 2001:2). Some research has been done on syntactic, semantic and pragmatic features causing difficulty and on programmes to support learners linguistically in their subjects and the development of academic language proficiency (Jacobs, 2001:2). The need for linguistic access to content knowledge has been highlighted by the scores of learners who are not taught in their first language. Cangelosi (2003:236) says that doing Mathematics creates messages that need to be communicated via speaking, writing, reading, listening and observing. Learners will only be able to communicate their ideas if they are taught the necessary mathematical language or "register" they need.

Adler (1999:4) distinguishes between educational discourse and educated discourse. Educational discourse is the informal mathematical language of teaching and learning in the classroom. Educational discourse should lead to educated mathematical language. Educated mathematical language is the Mathematics register where specific terminology and syntax are used. The learners have to use both educational and educated mathematical language to become familiar with it. The teacher has to facilitate the learners' "entry into mathematical [educated] discourse" (Adler, 1999:4). Lansdell (1999:227, 228) says that the language used when new concepts are introduced plays a critical role in the understanding of such a concept. When a new concept is formed, there is an interplay between the real world image, language and the learner's thought processes. Informal discussion around the concept helps the learner to form the concept. Lansdell presents a case study where "informal" discussion took place about a work card focusing on money. The discussion was conducted in what was referred to earlier in this study as "natural language". The learner originally talked about "*one penny she had left*" after she had bought an item. The term "*change*" was introduced by the teacher with the specific meaning of *a surplus of money returned when something has been purchased* (Lansdell, 1999:229-232). The learner first experimented with the word *change*, applied it incorrectly, was corrected by the teacher, and was in the end able to use it correctly. The word "*change*" may be an unsophisticated mathematical term and could by some perhaps also be classified as natural language. For this five-year-old, however, the word "*change*" was educated language, with a precise mathematical meaning that was not clear to her before the learning experience. This stresses the

importance of language in the teaching process. Learners have to form a concept through activities or learning experiences, but in the end the learners have to be able to describe the concept in words to enable themselves to apply the concept, think about it and communicate with others about the concept.

In the ESL-classroom the learner has to learn to grasp the different nuances of the natural English language as well as the mathematical educational and educated languages. Orton and Frobisher (1996:53, 55) caution that it should be considered carefully when to use informal language and when precise terminology (educated discourse) should be introduced. Specialist terminology could have an adverse affect during the "acceptance period" of a concept. However, the use of educational language, such as for example *fair shares* in fractions, could later lead to difficulties if not replaced by the more precise specialist terminology, for example "common denominator". New words associated with new concepts should be introduced carefully, discussed extensively and the learners should repeatedly get the opportunity to practise the new terminology in the correct context.

Pimm (1987:38-40) uses the terms message-orientated and listener-orientated speech.¹⁰ Message-orientated speech is goal-directed with a particular message and is explicit, while listener-orientated speech is more directed at the listener. Listener-orientated speech will make use of the immediate environment to point to something. Non-specific terms like *this* and *that* are used. Listener-orientated speech make use of common knowledge not explicitly mentioned, for example a teacher would talk about *the figure* and will suppose that the learners will all know which figure it is. In the classroom, listener-orientated speech is often the mode of discourse. Learners should be encouraged to use message-orientated speech, which is more explicit, so that everybody can understand their message. The meaning of *message-orientated language* is not congruent with *educated mathematical language*. However, message-orientated language would help to direct the learners to the goal of educated mathematical language, because they will need correct terminology and precise meanings of words to communicate their message. Pimm (1987:42) cautions

¹⁰ Pimm borrowed these terms from Brown, G. 1982. The spoken language. (In Carter, R. ed. Linguistics and the teacher. London : Routledge & Kegan Paul.)

that merely increasing pupil talk may not prove beneficial, but the talk has to be message-orientated, explicit and focussed.

Another phenomenon that needs attention is the interaction between natural language and mathematical language, whether educational or educated. Mitchell (2001:42) describes natural language, especially spoken language, as ambiguous. In natural language a sentence can often be interpreted in many different ways, depending on context and body language. This is opposed to scientific uses of language, where a more precise language is required. Mathematics language is at the other end of the continuum from natural language, as Mathematics presentations are required to be unambiguous.

In written language more care is taken to write accurately. This may be a reason why written language has been used more in the teaching of Mathematics in the past than discourse. Precise writing and formal definitions form a bridge to symbolic expressions in Mathematics. In the process of clarifying real world situations, the mathematician tries to describe the situation with carefully selected words which have an exact meaning that can be translated into a symbolic expression. Thereafter mathematical procedures can be applied to arrive at a solution.

However, ambiguities also occur in the mathematical register, where a word may be used in more than one context. The ambiguity has to be clarified by the context, e.g. the square of the number 4, would be 16 and in geometrical context a square will be a specific figure. It follows that ambiguities can only be sorted out if the learner has adequate knowledge about the different mathematical contexts involved. This is best illustrated by an example from the symbolic language. The symbol $(3, 4)$ could be interpreted as the co-ordinates of a point in a Cartesian plane or as an open interval, depending on the context. Another instance of ambiguity occurs when a question is not well formulated. For example, if the wording of the following is studied, the meaning is ambiguous: "A lady bought six peaches and eight apples, half of which she found have gone bad." Does this refer to half of the apples or half of both the apples and the peaches?

Sierpinska (1994:19-21) draws attention to the difficulty some learners may experience in recognising the subtle signals given to indicate which language zone they find themselves in. The learner has to develop an intuitive feeling for when and where natural language is wandering into the region of mathematical language and when educational language is changing to educated discourse. This negotiation of meaning takes place by speaking, using the terminology, asking questions and solving problems.

Mitchell (2001:30, 45, 46, 47) has observed the phenomenon of "wordwalking",¹¹ which sometimes takes place in the process of "translation" between natural and mathematical language. "Wordwalking" is when a learner substitutes a *mathematical* word or phrase in an original problem statement with natural language, but changes the meaning of the problem statement. The meaning of the substitution overlaps with the substituted word, but changes the structure of the resulting mathematical problem statement. The phenomenon was mostly observed in pair groups where one learner explained a problem to another. Dequantification was observed where the learner removed quantities such as *half* and substituted it with e.g. *part*. The research also reports more instances of "wordwalking" where prepositions (for example: *for every*, *for each*, *in*, *through*, etc.) are used to encode relations. This is on par with the Pimms' findings (1987:76, 86) reported earlier in this study that the specific use of prepositions in the Mathematics register of English is a problem area. Teachers have to be alert to the fact that when a learner experiences difficulty in modelling e.g. a word problem, language factors may be the problem and not Mathematics as such.

Adler (1999:3) also discusses the visibility and invisibility of language in the Mathematics class. When the language is only used to clarify the Mathematics it is invisible, but when specific attention is paid to the use of the correct terminology and phrases, the meaning of words and the correct syntax, it becomes visible. The mastering of the Mathematics language register becomes an outcome in itself. Adler (1999:2-3, 11) argues that explicit language teaching presents a dilemma. Too much visibility of the language can sometimes obscure the Mathematics itself, on the other hand being explicit about language benefits most pupils. The dilemma that presents

¹¹ Wordwalking is a term that Mitchell has invented for the phenomenon observed.

itself is how to keep the balance between the visibility and invisibility of language so that the learners have the benefit of the explicit language teaching but the Mathematics does not become obscured.

Mathematics teachers should make an effort to develop the skills to judge correctly when to focus on language and when it has to fade into the background as a tool to illuminate the Mathematics involved. Teachers could benefit by taking notice of the following features of language teaching in the Mathematics class reported by Adler (1999:6):

- attention to pronunciation and clarity of instructions;
- verbalisation by learners as a tool for thinking;
- clear verbalisation of mathematical thinking as a display of mathematical knowledge;
- verbalisation of learners as a tool for teaching; it helps the teacher to understand the reasoning of the learner.

Learners' listening skills have to be developed (Pimm, 1987:43). Learners are often passive listeners and do not take responsibility for clarifying aspects in the classroom discourse that they do not understand. Learners have to be encouraged to ask when something is not clear or to make a contribution to the discussion. A learner may sometimes even help to clarify a teacher's explanation.

3.3.1 Emotional factors in the teaching of Mathematics language

Sierpinska (1994:20) is of opinion that if a learner makes too many mistakes in the identification of the signals concerning the language register he finds himself in, it may contribute to anxiousness about Mathematics and loss of self-confidence. Furthermore, a teacher's negative reaction to a learner's language use may bring in an emotive factor into the Mathematics. Maree (1997: 83) draws attention to the fact that learners tend to get confused more easily when they are under stress. Questions in question papers that are not formulated well will therefore tend to give rise to misinterpretation. In examinations learners may not be able to cope with vague

language, because they may not have the time and are not cool-headed enough to negotiate meaning from context.

3.4 TEACHER EDUCATION AND THE LANGUAGE OF MATHEMATICS

Attention should be paid to the topic of mathematical language when training Mathematics teachers in South Africa. Teachers should be trained in such a way that they would consciously use and teach educational and educated mathematical language. The student teachers should become acquainted with the problem areas of the "translation" from natural language to educational and educated Mathematics. This becomes more and more important as teachers in many cases have to teach at least some LEP-learners through medium English. Not much has been done in South Africa to sensitise and train teachers to cope in this important area.

3.5 CONCLUSIONS

When learners are learning Mathematics they have to cope with the natural language of instruction, the educational Mathematics language, the educated Mathematics register and the symbolic language of Mathematics. Problem areas in the Mathematics register include the use of rigorous expressions (e.g. if and only if), prepositions, and words with different meanings in the natural language and in the Mathematics register.

Learners have to listen, speak, read and write the Mathematics language to master educational as well as educated mathematical language. They have to develop an intuitive feeling for when to use which register. They have to learn that the educated Mathematics register requires precise formulation. Each word in a definition is necessary and contributes to describe the relevant concept unambiguously.

Language interacts with the affective domain when the learners become confused about which zone of the language they are finding themselves in. Stress can aggravate feelings of anxiousness and render a learner incapable of interpreting

ambiguous language. Teachers have to be aware of the phenomenon of "wordwalking".

Language teaching has to take place in the Mathematics classroom, but the fine line between the visibility and invisibility of language must be managed so that the language does not obscure the Mathematics.

The topic of mathematical language and its teaching should be included in the curriculum for student teachers.

CHAPTER 4

THE INTERPLAY BETWEEN LANGUAGE AND MATHEMATICS IN THE MULTILINGUAL CLASSROOM WITH SPECIAL REFERENCE TO GEOMETRY

4.1 INTRODUCTION

Different factors are at play in the Mathematics classroom. The political views of the day and the educational policies that are in place, as well as the belief systems of the parents and the teacher have its influence. The profiles of the learner, in this study the Motswana Mathematics learner, and that of the teacher, as well as the teaching-learning methodologies, interact with the LoLT to set the stage in the Mathematics classroom. In this chapter some of these factors will be scrutinised and contextualised with reference to what is happening in the classrooms in other countries where English is the LoLT, but is not the main language of the majority of learners (ESL-classrooms).

4.1.1 The multilingual classroom

In South Africa the majority of classrooms for learners in the Intermediary Phase, Senior Phase and Further Education and Training-band, have become bilingual or multilingual classrooms with English as LoLT. In grade one to three most classes are conducted in the main language of the major language group of the learners in the school, where applicable.

With regard to ESL-schools Setati, Adler, Reed and Bapoo (2002:73-74) differentiate between a *foreign language learning environment*, mostly found in the rural or non-urban schools and an *additional language learning environment*, mostly found in the urban schools. In the foreign language environment most of the learners have the same main language. The learners have little contact with English outside the school, except through mass media in so far as they have access to it. This could be described as mainly a bilingual setting. In the additional language environment the

learners hear and see more English outside the school than in the foreign language environment. They have the opportunity to speak it in shops, hear people use English, see it on posters and in magazines.

Adler (2001:29-30) further distinguishes between *urban schools or township schools* and *urban-suburban schools*. In *township schools* many teachers are multilingual and are proficient in two or more African languages as well as in English or/and Afrikaans. The learners are African and some learners' main language may differ from the main language of the region. The level of proficiency in English differs from learner to learner. The *urban-suburban schools* are historically white schools, private or state run. Teachers are predominantly white with English or Afrikaans as main language. A range of main languages is found among the learners. The environment is supportive of English or Afrikaans respectively, according to the language of instruction.

The next two paragraphs discuss factors that influence the choice in favour of English as LoLT.

4.2 POLITICS AND PARENTS' BELIEF IN THE CHOICE OF ENGLISH AS LoLT

Adler (2001:26) shows the dominance of English in the world. Enough to say that the world of the computer and information storage is 80% English, 80 million learners study English at secondary level and 150 million people in 120 countries receives English radio programmes. It is therefore widely acknowledged that English is the leading language in communication and business globally (CHE, 2001:7). English is understandably the preferred language of instruction in the majority of South African schools, because many parents and learners see it as the language of the workplace and the "key to social mobility and economic advancement" (Hornberger & Chick, 2001:51; also see De Villiers, 2000:3). Some parents experienced problems to study at college or university level because their proficiency in English was not good

enough and therefore they see it as a solution for their children go to schools where the LoLT is English.¹² (Also see Adler, 2001:25, 63, 77).

Historically, many African people had the perception that the Apartheid regime promoted mother tongue instruction because they wanted to keep Africans from entering the world of commerce and obstruct their way to knowledge and the global community. Mother tongue instruction was viewed with suspicion (Hornberger & Chick, 2001:47, 48, 51). The Ministry of Education (2002:2) expresses this strong negative feeling as follows: "In the past, the richness of our linguistic diversity was used as instrument of control, oppression and exploitation. The existence of different languages was recognised and perversely celebrated to legitimise the policy of 'separate development' that was the cornerstone of Apartheid." These emotions also promote the use of English as LoLT.

Another factor contributing to the choice of English as LOLT, is urbanisation. In many classrooms there are learners from various different backgrounds and different main languages. In such a context it seems logical to choose English as LOLT because it serves as a common language.

Hornberger and Chick (2001:51) see the choice of English as LoLT as unfortunate and is of opinion that it will contribute to the emergence of a small English speaking elite, and not to the social advancement of the mass. Although they are in favour of promoting a widespread proficiency in English, they do not believe that English should be the sole medium of instruction. This opinion is based on a study of the type of learning that takes place in unfavourable social conditions combined with teaching through medium of a second language (see paragraph 4.6.2.2 on safe talk).

Brock-Utne and Holmarsdottir (2004:5) observed the same preference for English as medium of instruction by many parents in Tanzania and comment on this as follows: "They (*the parents*) mistakenly think, however, that the best way to learn English is to have it as language of instruction." They quote Qorro, the Head of the Department of

¹² This emerged from informal talks with coloured parents with main language Afrikaans, who preferred to put their children in schools where the LOLT was English, although good schools were available where the LOLT was Afrikaans both in their own township and nearby previously model C schools.

Foreign Languages and Linguistics at the University of Dar es Salaam and an experienced English teacher, to sustain their argument that it is in fact detrimental to the learners to learn through medium English because they not only learn bad and incorrect English from many of the subject teachers, but the learners are also handicapped in their learning of the subject matter. This opinion correlates with Cummins and Swain (1986:xv) who say that research shows that learners who are instructed in the “minority language” (which would be the main language of the learners in this study) for whole or part of the day, perform as well or better in the majority language over time, as learners who are instructed exclusively through the majority language (English in this study). According to Cummins and Swain (1986:80) the “maximum exposure” hypothesis is refuted by a considerable amount of research evidence. They further express the following opinion: “Clearly, sufficient exposure to the school language is essential for the development of academic skills; however, equally or more important, is the extent to which the students are capable of understanding the academic input to which they are exposed. In the case of minority students this is directly related to the conceptual attributes which have developed as a result of interaction in their L1.”

Qorro (2002:2) is of opinion that “the use of English as medium actually defeats the whole purpose of teaching English language”. She adds that the work done by teachers who are teaching English as subject, is defeated by the incorrect English that the learners learn from other teachers. The teachers who teach subjects other than English often do not speak English correctly. Qorro further argues that if they use the Kishwahili language as medium of instruction it will result in:

- Eliminating the huge amount of incorrect English to which our secondary school students are exposed.
- Enhancing students’ understanding of the contents of their subjects and hence creating grounds on which they can build their learning of English and other languages “the content that has been understood forms the substance of the ideas that we attempt to express in whatever language we are learning”.

The question that arises is whether it could also be said that the learners in the South African classes for subjects other than English as language hear “a lot of bad English”. It is not in the scope of this research to answer this question. However some concern in this regard is raised in paragraph 4.6.1 where the language efficiency of Mathematics teachers is discussed.

The decision of most of the schools in South Africa to use English as LoLT, does not reflect the policy of the government of the day, but the language policy introduced in 1979 by the previous government (Brock-Utne & Holmarsdottir, 2004:7). The next section will deal with the language policies of the current government and the extent to which, if at all, the government policies contribute to the choice of English as LoLT.

4.3 THE POLICY OF THE GOVERNMENT ABOUT LANGUAGE IN EDUCATION

4.3.1 The constitution

The language policy stated in the South African constitution of 1996 (SA, 1996:Section 6(1)) name the eleven official languages and in subsection 2 states:

“recognizing the historically diminished use and status of the indigenous languages of our people, the state must take practical and positive measures to elevate the status and advance the use of these languages”.

To give effect to this the Pan South African Language Board Act no 59 of 1995 established PANSALB. PANSALB’s role is “the development and promotion of the African languages to a higher rank in terms of status, functions, and domains where these languages should operate” (Marivate, 1998:1, 2).

In a draft discussion document of 1998, PANSALB (1998:2, 5) sees reassessing “the over-estimated use and reliance upon English as a lingua Franca” one of its responsibilities. They motivate this by stating the fact that isiZulu functioned, at the time of the report, as lingua franca for 70% of the people of South Africa (although

only 22% is mother tongue speakers), while only 20% of the population could be reached by means of English.

According to PANSALB (1998:4-7) the orientation of “language as a problem” is present in societies where segregation or assimilation is the policy. The answer to “the problem” would then be the “disempowering” monolingual habit, which the West has superimposed on countries it subjugated. Western development models and aid packages and the requirement of ex-colonial languages for national political and economic careers are seen as undermining the promotion of the use of African languages. In order to promote a multilingual society, language policy and planning would have to be informed by two other orientations, namely, language as a *right* and language as a *resource*. It follows, inter alia that “sources of knowledge and expertise which speakers of all languages possess” have to be acknowledged and exploited and “the potential of existing patterns of local and regional multilingual communication systems” should be unlocked. One prospect mentioned is the development of educational materials and literature in indigenous languages.

When the new board was announced in 2001, the spokesman of the ministers office again confirmed the role of PANSALB as to “promote multi-lingualism and to develop disadvantaged languages” (PANSALB, 2001:1). In the minutes of the education portfolio committee it was reported that PANSALB recommends that learners should learn in their mother tongue for *the first six years* of schooling. In the meantime English should be one of the subjects so that the learners will become proficient in English for the switch to English to be made successfully. PANSALB expresses concern for the fact that the education policy of 1997 has not been implemented. PANSALB concludes that it is a myth that most South Africans want English as LoLT for their children. They report that a survey done by MarkData for PANSALB shows that “88% of the South Africans want mother tongue education or bilingual education.” This wish is not reflected in what is happening in the schools.

From an analysis of statistics dr. Heugh, a member of PANSALB, (PMG, 2001:2-6) came to the conclusion that matriculation results deteriorated since the policy of eight years of main language education combined with good education in English and Afrikaans, was replaced by four years of mother tongue education followed by a

quick switch to English. The report goes as far as saying that the “government is discriminating against the majority of the population by using English as the teaching medium” (PMG, 2001:3). The Director General disagreed with PANSALB’s report.

4.3.2 The Language in Education Policy

The following can be highlighted from the Language in Education Policy (National Department of Education, 1997a:2, act 27 of 1996):

- The language policy is seen as a continuous process developed as part of a national language plan.
- The Department of Education is tasked with promoting multilingualism and respect for all languages used in the country and developing the official languages.
- “Being multilingual should be a defining characteristic of being South African”.
- Different opinions exist as to the approach to multilingual education. Without choosing a specific approach, the policy indicates that the underlying principle to be followed in education is “to maintain home-language(s) while providing access to, and the effective acquisition of, additional language(s)”. This means that an additive approach should be followed in acquiring new languages, contrary to the subtractive approach where the home language is neglected and the new language becomes the main language.
- The individual, (in the case of a minor: the parents) has the right to choose the LoLT.

It is clear that the language policy of the government of South Africa does not prescribe that the LoLT must be English from grade 4 onwards, as is the official policy of many schools. Such policies often allow for code-switching to the main language of the learners (see section 5.4.2). It is theoretically possible for education to take place, for example in Setswana, from grade one through to tertiary education. The opportunities that exist for learners whose main language is Afrikaans to study in Afrikaans up to tertiary level illustrate this.

4.3.3 The Council for Higher Education (CHE)

The Council for Higher Education (CHE) (2001:3) quotes the original report on Values, Education and Democracy as follows: “We do believe that an initial grounding in mother-tongue learning is a pedagogically sound approach to learning (p. 15 of the original report)”. The CHE furthermore has the opinion that regeneration of Africa, the African Renaissance, requires the full development of the African languages.

4.3.4 The Language Policy of Higher Education

In the Language Policy of Higher Education, the Ministry of Education (2002:5) states the following:

“The challenge facing Higher Education is to ensure the simultaneous development of a multilingual environment in which all our languages are developed as academic/scientific languages, while at the same time ensuring that the existing languages of instruction do not serve as a barrier to access and success”.

The Ministry of Education (2002:10) furthermore states that “consideration should be given to develop other South African languages for use in instruction”. A task team was to be established to develop a framework and implementation plan. The promotion of the languages would require the development of dictionaries and teaching and learning materials.

The policy statements mentioned above implicate the need for the development of subject-specific registers for use in instruction. This will also apply to Mathematics. Some headway has been made in this regard. A dictionary with thousand mathematical terms in eleven languages was recently published. (Department of Arts and Culture, 2003). This dictionary focuses on the terminology necessary for intermediate and senior phase Mathematics.

4.4 THE INFLUENCE OF EDUCATIONAL REFORMS ON CLASSROOM DISCOURSE

One of the main reforms in the new approach of Curriculum 2005 is better communication amongst learners and between teacher and learner (see 3.2.1). The classroom culture in the Mathematics class has changed accordingly. Language has therefore grown in importance in the Mathematics class. It is necessary for the learners to communicate with each other and with their teacher in the language of Mathematics. In a school where the LoLT is not the learners' main language communication takes on a complicated character. The informal as well as the formal mathematical register of both Setswana and English are involved when learners have to communicate their mathematical thoughts to their peers or teacher.

4.4.1 The need for communicative competence

Adler (2001:10-11, 65-66, 91-94) highlights the fact that communicative competence cannot be taken for granted. The art of "talking" Mathematics should be taught. Especially in the ESL-Mathematics classroom, specific language teaching is needed. Many of these learners have a limited English proficiency. The learners not only struggle with the mathematical terminology and expressions, but they also struggle to express their thoughts in English. In the new dispensation where learners are required to investigate, negotiate meaning, discuss problems with peers, report back findings to the class, participate in class discussions, write down thoughts and procedures in informal and formal Mathematics registers, communicative competence is of major importance. To reach the required communicative competence with most of the learners in the bi/multilingual class, becomes a mammoth task.

4.4.2 The role of the main language in communication in the Mathematics classroom

The educational reforms and the need for effective communication also give rise to the question of what place the main language of the learners should occupy. In the Mathematics classroom, exploratory talk on a new topic or a problem often takes place in the main language, in this case Setswana. The teacher faces two dilemmas. One problem is the shortage of mathematical terminology in Setswana, the other is how far the learners should be allowed to use Setswana and in how far they should be encouraged to use the LoLT, namely English (Adler, 2001:82-83). If the importance of the correct language in order to function efficiently at the different thinking levels in Geometry is taken into account, these dilemmas are central. This will be discussed in more detail in following paragraphs.

4.5 THE LANGUAGE RELATED PROBLEMS OF THE ESL-LEARNER IN THE MATHEMATICS CLASSROOM

4.5.1 Introductory remarks

In literature dealing with the problems that second language learners encounter in Mathematics, the benefit of the use of the mother tongue or main language of the learner in instruction is a recurring theme, especially in the construction of concepts. In the case of the ESL-learner it is very important how classroom discourse takes place. In Mathematics teaching the interaction between teacher-and-learner and learner-and-learner to negotiate meaning is very important. The main language of the learner supplies a support system while his proficiency in English is developed (Khisty, 1995:280-283; Setati, et al., 2002:77-78). According to Khisty, the development of proficiency in the cognitive academic language can take as long as seven years.

4.5.2 Terminology

There is a differentiation between *bilingual* learners and learners for whom English is a *second language* or *additional language*. The term “*second language learner*” refers to learners who are less proficient in their second language than in their main language. The term “*additional language learners*” refers to learners that may have another language (not their main language) in which they are more proficient than in English. For many of the Setswana learners, English may be a third language and to refer to English as an *additional language* will therefore be more appropriate than *second language*. However, most of the international literature employs the term *second language* and these terms will therefore be used interchangeably.

The term *bilingual* usually applies to someone that is fluent in two languages and both languages are used extensively (Kearsey & Turner, 1999:1037). The level of efficiency with which the bilingual person applies the two languages does not differ greatly. Setati and Adler (2000:246) support Grosjean's view that the language configuration of bilinguals differs from the language configuration of monolinguals. Bilingual persons must not be evaluated from the view of monolingualism. One integrated network is formed to negotiate meaning in the two languages. It involves other skills, for example problem solving (Clarkson, 1992:419). Cummins and Swain (1986:82-83) underwrite the common underlying proficiency or CUP-model of explaining the interdependence between languages. It is presented as follows (Cummins & Swain, 1986:83, fig.5.2):

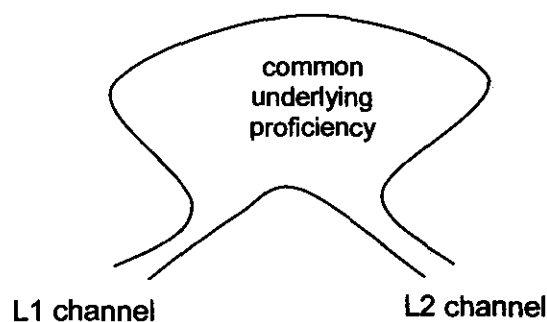


Figure – The CUP-model 4.5.2

This model illustrates the theoretical view that certain skills developed in the main language will also be available in the second language and vice versa. It could therefore benefit the English of Batswana learners if their Setswana competence is at a high level.

Cummins and Swain (1986:6) report some contradictory research findings in research about the relationship between bilingualism and cognitive functioning. This can be explained by the *threshold hypothesis* that “proposes that there may be a threshold level of linguistic competence which bilingual children must attain in both their first and second languages, in order to avoid cognitive disadvantages and to allow the potential beneficial aspects of becoming bilingual to influence cognitive functioning”. Cummins and Swain (1986:18, 19) feel that this implies an additive approach in education. The main language of the learner should not regress in favour of the second language. A competence above the threshold level should be acquired in both languages. Furthermore, where learners come from socially deprived homes and the main language is not highly valued, they recommend that the initial instruction should be in the learners’ main language.

According to Kearsy and Turner (1999:1038-1039), definite advantages can be expected for the comprehension and interpretation of scientific language if the bilingual person is involved in the practice of diglossic discourses. Diglossic means that the speaker uses one of his languages for a specific purpose such as, for example, business. This pattern of language-use confers a way in which language is used that may be of importance when scientific language is applied. The speaker analyses the function of language as it is received and then responds in the appropriate language. Through involvement in diglossic discourses the speaker acquires experience in linguistic problem solving.

Whang (1996: 291; 309-311) comes to an interesting conclusion in a study on word problems solved by Korean learners with English as LoLT. The study was done in the United States and the learners were clearly enrolled in a submersion model. Whang (1996:291) based his research on the Cummins’ classification of three types of bilingualism, namely semi-bilingualism where the learner is below threshold level in both languages, dominant bilingualism, where one of the learner’s languages is

above threshold level, and additive bilingualism, where both languages are above threshold level. In his qualitative study Whang (1996:291-292) identified six learners of whom two were Korean dominant, one English dominant, and one learner displayed additive bilingualism. Whang classified the other two learners as being in a "stage of transition" between dominant bilingualism and additive bilingualism. These learners have reached a "good" level of English. They however, have not yet fully reached the stage where they could be classified as *additive bilinguals* where both their languages were well above the threshold level. The selected learners were given word sums to solve in English after which they were provided with the Korean version. Although the learners in the transition stage could solve *more* problems than the Korean dominant learners when they were given only the English version, they could solve *fewer* problems than the Korean dominant learners when given *both* the English and Korean versions of the problems. Compared to an "additive bilingual" that was well above "threshold level" in both languages, the learner in the same grade but in the "stage of transition" did not achieve as was expected. The study was qualitative and the sample small, but it indicates that special attention should be paid to the understanding of the learner in the "transition stage" between being really dominant in his own language and being fully bilingual. It seems as if a subtractive element is present in the understanding of mathematical word sums in this transitional stage of the learners' development. It was also clear from this study that it was beneficial to the learners that the word sums were supplied in both English and Korean. The mathematical achievement of the learners can not be assessed accurately when using only the LoLT during the evaluation process. In all the stages of development the achievement of the learners were much better if they had the chance to study the word sums in their own language as well (in this regard also see PMG, 2001:3). The only exception was the learner that was fully bilingual. Her achievement was the same when she was given the word sums only in English or in both languages. This finding is of major importance for this study, because it indicates that learners need the support of their own language while they are developing towards full bilingualism.

In view of the above discussion it is appropriate to draw attention to the term "*bilingual classroom*" and "*multilingual classroom*". The term "*bilingual*" is used in a different sense from the meaning in the above paragraphs when applied in the

context of “a classroom”. A “*bilingual classroom*” will refer to the context where two languages play a significant role and the term a “*multilingual classroom*” will refer to a classroom that consists of learners from more than two language groups. In this context “*bilingual*” and “*multilingual*” refer to the number of main languages present in that specific classroom, and not to the efficiency with which the learners use it.

4.5.3 The importance of the learner’s main language for conceptualisation

An overwhelming number of researchers acknowledge the importance of the main language for conceptualisation. Though diagrams and physical models aid conceptualisation, especially in Geometry, Van de Walle (2001a:34-35) is of opinion that the models usually do not help the learner to *form* the concept. If the learner has no understanding of the new concept, the learner will have no relationship to impose on the model and will only see the physical object. Models help to *develop* the concept and rectify misconceptions. The models should be used as “talker toys” and “thinker toys” to expand the concepts. In the ESL-classroom the use of models is even more important than in classes where learners are taught in their main language. The discussions that take place around the model of a concept, are more fruitful if it takes place in the main language of the ESL-learner. When the concept is adequately formed it can be recoded in English (Thomas, 1997:38). De Villiers (2000:8) quotes Macdonald and Burroughs, who found that gr.5 ESL-learners are not ready to learn subjects other than English Language through medium English, partly because of their inability to recode existing concepts into English. The learners have to struggle to comprehend new content in different subjects through medium English at the same time as having to master the formal structure and vocabulary of English as language (De Villiers, 2000:4).

4.5.3.1 The “*language of thought*” in a second language context

The question arises of what language second language speakers think in when they are negotiating meaning in a second language context. It is not easily answered. This question was raised in an interview with a Physics lecturer, busy with a doctorate in Physics and whose mother tongue is Setswana. The lecturer had all his schooling in

English and wrote all his academic papers and his dissertation in Physics in English. His day-to-day communication in his workplace is English. When asked in which language he thinks when in a second language (English) context, he immediately answered: "In English". However, after a few moments he reflected "but if I really have to puzzle out a concept that I do not understand well, I think in Setswana". This may perhaps be attributed to the fact that when a person consciously tries to understand something, inner-speech becomes nearer to egocentric speech. The person "hears" himself think and language plays a more important role. This indicates that the mother tongue/main language may be needed to facilitate deep understanding, even after a high level of proficiency in English has been reached. Thought is complex and not yet fully understood as is clear from the lively research in the field of language and thought. Language and thought and by implication understanding, are undeniably intertwined as the study of Piaget, Vygotsky and Van Hiele's theories indicates. The Network Theory of Learning further highlights the inter-relatedness of knowledge. The mother tongue is one of the most elaborate early networks formed. This elaborated network facilitates word meaning, influx of sense and word sense that are necessary for understanding.

Mathematical thought has its own character because diagrams and symbols play an important role in the "language of Mathematics". Thought is often facilitated by images without the intervention of language. Thought by means of images will play an important role in Geometry, as Geometry is based on figures: manipulations with and calculations about figures and reasoning based on their properties. Geometrical thought could in certain contexts be facilitated by the pure symbolic language of Mathematics, e.g. $AB=CD$, $CD=EF$, $\therefore AB=EF$. The Mathematics teacher teaching ESL-learners could make use of these additional tools for thinking to enrich his communication with the learners. The teacher can use these tools additionally to explain concepts, methods and relationships, but if it is used to circumvent language, the teacher is depriving the learners of one of the most important communicative tools available to them.

The special "language" tools in Mathematics do not minimise the basic role of words in thought, even in mathematical thought. Language plays a major role in communicating thought, also mathematical thought, although symbols, diagrams and

physical models each play a significant part as well. As discussed in 2.3.2.2, before thought can be expressed, it has to be transformed into words. In this process word meaning and word sense are very important. The way in which the learner and the teacher negotiate word meaning and word sense will play an important role in communication from the learner to the teacher and vice versa. Theoretically it seems that it would be the easiest for learners if they could convey their thoughts in their main language to a teacher whose main language is the same as that of the learners, or who is conversant with their language. It could therefore be argued that a mathematical register for Setswana should be developed and subsumed into the main language network of the Motswana learner. Language could then better facilitate the communication of a learner's understanding of concepts constructed by experiences, and concepts can be linked more easily to the correct terminology and definition in a second language.

Theoretically a mathematical register in Setswana will make it easier for teachers to use the main language of the learner to formulate and refine concepts constructed by learning experiences and to communicate their own insights to a learner. The learner would have a more extensive vocabulary where word meaning would be clearer and word sense better developed than in the second language.

When conceptual thinking takes place new structures are formed and it can be argued that the main language of a learner will most efficiently facilitate conceptualisation.

4.5.4 Problems experienced by ESL-Mathematics learners

According to Orton (1987:137) the language used for thinking is likely to be the main language of the learner. In the ESL-classroom the Mathematics will be communicated in English to the learner, he will translate it back to his own language to think and then translate back to English to communicate with his peers or the teacher. It is understandable that errors and misunderstandings may arise from this process. The flaws in this two-way translation process will be heightened if the

learner is not very fluent in English. Three complicating factors can be identified, namely when:

- the two languages differ greatly in construction, as is the case between Setswana and English;
- there are different ways of translating symbolic language into English;
- the main language lacks mathematical vocabulary for certain concepts.

4.5.4.1 *The LoLT and the main language differ greatly in construction*

Costello (1991:179) sees the real difficulty of understanding of Mathematics in a second language “in appreciating the nuances of meaning conveyed by prepositions and connectives ... its exact significance is elusive”. According to Costello the real meaning of a word or expression in a certain context may even be inaccessible to a learner with limited English competence. This reminds of the importance of “word sense”, as used by Vygotsky.

The word order in English and Setswana corresponds sometimes but not in sentences with adjectives and possessives. The structure of Setswana grammar differs greatly from that of English. Plurals are determined by a prefix, e.g. rra (father), plural borra (fathers) while in English the plural is formed by the suffixes e.g. father(**s**), child(**ren**) and flexional forms, e.g. man (**men**). The definite and indefinite articles “a” and “the” do not occur in Setswana. Alliterative concords from their respective predicates are used to represent subjects and objects in the verb, e.g. **basimane ba a di rata dijô** (the boys *they* like *it* the food). Short form: **basimane ba rata dijô**. The subjectival and objectival concords are not expressed in English and the correct translation into English would be: *the boys like the food* (Snyman, Viljoen & Ntsime, 1994:4, 8). The influence of these differences can often be detected in the sentence construction in the written work of Setswana teachers in training.¹³ It is not easy for the Motswana learner to comprehend all the nuances of the English language.

¹³ The researcher observed this while teaching in-service teachers in upgrading courses.

Khisty (1995:283-286) draws attention to the difficulty that learners with limited English proficiency have with words in the LoLT that have non-mathematical homonyms. The learners have to make sense of the different meanings of e.g. *left* (direction) in ordinary language, and the mathematical meaning where six is subtracted from eight and two are “*left*”. Another problem is mathematical terminology with synonyms, like three-fourths and three-quarters. Teachers may sometimes use these words interchangeably and be oblivious of the fact that some learners do not know both terms.

The second language learner has to sort out confusing terminology or words in *both his main language and the LoLT*, because there are also homonyms and synonyms in the learner’s main language. In other instances, words may have two or more meanings in one language, for example “left” in English, but when translated to the other language the confusion can be cleared because the other language would have a different word for each context (Khisty, 1995:287). For example, the word for “left” (direction) is “molema” in Setswana, while in the sense “how much money is left” the word “setse” will be used. In such a case the use of the two languages may be helpful.

In the same sense, different English words can sometimes be translated to the same word in Setswana and it does not reflect the different nuances or even totally different meanings of the English words. If the learner does not really understand the English words, it may create confusion when the main language is used. An example of this in Geometry is the word for angle, “khutlo”, which is the same as the word for point.

4.5.4.2 *Different ways of translating symbolic language into English*

Another problem area for the LEP-learner is the translation to and from symbolic expressions. For example a simple expression like $7x^2 + 1 = 10$, may be translated in several ways, e.g.

Seven times the square of x added to one equals 10,

The sum of x to the power two multiplied by seven and one results in 10,

The sum of the product of seven and the square of x and 1 is equal to ten;

If seven times the square of x is increased by one you will have ten, etc.

If this example is studied it is clear that different words are used for the symbols:

+: e.g. “and”, “sum”, “increase”

=: e.g. “have”, “equals”, “is equal to”, “results in”,

x^2 : e.g. “squared”, “square of”, “ x to the power two”.

Aside from this the change of word order can play havoc with the learner’s understanding.

4.5.4.3 *The main language lacks mathematical vocabulary*

The difficulties may become more acute if no real parallel of the English word exists in the learner’s main language of the learner, for example, the expression “*corresponding angles*”. The researcher asked a small group of Batswana Mathematics teachers to try and coin a term for “*corresponding angles*” in Setswana. The teachers encountered difficulties and quite a long description was needed. No two or three words would suffice. A description was decided on with the inputs of a language expert. However, no real solution was found because some of the Batswana teachers could not recognise corresponding angles from this description. Later in the study a translation institute coined the term *dikuthlo-tsamaelano*, which was then used in the Setswana notes for the empirical study. From this experience it is clear that learners may sometimes be unable to formulate a concept or relationship in their own language in cases where no terminology is available. The learners will then have to revert to English and their understanding of the concept will depend on their command of the LoLT. It may also be possible that learners sometimes understand concepts that they are unable to describe in English.

It follows logically that second language learners will depend more heavily on the visual and symbolic means to understand and communicate their mathematical ideas and knowledge.

The question of code-switching and the development of new mathematical terminology in Setswana were presented at the 2003 AMESA conference. From the

discussions it became clear that quite a strong contingent of teachers asks the question of whether it will be beneficial to the Motswana learner to learn mathematical terminology in Setswana as well as in English (also see Setati & Adler, 2000:250). The following questions can be raised. Is it not easier to supply the English terminology and use it even when code-switching is used to explain the concept? Is it really necessary to struggle to develop a fully fledged Setswana mathematical register? Some of these terms in Setswana are new to the learners and they first have to learn and understand them, just to revert to English to communicate in the work place. Will it not be detrimental to the learners to try and teach them Mathematics in Setswana?

On the other hand, as will be shown in the next chapter, research has indicated that there is a strong contingent of teachers who feel the need for the development of a more extensive Setswana mathematical register.

4.5.5 Enculturation of the learner into Mathematics

The learner has to make Mathematics his own. Adler (1997:237) says that learners "can develop familiarity with educational and educated discourses only by using them". It is not enough that the learner understands some concepts and can do algorithms or even solve some problems. The learner should be able to talk about Mathematics, to explain his understanding or lack of understanding of concepts and processes to peers and to the teacher. The learners should be able to pursue the solution of a problem together with others. For this the learners have to be able to talk about Mathematics and talk Mathematics. They should not be gagged by either a lack of proficiency in the language of Mathematics of the LOLT, a lack of knowledge of the mathematical register in his own language or by a lack of the existence of such a register.

Khisty (1995:290) expresses it as follows: "But one crucial means by which students become enculturated is by having ample opportunities to talk about Mathematics ... and in general, to participate in the higher cognitive levels of the subject that

accompany active dialogue.” Khisty sees “talk” as a “critical vehicle” to becoming empowered in Mathematics.

In cases where the learner is not yet proficient in the LoLT and the Mathematics register of his/her main language is not yet fully developed, some means of communication should be developed that will empower the learner to talk and communicate freely. Code-switching seems to be the best alternative, provided that it is used effectively to facilitate the use of both languages in such a way that the learner will benefit from his knowledge of both languages. One language may be instrumental to bridge shortcomings in the other.

It is therefore essential that the practice of code-switching be taken seriously. Researchers should identify shortcomings and provide assistance to teachers so that they can use code-switching as effectively as possible to facilitate conceptual development in Mathematics.

4.5.6 Assessment

If learners are not proficient in English they will be at a disadvantage if a test is in English. There will be some words and phrases that the learner will not understand well enough and sometimes the learners will not be able to express their thoughts in such a way that the teacher will understand their reasoning. However, this problem can not be solved by supplying a test in the learners' main language *when the learners have not been taught the mathematical register of their own language* (Flores, 1997:88). The learners do not understand the technical mathematical terminology in their own language automatically. As is the case in English, the mathematical register of the learners' main language is a special register that is a “new” language to the learner. In view of the theoretical discussion, it may be easier for the learners to link the new terminology of the mathematical register of their main language to their existing language structure, than to master the mathematical register of English. It is of utmost importance that the teacher takes care to facilitate “links” to the natural language when teaching the mathematical register, even if it is the main language of the learner. In other words the teacher should take care to teach “language” when introducing new terminology in the main language. However,

new terminology in the main language would most possibly have much less value if it is introduced after the English terminology is already well-established.

One way to overcome the language problem in the assessment of Mathematics is to use the minimum of words. In such cases written instructions are kept short and as simple as possible and the answers require mostly symbolic language. This leads to a focus on testing of algorithmic and manipulative knowledge. It is already proven that what is important in assessment, becomes important in teaching. The practice discussed above leads to teachers expecting less of learners because their conceptual knowledge and problem solving skills are not tested adequately.

OBE assessment requires more. The focus is on the learner's conceptual knowledge, problem solving and construction of knowledge through learning experiences. The teacher should require learners to explain processes and reasoning. Problem solving should be in the centre and this requires language, both in the questions and in the solution of the problem. Assessment should reflect the teaching strategies. Learners should be required to explain concepts and discuss the reasoning strategies they use. This involves language. If teaching-and-learning has to be constructive and conceptual understanding and problem solving are important, there is no way to circumvent language, not even in assessment.

Therefore, it could be argued that

- code-switching should be used elaborately in the classroom during the years in which the learner is still developing fluency in his second language;
- a register for Geometry should be developed in Setswana to facilitate the use of code-switching;
- teachers should teach the learners the new Setswana terminology and link it to the existing language network;
- Setswana terminology should be linked to the correct geometric terminology in English by means of a glossary;
- as fluency in the second language increases, code-switching can be reserved for the introduction of new concepts and facilitation of understanding where

necessary. Although the construction of a new concept could be facilitated by explanations in the main language of the learner, it should be linked to the correct English terminology;

- the development of English as language should not be the primary responsibility of the Mathematics teacher. The Mathematics teacher should be able to concentrate on the teaching of language only in so far as it concerns the mathematical register of both English and Setswana;
- teachers should at all times be aware that they should use correct English when communicating with the learners.

In a setting where the LoLT is English, assessment is done in English in the final examinations and entrance to university and the labour market requires a high proficiency in English, the issue of code-switching is not that simple.

4.6 THE TEACHER AS ROLE PLAYER IN THE INTERPLAY BETWEEN MATHEMATICS AND LANGUAGE IN THE MATHEMATICS CLASSROOM

4.6.1 The language proficiency of the teacher

The teacher is the facilitator of the learners' learning process. The teacher has to make the instructional decisions (Khisty, 1995:280). Therefore the language profile of the teacher is very important. In the bilingual or multilingual classroom this includes the teacher's efficiency in English, the English mathematical register, the main language of the learners, as well as the mathematical register of the main language. De Villiers (2000:3) stresses that the English proficiency of any subject teacher that teaches through medium English should be "above suspicion". The proficiency of some of the Mathematics teachers is an area of concern. The researcher has come across teachers, busy with in-service training, whose efficiency in spoken and written English are so impaired that they cannot always formulate a sentence in a way that makes sense. The following written answers provided by different teachers serves as evidence: "The learners will used model to this concept to computation in the number sentence" (teacher A) and "To be the strongest team we have to be feed out the

given maths and also to do the best” (teacher B). The situation arises that a teacher who often formulates sentences in a way that does not make sense, teaches through medium English to a learner that cannot understand even well formulated English properly. Mathematics cannot survive in such a situation. The level of English proficiency of teachers that have to teach through medium English should receive urgent attention.

When teachers are teaching new content and new concepts, they also have to teach new terminology and subject specific phrases. In Geometry these subject specific phrases often have a strong link with the logical structure of the mathematical reasoning process, e.g. if and only if, deducted from this, therefore, generalise, etc. It follows that the language profile of the competent teacher would have to include knowledge about the existence of an informal (educational) as well as the formal (educated) mathematical register. Furthermore, the teacher’s language profile will be defined by the ability to make informed decisions on how to negotiate the journey from the educational mathematical discourse to formal mathematical discourse. The teacher who teaches in a second language and uses code-switching will also need to acquire a sense of when and where to use code-switching.

As “the relationship between language and Mathematics education in bi/multilingual classrooms is particularly complex” (Adler, 2001:9), teachers are needed who are really knowledgeable on the language frontier. The efficiency of teachers to handle the complexity of teaching the learners the mathematical register, especially in a second language context that involves code-switching, cannot be taken for granted. Training of pre-service teachers should include the domain of “Mathematics and language” with all its different facets as discussed above.

4.6.2 Language strategies and techniques used by teachers to teach language in the Mathematics class

4.6.2.1 Terminology

The term *language strategies* will be used for the manner in which the teacher uses the language in the Mathematics classroom. Two main strategies can be identified.

The first is the strategy of using only the LoLT when teaching. This strategy is mostly found in the *submersion model*. Due to the phenomenon of migration of people over the world, many learners in different countries have to study in their second or third language. Much of the research reported in literature is based on the model of submersion, especially the literature from North America and Great Britain. In many third world countries there are numerous different indigenous languages, in some countries up to 120 (Orton, 1987:137). It has become common practice to teach in one language that becomes the LoLT in the specific country, often English. English is seen by many as the lingua franca of the world and as the key to international communication. It is no different in South Africa. In the North-West the strategy to teach only in the LoLT (whether Afrikaans or English) would apply mostly to the old model C state schools and to some private schools. This strategy will not be discussed further as it is not in the scope of this study.

The second strategy is the strategy of code-switching. This strategy is mostly found where the *immersion model* is applicable. In the schools that form the population of this study the model of immersion is used and the use of code-switching is common practice. As has been defined before, code-switching refers to the practice of switching between the LoLT and the main language of the learners. As this strategy is of great importance to this study, it will be discussed separately in more detail.

The term “*techniques*” will be used for different methods the teacher uses to teach the learners new terminology, new words or synonyms in the LoLT.

4.6.2.2 *Techniques used by teachers to teach language in the Mathematics class*

In his study of teachers’ language practices in class, Khisty (1995:284-286) observed two positive techniques: The first technique entails that the teacher uses voice tone, volume and pausing to draw attention to a specific word. The word is either written or pointed to in a previously prepared list. The second is the technique of *recasting*. This is where the teacher uses a word in a different sentence or context. The recasting includes the use of synonyms (e.g. *outline of a figure* and *perimeter*) as well as different ways of looking at a problem. The recasting provides the learner with examples of how to use mathematical terminology in different sentences.

Setati and Adler (2000:248) refer to a third technique, namely, the practice of *revoicing* where the teacher listens to the learners mathematical talk and revoice their expressions to lead them towards correct and more formal mathematical discourse.

These techniques are used within the practice of code-switching. Khisty (1995:285) makes the important observation that it is not enough to provide a formal definition of a term or to translate it into English. Later, the learner may become confused when his peers or the teacher uses synonyms of the term because the learner knows only the one word for the concept. It is just as true to say that it is not enough to merely translate a formal definition of a term from English into the main language of the learner to give meaning to the term. The mathematical term has to be used in different sentences and synonyms have to be provided, explained and used by the learner. In the example of recasting given by Khisty, the teacher moved from the educational language (outline of a figure), in *both* Spanish and English, to the educated language (perimeter), again in *both* English and Spanish. On the negative side teachers sometimes miss opportunities to draw the learners' attention to words that may be confusing, or have synonyms that are often used (also see Khisty, 1995:286).

Another technique sometimes employed by teachers to *circumvent* communication problems with LEP-learners, is the use of manipulative materials. The use of diagrams and concrete manipulative mathematical aids is valuable and in fact essential, but it should not be used to replace language. Flores (1997:86) stresses that the vocabulary to talk about these aids should be developed in order to empower the learner to reflect and communicate *about* the aids, not only in the LoLT, but in both languages. Flores' view concurs with the view of van de Walle on the forming of a concept as discussed in 4.5.3. Concrete manipulative aids should therefore not be used *instead of language* but should be used to *open up communication* about concepts and relationships.

Heller and Martin-Jones (2001:13) describe the techniques of "*ritualization*" and "*safetalk*". They see "*safetalk*" as classroom talk where there is no chance for the

learner or the teacher to “lose face”. This is usually found in situations where the classes are large, teacher education is inadequate and the LoLT is not often used outside the school. “*Safetalk*” is established by means of “teacher dominated patterns of classroom talk, and the highly ritualized rhythmically teacher co-ordinated prompts and choral responses from the learners” or the so-called “*ritualization*”. An example of this would be if the teacher says: “vertically opposite angles are ...” and the class would answer in a chorus: “equal”. This practice takes place through medium of the LoLT. According to Hornberger and Chick (2001:42) the teacher in these hazardous situations often chooses for the social function over the academic function of language and so creates “safetime” in the classroom. The teacher disguises his incompetence, as well as the learners’ lack of understanding. Little learning takes place, but it seems that everybody is actively taking part.

4.6.2.3 *Interaction between teaching methods and language*

In his observations of the language practices of teachers in Mathematics classes, Khisty (1995:289) noticed that the teacher who spent the most time talking in Spanish, the main language of the learners, was also the teacher who took the most time to facilitate understanding of the Mathematics. Her primary goal was to teach mathematical concepts. The teacher spoke Spanish continuously for long periods of time. She had a pattern of complete thoughts and did not mix the languages. She balanced this with “active development of English skills in highly contextualized situations”. From the report Setati (1996, 2002) gave of her research on code-switching, it was clear that she observed the same phenomenon, although she did not describe it in such terms. From the transcription of the lessons Setati gave, it could be seen that the teachers that she described as the teachers that was the most concerned with facilitating the development of concepts (2002:73, teacher Kuki, 1996:60-62, 91-104 teacher Thato) were also the teachers that used the main language of the learners for longer periods of time, especially when they were introducing new mathematical content. Thato used more English to the end of the follow-up lesson when the new content was clear to the learners, than in the first lesson and first part of the second lesson when she was introducing new material. Thato expressed her opinions about the first lesson as follows: “... I use a lot of Tswana when introducing the lesson to try and drive them into the lesson” (Setati,

1996:60) and about the use of English: "What they (*the learners*) said in Tswana they have to know it in English." (Setati, 1996:62).

4.6.3 Teachers that do not understand the main language of the learner

Teachers who don't speak or understand the main language of the learners should still encourage learners to communicate about Mathematics in their own language with their peers. It will give the learners some of the benefit that is derived from communicating in their own language, such as for example that they feel more confident to make a contribution. It will also show the learners that the teacher value their language although he is not able to speak it. Learners with proficiency in both the LoLT and the main language of the learner(s) can serve as mediators to explain the learners' discussions in the main language to the teacher whenever necessary (Flores, 1997:89; 90).

It is sometimes possible to group together learners based on a vernacular other than the main language of the majority of learners in the school. Code-switching is possible in this context. An example of this was encountered in the township school where the research was done.

4.6.4 Language and teachers education

4.6.4.1 *Efficiency in English as language*

Though it should not be the task of the Mathematics teacher to teach the learners the English language as such, it is important that the teachers should use correct English when teaching Mathematics. Furthermore, the teacher should be able to construct sentences in a way that is simple and clear to the learners. To be able to do this the teacher has to be competent in English. It is therefore essential that teachers' education pays attention to the English language efficiency of the teachers. The efficiency of the student teachers should be tested and if their level of competence is not satisfactory an obligatory course in English is recommended.

4.6.4.2 *Efficiency in the English register of Mathematics*

It is not only English as language that is important but also to the correct use of the English register of Mathematics. It is a Mathematics lecturer's task to ascertain that Mathematics student teachers master the register of Mathematics in English. In this sense the lecturer should be a language teacher. Furthermore, the didactics of *how* to teach the English Mathematics register should be part of the curriculum, including the journey from the informal Mathematics register to the formal.

4.6.4.3 *Efficiency in the Setswana Mathematics register*

If teachers are teaching partly through the medium of Setswana and want to exploit this resource effectively they should also be competent in the Setswana register in as far as it exists. The whole issue of code-switching and code-mixing¹⁴ has to be worked through in the training of student teachers and attention should be given to the competence of the student teachers in the Mathematics register of Setswana and how to use it to improve conceptual understanding. The student teachers should be updated in this regard as to where they can find resources.

4.6.4.4 *Strategies for using code-switching and code-mixing effectively*

The practice of code-switching sprung from need. There was never any official decision or even acknowledgement of this practice (Brock-Utne & Holmarsdottir, 2004:12). Consequently, not all teacher education courses include effective strategies to move between different languages and registers. Expert advice or training to facilitate the smooth transition from the main language of the learner to English as LoLT without loss of conceptual understanding, is a scarce commodity. Setati, et.al. (2002:89) recommend that urgent attention should be given to this deficiency in the Mathematics teacher education (see 4.7.4 on discourses).

¹⁴ Code-mixing refers to a switch in language that takes place within the same sentence also called "intrasentential change." (Brock-Utne & Holmarsdottir, 2004:10). It is often found that a teacher teaches in Setswana, but use the English mathematical terminology and snatches of the English mathematical register within a Setswana sentence.

4.7. CODE-SWITCHING

4.7.1 Introduction

Code-switching as phenomenon in education in bilingual/multilingual schools is an established practice. This phenomenon is like a diamond with many different sides, and the colour of which changes with context. It differs from an urban/suburban context to a township context to a rural context. The beliefs and linguistic competencies of the teacher and the number of different main languages learners bring to the classroom also influence features of the code-switching that takes place (Adler, 2001:85, 93). The use of code-switching is a complex issue. A fine balance has to be preserved. On the one hand the learner has to understand the mathematical concepts and processes. To reach this outcome the use of the learner's main language may be indicated in certain circumstances. On the other hand the learners have to write examinations in English. Furthermore, there is a demand for proficiency in the mathematical register of English, as well as English as language, to further the learners' career opportunities and to facilitate further studies. The teacher has to ensure that the learners know, understand and would be able to apply the educational and educated Mathematics registers of Mathematics in English. Adler (2001:2) identified the continuous choice of using code-switching or not to use code-switching in a given teaching-learning situation as one of the teaching dilemma's, namely the "*dilemma of code-switching*".

4.7.2 Different uses of code-switching

4.7.2.1 The main language "backstaged"

Heller and Martin-Jones (2001:9-11) use the terms "front stage and back stage" and "keying and footing". Certain discursive practices are marginalized or placed *back stage* even though they may be essential to the accomplishment of the *front stage* goals. *Keying and footing* "concerns ways in which speakers signal their position with respect to conventions and forms of language being produced interactionally" (Heller

& Martin-Jones, 2001:9). If this is applied to code-switching where the teacher uses one language for certain purposes and another for other purposes, it becomes clear that the main language of the learner is often allotted a place “back stage”. In these instances the learners’ main language is used primarily for expressing solidarity with them and for organisational and disciplinary purposes. When the lesson proceeds the LoLT is used. With this practice the teacher, often unwittingly, signifies to the learners that their main language is inferior to the LoLT. Arthur (2001:64-73) reports such instances in Botswana in the classes where she has done her research:

- *expressing solidarity*. Buela go godimo tsala ya me (*speak up, my friend*) and Leka mma. Re utlwe. (*Try madam. We are listening*). The teacher is encouraging the learner to take part (Arthur, 2001:63).
- in a next example (Arthur, 2001:63, example 3) the teacher goes as far as to translate the content sentence into Setswana. However, immediately when the learner answers in Setswana he is checked and his answer translated into English. The main language is thus thrown “back stage” again.

Arthur (2001:65, 68) reported that code-switching was not available to the learner as a self facilitative strategy in class. In other words the learners’ answers were supposed to be in English and they could not use their own language to express their reasoning and thus to communicate their thoughts effectively. Conversations outside the classroom took place in the main language of the learners, again in a “back stage” position.

The use of language “front stage” and “back stage” is reported throughout literature on code-switching, although the terminology is not used. The language that is “backstaged” becomes marginalized and is not used to its full potential as a resource.

4.7.2.2 *The main language “frontstaged”*

Code-switching is especially valuable to facilitate conceptual development (See Adler, 2001:75). When the teacher wants to probe the thinking processes of the learners, the gateway is the learners’ own mother tongue or main language. Studies have shown that a Mathematics learner’s main language provides support while he is

developing proficiency in the language of teaching and learning. The need for the main language in exploratory talk is stressed. Most learners in ESL-schools are not fluent in English and therefore “code-switching practices are not only inevitable but necessary in school where English is being learned at the same time as it is being used as the LoLT” (Setati, et al., 2002:77, 78).

The classroom discourse that Grima (2001:228) reports in the Maltese schools, mirror the use of the main language of the learner “front stage”. The following sentences from a biology lesson illustrate this (Grima, 2001:228, Extract 2):

“Teacher: ‘did you understand it, orrajt mela tghidli Kenneth, tell me in your own words kif taghmel l-istomata biex tinfetah u biex tinghalaq’ (did you understand it, *alright so can you tell me Kenneth, tell me in your own words how does the stomata open and close*)”

The learner then answers in **Maltese**. It is clear that code-switching is used “front stage”. The teacher tries to facilitate understanding by using the learner’s main language. The learner is allowed to demonstrate his understanding in Maltese. The resource of the main language of the learner is used optimally to facilitate understanding.

4.7.3 Teachers’ beliefs and the influence of context

According to Grima (2001:223-224) the use of English in the Maltese classrooms stems from the fact that most written work is done in English. Grima reports the views of some secondary school teachers and lecturers at a university in Malta. They are of opinion that English creates a barrier between the teachers/lecturers and the learners. These views are coherent with the example given above where the teacher gave the Maltese language a more important place and used it “front stage” and through these means tried to facilitate understanding and overcome the “barrier” between teacher and learner.

4.7.3.1 *The context of rural or urban areas*

An interesting phenomenon that Setati, et.al. (2002:85, 86, 89) observed is that the Mathematics teachers in the four rural primary schools included in their research in Gauteng and Northern Province, used more English and less code-switching than the Mathematics teachers in the secondary schools (also see Setati & Adler, 2000:251). They ascribe it to the fact that these teachers see it as their task to teach English, as well as mathematical English, because the learners have very little contact with English outside the classroom (also see Adler, 2001:87-90). The irony is that these learners would most possibly be in great need for clarification of concepts in their own language because of their inadequacy in English. These teachers are in fact caught up in a situation of a clash of interests. On the one hand they want to promote fluency in English and, in their view, to achieve this have to teach through medium English as much as possible. If they do this, the understanding that could be facilitated through code-switching is lost, and vice versa.

In grade four the official LoLT in many schools changes to English. The learners enter this phase while they are still not competent in English as language (see also Setati, et al., 2002:73). If the main language of the learners is not exploited as resource, especially in the rural areas, it may lead to a new social stratification. In the urban areas where English is often heard and read the learners will be more competent in English. Furthermore, well-to-do parents can afford television, extra lessons in English or other aids, while the learner in an impoverished rural community can not afford it. The conceptual development of the learners who do not have an English rich environment therefore becomes impeded because their competence in English is inadequate for facilitating true conceptual development and they are deprived of the resource of their main language. If their main language is “backstaged” the consequence may be that rural learners will stay underachievers and therefore “lower class”, while the urban learner and those with well to do parents will stay “upper class”, partly because of language strategies in the classroom.

The language of teaching and learning in grades 1-3 in North-West is the main language, in this context mostly Setswana. Learners are supposed to start

recognising geometrical figures at an early age. The visual level of reasoning requires the correct mathematical language. Even in grades 1-3 the teachers tend to use English terminology. Sometimes this is because of a lack of words for the specific concept in Setswana, but concepts are often introduced in English even though the terminology does exist in Setswana, e.g. circle (sediko), square (sekwere) and rectangle (khutlonnetsepa)¹⁵.

Contrary to Setati and Adler's findings mentioned above, the LoLT in many rural primary schools in the North-West, also in the intermediary phase, was found to be mainly the main language of the learners, sprinkled with English terminology. This is based on the observations of the staff of Math Centre for Professional Teachers (MCPT) in North-West (MCPT, 2004), who visit many schools in the area, including many farm schools. It could be because it is a different region than the one Setati and Adler studied, or because code-switching and teaching in the main language with code-mixing has gained momentum since their study. Brock-Utne and Holmarsdottir (2004:12) found the same phenomenon in their research in schools where the main language was isiXhosa. The official policy of the schools was that the LoLT should be English from grade four, but they found that "the actual language used in the classrooms is isiXhosa". They reported that the teacher would at the end of the lesson write some English sentences on the chalk board, which will then be copied into the learner's books. A cursory examination of the learners' books gives the impression that teaching is actually taking place in English, though the whole lesson was mainly conducted in isiXhosa. The negative side of this practice is that the learners' English proficiency in the register of the relevant subject may be less developed by the time they reach the secondary school. In this situation notes and a glossary in both languages may be helpful to the learners in the long run.

4.7.3.2 *The context of group work*

Setati and Adler (2000:254) report in their study that teachers and learners mostly used English in the public domain (front stage). The learners' communications were

¹⁵ This was revealed by the results from a questionnaire on the use of terminology for basic geometrical shapes in Mathematics classes of teachers teaching in primary schools where the main language of the learners is Setswana

“limited to short phrases, single words or recall of procedures”. This last observation corroborates with the opinion of the lecturers in Grima’s study that English creates a barrier between the learners and their teacher. In Setati and Adler’s research new teaching strategies were encouraged. As the strategies changed over time Setati and Adler (2000:254) observed that the teacher switched to the main language to reformulate in the whole class situation, but also for interaction with individual learners or small groups. What is important is that they also observed that with increased learner interaction later in the research, the communication between the learners were always in their own language, although some English terms were used for mathematical terminology.

Earlier in this study the statement was made that language has become more important in the classroom because of the employment of group work, investigations and other teaching methods used in OBE. Setati and Adler’s observation indicates that not only language as such has become more important, but especially the *main language* of the learners. It is used more often as interaction increases among learners and between the learners and the teacher. The main language is used more for mathematical discussion, especially in group work.

4.7.3.3 *The context of primary school or secondary school*

The character of the code-switching, whether the main language is “front stage” or “back stage”, and the frequency with which it is used are influenced by whether it is a primary or secondary school. According to Setati and Adler (2000:254-256) code-switching in the cases that they studied took place less in the primary schools than in the secondary schools. This is an interesting phenomenon since the learners in the secondary schools had more opportunity to become fluent in English. From their research it emerged that both rural and urban primary teachers feel a strong responsibility to teach in English because the learners are still learning English.

94,2% of the primary teachers in the survey done in this research indicated that they use code-switching when teaching Mathematics as opposed to the 84,1% of the secondary school teachers in the survey. This survey therefore indicates that the situation may be different in the North-West regions covered in this survey, or that

the situation has changed in the last few years. Indications are that the main language is used more in the primary schools than in the secondary schools. However, it should be mentioned that the teachers in the survey were not asked to indicate the *ratio of time spoken* in the different languages (see 5.4.2 & 5.5.2).

4.7.4 The language journey between discourses

The phenomenon of a Mathematics register in the English language has been discussed and it is clear that an informal Mathematics register exists that the learner uses to explore, discuss and develop new concepts. The informal language of the learner in the multilingual classroom will often be a register of his main language. The learner then has to grow into the formal mathematical register that will more often than not be in English (Adler, 2001:85, 86).

Setati and Adler (2000:249) identify three levels of movement from informal spoken to formal written Mathematics in the multilingual classroom, namely from

- spoken to written Mathematics
- informal to formal mathematical language
- main language to English

Setati, et al. (2002:80, fig. 5.1) illustrates the different possible routes from informal mathematical language in the main language, to the formal mathematical register in English. Their conclusion is that the development of the learners from informal discourse in the main language to the formal mathematical register in English is not being facilitated adequately (Setati, et al., 2002:82). More often the classroom discourse followed the route from informal exploratory talk in the main language directly to the formal English register as used by the teacher (Adler, 2001:91). It may be that the link between the formal English mathematical register and the understanding, facilitated by the informal exploratory talk in the main language, are not established well enough.

A Setswana/English glossary and notes in both languages (or alternatively if the learners have an English textbook and Setswana notes) could possibly be applied to induce the teacher to follow a less direct route from the main language explorations to the English formal mathematical register. Van Hiele (1986:50, 79) indicated the necessity for the acquirement of the correct language to reach the different levels of reasoning. Acquiring the formal language of Mathematics is of utmost importance in the teaching of Geometry. Knowledge of the correct terminology is however of no use if the underlying concepts are not adequately developed.

Setati, et al. (2002:80, fig. 5.1) offers the following diagram to illustrate the different possible language journeys:

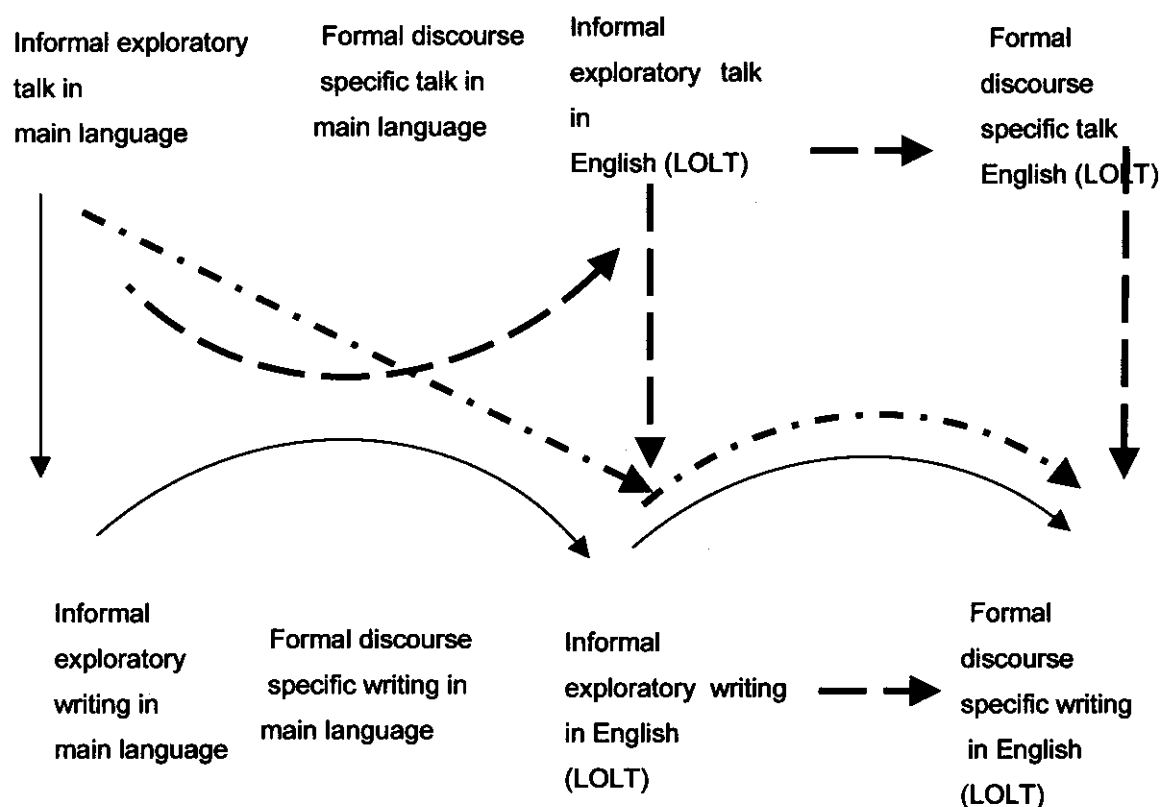


Figure 4.7.4 Language journeys

Setati, et al. (2002:89) spells the following implications of their study:

- during training attention should be paid to possible journeys from exploratory informal talk in the main language to discourse specific talk and formal writing in English. The pitfalls that teachers and learners could encounter on such a journey should be explored as well. These trainees should furthermore study

possibilities and constraints regarding language of “good” practices, for example group work;

- the issue of code-switching and the journey to the formal English register of Mathematics should be addressed in curriculum policies;
- the different language infrastructures should be taken into account and be addressed in the language policies of the Department of Education in South Africa;
- the possibility that group work is not facilitating the mathematical language journey should be explored;
- INSET should pay attention to upgrading of the “journey skills of teachers”.

These recommendations can only be applauded and need to be put into practice.

4.8 DIFFICULTIES ENCOUNTERED IN THE DEVELOPMENT OF A REGISTER FOR MATHEMATICS IN SETSWANA

4.8.1 The negative attitude of some Setswana speakers

The Mathematics language is a “new language”, as discussed in chapter 3. Mathematics teachers that were taught and teach through medium of their own mother tongue have grown into this language from their first encounter with Mathematics. This is different for teachers who have been taught through a second language. Batswana teachers who had their schooling and training as teachers through medium English know the English register of Mathematics intimately. On the other hand they know only the terminology for isolated concepts in Setswana.

The mathematical terminology has to be subsumed into the language network of the learner. To facilitate the effective incorporation of new terminology into the language network of the learner the teacher has to do some language teaching. Sometimes the origin of the word has to be explained and sometimes the structure of the word has to be investigated to determine the words that form part of its composition. An example is the word for adjacent angles namely, *khultomabapi*, (Department of Arts and

Culture, s.j.:5) formed from the sentence *dikhutlo tse di bapileng* (angles that are alongside each other). To accomplish the language teaching needed, the teacher has to have a certain expertise that may be lacking, as the teacher will be encountering some of the new Mathematics terminology for the first time in his own language. The links to his own language network were not established and it seems to the teacher like another foreign language (see in this regard 6.6.3). It is not difficult to understand why some Batswana Mathematics teachers cannot see the rationale of why they should teach the Setswana register. They feel that it is not worth the effort to teach the learners terminology in Setswana if the learners have to write examinations in English (see 5.4 & 5.5).

If the learner encounters Setswana terminology *from the start* and the terminology is explained when needed and integrated into the existing Setswana language network, it becomes a different experience and may facilitate better understanding of the concepts in Mathematics. It is necessary for the teacher to understand the difference between his own encounter with the Mathematics register of Setswana and the learners' experience.

4.8.2 Regional differences

Regional differences exist and different words for the same concept may be found in different regions. For example, a group of fifty in-service teachers enrolled in an upgrading course for intermediate and senior phase Mathematics teachers was asked to write down the Setswana words, if any, that their learners use for a circle. The words *sekele* (2), *kgolokwe* (4), *tshekeletsa* (4), *sediko* (5) and *sedikwe* (2) emerged, while 33 only used "circle". Of these the Multilingual Mathematics Dictionary for grade 1 to 6 (Department of Arts and Culture, s.j.:22) gives only *sediko* as the Setswana word for circle and *sekele* as one of the two terms for circle in Xitsonga. Which of the different terminologies should be chosen? Should the one that is used most be selected or should all the different regional words be included in a dictionary of mathematical terminology? Standardisation seems the way out, but this variety in terminology may contribute to some teachers' feeling that it would be a

better choice to use the English terminology than to develop and implement a Mathematics register in Setswana.

4.8.3 The structure of the language

The structure of Setswana is such that it sometimes takes a whole sentence to explain a concept. In some cases the words can be linked together to form a new word, as described in the case of *khutlomabapi*. It would be essential for the teacher to understand which words were used in the construction in order to facilitate understanding of the concept. To really benefit from a Setswana register, "visible" Mathematics language teaching is essential to facilitate the links to the existing language network.

4.8.4 Final examinations in English

Many teachers view the effort to develop a Setswana mathematical register for Mathematics as unnecessary because the learners have to write their matriculation examination in English. As reported in Chapter 5, a survey was done on language issues including both secondary and primary teachers. 65 out of 207 teachers were negatively inclined towards the use of an English/Setswana glossary in Mathematics classes. Different reasons were provided and some are even of opinion that the use of a Setswana Mathematics register will have a detrimental effect. The fact that the final examinations are only conducted in English and Afrikaans and not in the different vernaculars of the country in it self has a negative influence on the diligence with which a mathematical register in Setswana is developed.

However, the problems that especially the LEP-learners encounter when learning Mathematics are a reality, which is identified throughout literature in different terminology. Howie and Hughes (1998:5, 33, 59) name the role of language as one of the possible contributing factors to South African Mathematics learners' underachievement in their analysis of the TIMMS-report. Brock-Utne and Holmarsdottir (2004:16 and also see 13-17) go as far as to identify the African child's

major learning problem as linguistic. This contravenes the above viewpoint that only English terminology should be used in the teaching and learning when it comes to Batswana Mathematics learners.

4.9 CONCLUSIONS

The language scene in the Mathematics classroom is complex. The policies of the government as well as the de facto leaning towards English as medium of communication of the government, the economic society's drive towards monolingualism, the quest for proficiency in English in the workplace and in a lesser degree the influence of financial aid programs from western sources are outside factors influencing the language policies of schools. Nearer to home the context, whether it is urban, suburban or rural, primary or secondary, as well as the beliefs of the parents play its role to determine the language policies of a specific school. In the last instance the learning phase in which the learners are, the number of different main languages in the class, the proficiency of the learners in English, the proficiency of the teacher in the main language(s) of the learners and the views of the teacher are the final determinants of the language strategies for a specific classroom.

Educational reforms highlighted the need for learners to be communicatively competent in order to be able to take part in classroom discourse and be enculturated into Mathematics. Indications are that the learners need their main language for effective conceptualisation and to reason and express their thoughts in the register of Mathematics. The main language therefore becomes the natural medium of communication with peers and the teacher about Mathematics. There is research that indicates that the learners' achievement when assessed in their main language, or both the main language and the LoLT, is better than when they are only tested in the LoLT, especially in word sums where language plays an important role.

LEP-learners experience problems when the construction of the language differs greatly as in Setswana and English. They struggle with the different ways in which symbolic language can be expressed in English and a lack of word sense impairs their understanding of nuances in the English language. The lack of terminology for

certain concepts in Setswana is detrimental because of the dependence on the English register of Mathematics.

The language efficiency of the teacher in both the main language and English plays a critical role. Some researchers see the use of English as medium of instruction as a negative influence on the learners' proficiency in English, because the learners are exposed to incorrect English used by some teachers of subjects other than English language. Attention should be paid to the language aspects in teachers' education. This should include the use of the mathematical registers in English and Setswana, as well as knowledge on how to negotiate the journey between the different discourses when using code-switching.

Code-switching has become general practice, not because of any policy but because of the need that exists. In some instances Setswana is used "back stage" emphasising the importance of English for teaching Mathematics. Other teachers use it "front stage", especially for conceptual development. This enhances the status of the main language and promotes learner participation. Code-switching is complex and the teacher should understand that informal as well as formal registers exist in both English and Setswana and that he should be well equipped to negotiate his way between these registers.

Research indicates that some teachers, who use code-switching for conceptual development, tend to develop the concepts through the medium of the informal Mathematics register of Setswana and then proceed directly to the formal Mathematics register of English. There is a possibility that the link between the informal Setswana Mathematics register and the formal English Mathematics register is not established well enough. A glossary and /or notes in Setswana could assist the process.

Regional differences, the structure of the language, the fact that the final examinations are in English and the negative attitude of some of the mother tongue speakers of Setswana are some of the factors that delay the expansion of the Setswana Mathematics register.

CHAPTER 5

EMPIRICAL INVESTIGATION OF THE LANGUAGE PROFILE OF THE MATHEMATICS CLASSROOMS IN THE NORTH-WEST PROVINCE OF SOUTH AFRICA

5.1 INTRODUCTION

The study of theories on the relationship between thought and language and the importance of language in the learning of Geometry, as well as the study of literature on the special language of Mathematics, the problems of LEP-learners in Mathematics and the phenomenon of code-switching, gave rise to two areas of interest. The first area of interest was the need to understand what is happening in the Mathematics classrooms of North-West on the language frontier. The second was whether Setswana notes and an English/Setswana glossary will be helpful to the Batswana learners in the learning of Geometry. The next two chapters will focus on empirical data collected on these two areas of interest by means of collaborative action research which was done in two phases. Chapter 5 addresses the first phase and offers the findings of a survey done amongst Mathematics teachers in North-West on their classroom situation regarding the different main languages of the learners, their own main language as well as their views on code-switching and the use of an English/Setswana glossary and Geometry notes for the learners in Setswana. This investigation represents the first phase of the action research, namely the diagnostic stage as described in chapter 1.

5.2 THE GENERAL LANGUAGE ENVIRONMENT OF THE BATSWANA LEARNERS IN THE NORTH-WEST

5.2.1 The classroom context

As stated in the previous chapter, the focus of the study is on the schools in the rural and township contexts of the North-West. Most classes are conducted in the main language of the major language group of the learners in the school in grade one to three, as in the rest of South Africa (PMG, 2001:2). From grade four onwards the LoLT is the choice of the specific school. In most schools where Setswana is the

main language of the majority of learners, the official LoLT from grade four onwards is English.

The learning environment in the majority of the rural schools is a *foreign language-learning environment*. In the township schools it would be nearer to an *additional language learning environment*, although the learners will hear less English in the community than in urban-suburban schools and the level of proficiency in English differs from learner to learner, as described in section 4.1.1.

5.2.2 The model of teaching

The model of teaching is *immersion* (See 4.6.2.1). The majority of the learners in the rural area are from the same cultural and linguistic background. In the townships learners with different main languages are present. The main language of the North-West region is Setswana and the focus of the study is on schools where Setswana is the main language of the majority of learners. The official LoLT of the schools is English. Code-switching is a strategy in most of the schools, as will be seen from the results of the survey.

5.3 SURVEY CONDUCTED AMONG TEACHERS IN THE NORTH-WEST

As phase one of the action research (the diagnostic stage), a survey was done among teachers in the North-West to try and gain a deeper understanding of the language scenario in the schools (see 1.4.2.1). The participants were teachers in the Sediba- and Nasop-programmes of the Potchefstroom University for Christian Higher Education (now the Potchefstroom campus of the North-West University). These are upgrading courses for in-service teachers to improve their qualification from a three-year diploma to a four-year diploma (ACE) with Mathematics as major.

Samples of convenience were used and no random sample was selected. The samples were stratified in that the two samples represented one group of teachers from secondary schools and one group of teachers from primary schools. The results

of the survey were processed separately for each group (Leedy and Ormrod, 2001:210- 223).

5.3.1 Profile of the participants in the survey

The teachers in the Sediba-programme are secondary school teachers. The programme is sponsored by industry. These teachers are selected each year by the School for Science, Mathematics and Technology of the North-West University, from applicants that come mainly from the North-West, but a small number of teachers teaching in Mphumalanga, the Free State and Gauteng are also accommodated. The teachers all have a three-year diploma with Mathematics as major. All these Mathematics teachers are teaching grades in the FET band. The number of men and women in the course are more or less even. The teachers originate from many different regions of North-West, approximately half come from rural areas and half from townships, with only a few coming from urban schools.

The teachers in the Nasop-programme are mainly primary school teachers. These teachers also have a three-year diploma with Mathematics as major. Some of the teachers teach in the intermediate phase and some in the senior phase. A few of these teachers are teaching grades in the FET band. The teachers in the Nasop-programme are selected by the Department of Education of the North-West. Each year a number of teachers are selected from different schools, in two different regions, approximately the same number of teachers from each region. The three yeargroups that were included in the study came from the following regions respectively: Mothibistad/Atamelang, Temba/Mabopane and Zeerust/Mafikeng.

Mothibistad and Atamelang are two townships in rural areas about 230 km from each other. Both the regions have many rural schools, but especially Mothibistad includes widespread rural areas. Some of the teachers are from the townships of Atamelang and Mothibistad itself. Temba and Mabopane are two regions with widespread townships in the wider vicinity of Pretoria and Hammanskraal. Although large townships, these areas are not very cosmopolitan. The Zeerust and Mafikeng regions differ from the previous in that it includes the city of Mafikeng. Mmbatho/Mafikeng

was previously the capital of Bophutswana, which may account for its more multicultural composition. Both Mafikeng and Zeerust are near to the border of Botswana, which contributes to more different languages found in this area.

The survey was done in the first week of each course. The Sediba-course runs over two years with 80 days contact time. It consists of four modules that cover mathematical content, one module Mathematics Subject Didactics, two Education modules and two modules Computer Literacy. The Nasop-group has 36 days contact time over two years and the course consists of same modules as the Sediba-programme, with the difference that the four Mathematics content courses focus on concepts and skills development in the intermediate and senior phases. The groups of each course for 2001, 2002 and 2003 formed the population for this survey.

5.3.2 The questionnaire

The following questions motivated the survey:

In how many classes have the practice of code-switching taken root? Do the teachers feel that English as LoLT is impacting negatively on their learners' performance? Will the teachers feel any need for a scaffold such as notes and a glossary in the main language of the learners to assist teachers and learners in overcoming possible negative effects of English as LoLT? What are the problems that the teachers may foresee with regard to the use of mathematical terminology in Setswana? To what extent may the presence of a variety of main languages among the learners in the class be an obstacle to the use of such an aid?

A questionnaire was compiled by the researcher to gather information on the language scenario in the Mathematics classes of the North-West. Some biographic data was gathered such as the mother tongue of the teacher and the grades the teachers taught. A few questions focussed on the composition of the different languages of learners present in the classes and the language policies of the schools. However, the questionnaire mostly dealt with the views of the teachers on language issues such as the use of code-switching and language aids, for example

notes and a glossary for the learners in their own language. The questionnaire was anonymous. It was therefore not possible to do a follow-up on whether teachers for instance only spoke English in class if that was what they reported, or whether it was only a projection of the ideal situation according to their views. On the whole the researcher's impression was that the teachers stated their views uninhibited and honestly. The results of the Nasop-group (primary teachers) and the Sediba-group (secondary teachers) were processed separately.

5.3.2.1 Validation

The teachers are asked to comment on the questions where they are required to give their views. These comments helped to verify that the teachers understood the multiple choice questions correctly and answered according to their views. Quite a large component of the teachers only commented on questions 11 (LoLT English), 12 (glossaries) and 15 (strategy proposal) of the questionnaire and not on questions 13 (notes) and 14 (tests). It may be that they felt that they would be repeating themselves. In these cases however, it could still be determined from the comments on questions 11, 12 and 15 whether the answers given to the multiple choice questions are in line with the teacher's views.

5.3.2.2 Interpretation of the results

Descriptive statistics are used to interpret the results of the survey.

A summary of reasons given by the teachers to motivate their answers for questions 11, 12, 13 and 14 respectively has been compiled for each group. The number of participants that gave a specific reason was separately documented for each group. No percentages were given as some participants supplied more than one reason and therefore percentages would not add up to 100%. Of question 15 (language strategy proposal) only a representative sample of ideas were documented.

A copy of the questionnaire can be found as Annexure A.

5.4 THE SITUATION IN THE NORTH-WEST IN PRIMARY SCHOOLS

A survey was conducted among 121 primary school teachers from three yeargroups of the Nasop-teachers in the ACE-programme as described above. The following results occurred:¹⁶

5.4.1 The language policies of the schools

- Only 0,8% (1 of 120) of the teachers reported that their school did not have an official language policy;
- 6,7% of the teachers (8 of 120) reported that the policy in their school was that the teaching and all the discussions should be strictly in English;
- 2,5% of the teachers (3 of 120) reported that the policy in their school was that the teacher should use English only, but the learners may use their vernacular;
- 90% of the teachers (108 of 121) reported that the policy in their school was that the teaching should take place in English, but that the teacher may switch to a vernacular when he deems it necessary.

5.4.2 The phenomenon of code-switching

- 94,2% (114 of 121) of the teachers reported that they used code-switching when teaching Mathematics.

When asked to which language they switched

- 72,3% (86 of 119) of the teachers indicated that they switched to the main vernacular of the group and it coincides with their own;
- 15,1% (18 of 119) of the teachers indicated that they switched to the main vernacular of the group and it does not coincide with their own;

¹⁶ The number of participants are 121. Sometimes the number will be given as e.g. 4 of 119. This means that two of the participants did not answer that specific question.

- 7,6% (9 of 119) of the teachers indicated that they switched to different vernaculars of learners in a multilingual group;
- 5% (6 of 119) of the teachers did not switch at all.

5.4.3 The mother tongue of the teachers

The mother tongue(s) of

- 77,7% (94 of 121) of the teachers was Setswana;
- 15,7% (19 of 121) was Sotho (North and South Sotho);
- 0,8% (1 of 121) was Afrikaans;
- 0,8% (1 of 121) was Zulu;
- 0,8% (1 of 121) was Xhosa;
- 4,1% (5 of 121) were other languages.

96,7% (117 of 121) of the teachers believed that they were competent in Setswana.

5.4.4 The language composition of the classes

90,8% (108 of 119) of the teachers reported that the main group in their classgroups is Setswana mother tongue speakers. Other language groups that were significantly present in the classgroups of the teachers were:

- Zulu (in 14% of the classgroups, 17 of 121);
- Xhosa (in 12,4% of the classgroups, 15 of 121);
- South Sotho (in 14,9% of the classgroups, 18 of 121);
- North Sotho (in 19% of the classgroups, 23 of 121);
- English (in 8,3% of the classgroups, 10 of 121);
- Afrikaans (in 3,3% of the classgroups, 5 of 121);

- other languages (in 12,4% of the classgroups, 21 of 121). Quite a number of these were Tsonga.¹⁷

The composition of 54,6% (65 of 119) classgroups consisted of learners of whom the mother tongue is either Setswana (1 homogeneous South Sotho group) or English. Code-switching to only one indigenous language would therefore be indicated. Of the 65 teachers teaching the homogeneous classgroups, 10 teachers indicated that their mother tongue is a language other than the language of the group, 9 of these teachers indicated that they see themselves as being competent in the language of the group, while one teacher saw himself as only competent in his own language as well as English and Afrikaans.

In 18,5% (22 of 119) classgroups there were significant groups of two indigenous languages. Only 5 of the teachers were competent in both languages.

26,9% (32 of 119) of the classgroups was multilingual.

Regional differences were apparent

If only the data of the regions Mothibistad/Atamelang and Temba/Mabopane are scrutinised the following picture emerges:

- *The composition of 76,7% (56 of 74) of the classgroups were homogeneous. In 15% (11 of 74) of the classgroups there were significant groups of two indigenous languages. 9,5% (7 of 74) classgroups were multilingual.*
- *In the Zeerust/Mafikeng districts 55,6% (25 of 45) of the classgroups were multilingual, and in another 24,4% (11 of 45) there were significant groups of*

¹⁷ When reference is made to "classgroups", it is all the Mathematics classes that the specific teacher are teaching seen as one group. It may be that in some of a specific teacher's classes, some classes may be homogeneous and others would be mixed language groups. As one group it will however be classified as a mixed language groups. The classes of the 35 teachers that indicated that they teach homogeneous groups would then all be homogeneous. This will be the same for the relevant question for the secondary schools.

two languages, with only 20% (9 of 45) of the classgroups homogeneous as opposed to the 76,7% of the other two regions.¹⁸

5.4.5 The language facilitating the Geometry reasoning of the teachers

15% (18 of 120) of the teachers said that they think only in their own vernacular, 60% (72 of 120) said that they think in English, and 25 % (30 of 120) said they think in both their vernacular and English.

5.4.6 Teachers' views on whether English as LoLT hindered the performance of the learners

On the issue of whether they think that English as LoLT hindered the performance of the learners, the teachers were divided. 48,7% (56 of 115) of the teachers were of opinion that it is detrimental and 51,3% (59 of 118) had the view that it is not.

In their comments on this question the teachers motivated their opinion that English as LoLT hindered the performance of the learners as follows:

The learners

- will understand better in their mother tongue (18);
- do not always understand the questions asked in English correctly and therefore give wrong answers (5);
- will express themselves better in their own mother tongue (13);
- are not competent in English because they hear English only at school and have only started English in grade 4 (5);
- performance would be better (2);
- use their mother tongue in group sessions (2);

¹⁸ The data of the groups of Mothibistad/Atamelang and Temba/Mabopane was processed together and that of the group of Zeerust/Mafikeng added at a later stage. It was reprocessed to give the results for the whole group of teachers. When it became apparent that a different picture of the language composition of the classgroups emerged for the Zeerust/Mafikeng region, the data for these questions were processed also for this group on its own to make a comparison possible.

- forget more easily because they are taught in English (3);
- like to use their mother tongue (2);
- have to struggle to understand the language first. If it was in their own language they could focus on the Geometry (3).

One teacher commented that if the concepts are taught in the vernacular from the beginning it will help the learners a great deal and another commented that the vernacular should only be used as a supplement.

The teachers that were of opinion that English as LoLT **does not** hinder the performance of the learners motivated it as follows:

- there are other reasons than language for the low performance (3);
- as the learners' mother tongue is used to explain the Geometry it does not hinder them to use English in the examination (4); the learners use their mother tongue in their groups (1);
- *the learners*: really understand English very well (3); can understand written English (1); already understand Geometry better in English (2);
- the concepts of Geometry are in English (1); if a correct foundation is laid there is no problem (1);
- learners can express concepts better in English and overcome their difficulties by interacting with other international learners (1);
- the mother tongue of the learners lacks some technical words (3); Setswana words are too long and are mostly just a direct translation of English (1).

Reasons provided that circumvented the issue of whether it hindered the learner but reflected a view why English should be the LoLT are:

- learners should learn to use English because it is the LoLT and is used across the curriculum and they write their examinations in English (10);
- textbooks are written in English (2);
- English has to be used in future for example in the work place (4); it motivates the learners to learn a foreign language and communication with other groups is

enhanced (1); English is the means of communication and empowers the learners to communicate everywhere (1); to teach in English motivates the learners to learn English as official language (1);

- if the learners speak English regularly they will learn to understand English better (2).

5.4.7 Teachers' views on a glossary, notes and tests in Setswana

- 71,3% (82 of 115) were of opinion that a **glossary** would be helpful while 26,1% (30 of 115) had the view that it will be detrimental or of no value, and 2,6% (3 of 115) were of opinion that it will be impossible to attain.
- 53% (61 of 115) of the teachers were of opinion that **notes** in the vernacular would be helpful while 42,6% (49 of 115) had the view that it will be detrimental or of no value and 4,4% (5 of 115) had the view that it will be impossible to attain.
- 52,6% (61 of 116) of the teachers were of opinion that **tests** in the vernacular will be helpful while 44% (51 of 116) had the view that it will be detrimental or of no value and 3,5% (4 of 116) had the view that it will be impossible to attain.

The majority of teachers, 94,4% (113 of 120) and 99,2% (117 of 118), reported that they never give notes or tests respectively to the learners in their own vernacular.

The teachers were asked to motivate their answers.

The reasons why teachers had the view that a **glossary** would be helpful can be summarised as follows:

- learners will be able to understand the concepts and questions better in their own vernacular (26); learning the concepts in their vernacular will make the knowledge more permanent because they use the terms everyday (1);
- it will give more meaning to what they do (2); it will enable the learner to move from known to complex (1); learners have previous knowledge of their mother tongue (2);

- it will help them to relate the concepts to their daily experience (1); they will identify themselves with what they learn (1);
- the learners will remember the work better (4);
- learners get confused with the English terminology (1); learners could refer to the glossary when they are confronted with English words they don't understand (1); a glossary will promote the development of language (2); it will help them to understand the English terminology better and so promote their English (5);
- a glossary will be helpful when you do code-switching (1);
- learners want the teacher to explain in Setswana (1); learners will like Geometry more (1); learners will be proud of their language (1);
- it would enable learners to study on their own because they do not always understand the English terminology (1);
- learners will be able to express themselves clearly without hesitation (1).

Teachers who had the view that a glossary would be detrimental, of no value or impossible to attain, gave the following reasons:

- The learners will get confused by switching between the languages (3); they are used to terminology in English (1);
- learners must get used to English to understand the terminology (1); they should know the terminology in English to use it in their workplace and in a global context since Geometry is a science subject (3); if the learners use the terminology in the vernacular they will not be able to communicate with foreigners in future (1); learners are expected to master English to be able to communicate with anyone (2);
- learners will try to switch to the vernacular when they are supposed to answer in English (1);
- the vernacular doesn't have a scientific register (5); things are explained in long sentences in the vernacular, while scientific language in English is easy with short sentences (1); technology and science is growing rapidly, there will be no place for vernacular terminology (1);
- a glossary will be of no help because the content is in English (1); textbooks are written in English (1);

- the vernacular is useful for explanation but a glossary is unnecessary if the learners listened carefully (1); understanding of the concepts is the main issue (1);
- it will be time consuming (1); a glossary will only be a lot of unnecessary extra information that the learners can't grasp (1).

Teachers that have the view that notes in the vernacular would be helpful gave the following reasons:

- learners will understand content and terminology better (35);
- it will help the teachers to understand the learners' problems better because the learners can concentrate on the Geometry instead of the language (2).
- it will improve critical thinking (1);
- learners will use their vernacular to think (1);
- learners will be able to associate the concepts with their backgrounds (1);
- learners like their own language (1); Geometry will be liked more (2);
- it will facilitate independent study (1);
- it will promote their language skills (1); a balance will be struck and the learners will be able to communicate in their vernacular and in English (1);
- it will make all languages equal and official (1).

Teachers that had the view that notes in the vernacular would be of no value, have a negative effect or be impossible to attain gave the following reasons:

- it is going to cause a lot of work for the teacher to give the notes (1); even the teachers do not know all the terminology in their vernacular (1);
- it will be confusing for the learners (6); the learners will start translating English into Setswana (1); if the terms are provided in Setswana when doing Mathematics it will be difficult for them to cope when they encounter the same concepts in science (1);
- the learners will not participate when they are given notes in their own language (1);
- the learners will not be able to use their vernacular on national level (1); the vernacular is not recognised internationally (2);

- the learners will understand the scientific concepts better in English (1); the scientific language is easier and more comprehensive in English (2);
- the learners will not be eager to learn the English terminology if they have it in their vernacular (3); it will be detrimental to learners' English competence (5);
- it will be of no value since the learners have to write their examinations in English (1); most textbooks are written in English (3);
- it is not possible when you teach learners with different vernaculars (2);
- learners don't need notes because Geometry must be practised, not read (1);
- it is a waste of time because it will not help the learners at all (4).

Teachers that were of opinion that **tests in the vernacular would be helpful** gave the following reasons:

The learners:

- will understand the questions better (12);
- will be able to recall what they learnt (2);
- will be able to express themselves better (2);
- would not have to start thinking in their own language and then switch to English and waste valuable time (2);
- will have a better attitude (1);
- will understand the concepts better and relate it to what they know (9); will know what they learn (1); learners will understand the geometric concepts when it is later taught to them in English because the meaning of the concepts is already clear to them (1);
- it will bring reality to the classroom (1); what the learners know will be of more importance to them (1); if something is structured in their language learners will relate it to reality (1).

Other following comments expressed reservations:

It will be useful only if the examinations are also in the vernacular (1); both languages should be used (2); a glossary can be used where the vocabulary in the vernacular is adequate (1).

Teachers that were of opinion that tests in the vernacular will be of no value, have a negative effect or will be impossible to attain gave the following reasons:

- the LoLT is English and the tests should be in English (7);
- it will confuse the learners (3); it will impact negatively on their studies (1); if it is used in Geometry it should also be used in Science (1); there are no textbooks in the vernacular (1);
- the learners should learn and practise English to become better scientists (3); they must be tested in a language in which they will be able to compete with their counterparts in other countries (2).

5.4.8 Conclusions on the results of the primary schools

- An overwhelming majority of the primary school teachers in this survey uses code-switching, namely 94,2%.
- A significant number of the classgroups were homogeneous with regard to the main language of the learners, although it differs from region to region. With one exception these homogeneous classes were taught by teachers seeing themselves as competent in the main language of the learners.
- In homogeneous classgroups it would be possible to give a test/notes/glossary in the learners' main language, as well as in English, although it will comprise more work for the teacher. These homogeneous Setswana classes harbour many LEP-learners and they need the resource of their main language urgently.
- Many of the teachers have the view that an English/Setswana glossary would be helpful. There are some qualms that it may confuse the learners and have a negative impact on their English, which is the medium of communication nationally and internationally. The lack of terminology in the vernacular is seen as a problem. The problem does not only lie with compiling a glossary, but with the fact that the vernacular is disqualified as scientific language and therefore necessitates the use of English as LoLT.
- A still significant, although smaller group of teachers, feel that notes and tests will be helpful. Quite a significant group (35) motivated their choice in favour of

notes in the vernacular with the opinion that learners would understand content and terminology better if they have notes in their vernacular. The use of English as medium of communication in the world outside, as well as the lack of mathematical terminology in the vernacular, is seen as strong arguments against it.

- There is a considerable number of classgroups that are multilingual. Although the teachers indicated that the number of learners whose vernacular is a language other than Setswana was significant, it could not be determined from the results of this survey how large these numbers are. It is also possible that some of the learners in question speak Setswana fluently and that Setswana is their second language, as they are living in regions where the majority of people speak Setswana.

5.5 THE SITUATION IN SECONDARY SCHOOLS IN THE NORTH-WEST

A survey was conducted among 97 secondary school teachers from three yeargroups of the Sediba-teachers in the ACE-programme as described in section 5.3.1. These groups were mainly from the North-West, but they were not selected from specific regions. The survey gave the following results:

5.5.1 The language policies of the schools

5,8% of the teachers (5 out of 87) reported that their school did not have an official language policy.

26,4% (23 out of 87) teachers reported that the language policy prescribed that they should strictly teach in English. These were divided as follows:

- 20,7% of the teachers (18 out of 87) reported that the policy in their school was that the teaching and all the discussions should be strictly in English;
- 5,8% of the teachers (5 out of 87) reported that the policy in their school was that the teacher should use English only, but the learners may use their vernacular.

67,8% of the teachers (59 out of 87) reported that the policy in their school was that the teaching should take place in English, but that the teachers may switch to a vernacular when they deem it necessary.

5.5.2 The phenomenon of code-switching

84,1% (74 out of 88 teachers) of the teachers reported that they use code-switching in class.

A total of 14,8% (13 of 88) of the teachers indicated that they conducted their classes strictly in English. These were divided as follows:

- 8% (7 of 88) indicated that the class was strictly conducted in English by both the teacher and the learners;
- 6,8% (6 of 88) indicated that the learners are allowed to use the vernacular, but the teacher uses only English.

In the next question the teachers gave information about the languages they used when they switched. The frequency missing in this question was only 4 and there was a slightly raised percentage of 86% of the teachers who indicated that they code-switched. The raise in percentage could be accounted for if the teachers that did not answer the previous question all code-switched.

75,2% (70 out of 93) of the teachers indicated that they switched to the main vernacular of the group. These were divided as follows:

- 60,2% (56 of 93) of the teachers indicated that the main vernacular of the learners coincided with their own;
- in 15% (14 of 93) of the cases the main vernacular of the learners did not coincide with the teacher's own vernacular.

Another 10,8% (10 of 93) of the respondents indicated that they switched to different vernaculars in a multilingual group.

14% (13 of 93) indicated that they do not switch.

5.5.3 The mother tongue of the teachers

The mother tongue(s) of

- 63,5% (61 out of 96) of the teachers was Setswana;
- 25% (24 out of 96) of the teachers were South or North Sesotho;
- 6,3% (6 out of 96) of the teachers was Xhosa;
- 3,3% (3 out of 96) of the teachers was Zulu;
- 2% (2 out of 96) of the teachers were other languages.

57,3% (55 out of 96) of the teachers could speak at least one indigenous language other than his own main language (excluding Afrikaans).

15,5% (15 out of 97) of the teachers did not see themselves as competent in Setswana.

50,5% (49 out of 97) of the teachers did see themselves as competent in Afrikaans.

5,2% (5 out of 97) of the teachers did not see themselves as competent in English.

5.5.4 The language composition of the classes

76,7% (66 out of 86) of the teachers reported that the main language group in their classgroups is Setswana. The main language group in 15,1% (13 out of 86) of the classgroups was South Sotho.

The other language groups that were significantly present were:

Xhosa (in 39,2% of the classgroups);

South Sotho (in 37,11% of the classgroups);

Zulu (in 25,8% of the classgroups);

North Sotho (in 22,7% of the classgroups);
Afrikaans (in 11, 34% of the classgroups);
English (in 9,3% of the classgroups).

34,4% (33 of 96) of the teachers taught *homogeneous classgroups*,¹⁹ which entails code-switching to only one indigenous language. Some of the homogeneous groups' vernacular was South Sotho, one English and one Shangaan and all the others Setswana.

- Of the 33 teachers teaching the homogeneous classgroups the vernacular of 21,2% (7 out of 33) teachers was a language other than the language of the group, and 6 of these teachers indicated that they see themselves as being competent in the language of the group. The vernacular of 78,8% (26 out of 33) of the teachers coincided with that of the group.

65,6% (63 of 96) of the teachers taught mixed language groups. Of these:

- 61,3% (38 out of 63) of the teachers' own vernacular coincided with the main vernacular of the group.
- 38,7% (24 out of 63) of the teachers' own vernacular did not coincide with the main vernacular of the learners. Of these 18 of the teachers saw themselves as competent in the vernacular of the main group and 6 teachers did not.
- In 17,5% (11 out of 63) classgroups there were significant groups of two indigenous languages. Only three of the teachers were competent in both languages.
- In 82,5% (52 of the 63) of the mixed language groups there were more than two vernaculars present.

From 96 classgroups there were therefore 54,2% of the classes that had significant groups of three or more indigenous languages.

¹⁹ A few of these classes had a significant group of English or Afrikaans speaking learners. Since the LoLT is English and Afrikaans and textbooks and mathematical vocabulary are readily available, these classes were included in the homogeneous groups.

In total 7,3% (7 teachers out of 96) did not see themselves as competent in the main vernacular of their groups and it will therefore not be possible for the teacher to code-switch effectively.

5.5.5 The language facilitating the Geometry reasoning of the teachers

6,3% (6 of 95) of the teachers said that they think only in their own vernacular, 74,7% (77 of 95) reported that they think in English and 19% (18 of 95) said they think in both their vernacular and English.

5.5.6 Notes and tests in the vernacular

The great majority of teachers 95,8% (91 of 95) and 97,9% (94 of 96) said that they never give notes and/or tests respectively to the learners in their own vernacular.

In the following questions the teachers were also asked to motivate their answers:

5.5.7 Teachers' views on whether English as LoLT hindered the performance of the learners

On the issue of whether they think that English as medium of teaching hindered the performance of the learners, the teachers were divided. 47,9% (45 from 94) had the view that it is hampering their achievement and 52,1% (49 of 94) had the view that it is not.

In their comments on this question the teachers motivated their opinion that English as LoLT hindered the performance of the learners as follows:

- the learners think in their vernacular and would understand concepts better in their vernacular (16);
- they understand their own language easily and would therefore be able to interpret questions clearly (7);

- learners can express themselves better in their vernacular (5); if the learners could learn in their vernacular from the start throughout and also write their examinations in their vernacular they would do better (1);
- learners feel that Geometry is difficult in English (1); language plays an important role, “most races that perform well are doing the subjects in their own language” (1); learners have a poor command of English (1); learners first try to understand the English before they can concentrate on understanding the Geometry (1).

On the other hand some teachers reasoned that:

- Mathematics is a language on its own and if the learner understands the mathematical language, English does not play an important role (5);
- as the teachers first explain the work in the vernacular and then in English, there is no negative effect when they write examinations in English (2); the vernacular can be used for clarity, but the terminology must be given in English (1); the textbooks are in English (1);
- learners do their Mathematics in English from the start and are efficient in mathematical English (1); the English terminology for Geometry is easy, short and pose no problem (3); there is a lack of mathematical terminology in the vernacular (10);
- learners did not achieve as expected, but it is either the Geometry itself that is the problem or the learners do not work hard enough (4).

Quite a few of the teachers did not really express their view on whether English as LoLT is hindering the learners' achievement, but reasoned that:

- as English is LoLT the learners should use the terminology in English (4); the examinations are in English (1); the learners' competence in English as scientific language should be improved by exposing the learners to it more (2); they need English in the workplace and internationally and it is important for the learners to read write and speak it (3).

Although these are arguments for English as LoLT, it was circumventing the question of whether English as LoLT hampered the progress of the learners in Geometry.

5.5.8 Teachers' views on an English/Setswana glossary

A significant group namely 65,2% (60 of 92) had the view that an **English/Setswana glossary** would be helpful, while 10,9% (10 of 92) of the teachers were of opinion that it would be of no value. 17,4% (16 of 92) of the teachers had the view that it would have a negative effect on their competence in English and 6,5% (6 of 92) that it would be impossible to attain.

55% (50 of 91) of the teachers expressed the view that **notes** in the vernacular would be helpful while 16,5% (15 of 91) of the teachers were of opinion that it would be of no real value. 16,5% (15 of 91) of the teachers were of opinion that a glossary will have a negative effect on the learners' English and 12% (11 of 91) that it would be impossible to attain.

Only 37,8% (34 of 90) of the teachers had the view that **tests** in the vernacular of the learners would be helpful, 24,4% (22 of 90) that it would be of no value and 22,2% (20 of 90) that it will be detrimental to their competence in English. 15,6% (14 of 90) had the view that it would be impossible to attain.

Teachers were asked to motivate their answers to the questions on the English/Setswana glossaries, notes and tests in Setswana.

Reasons why teachers were of opinion that an English/Setswana glossary of geometric terminology would be helpful to promote the construction of concepts and understanding in Geometry are the following:²⁰

- Learners will be able to understand the concept/terminology better in their own vernacular (13); they will understand what is asked in questions (2); it will give

²⁰ Whenever inverted commas is used, it means that it the sentence or word is directly quoted from a response to the questionnaire because the teacher formulated it descriptively.

- meaning to both languages (1); it will promote understanding and “clean away the doubts” (1); some learners do not understand English so well (1);
- it will be easier to explain (1); you can “drive the point home” if the discussions are in the vernacular (1);
 - the learners think in their own vernacular (2); it will be easier to relate the new concepts with what they already know (2);
 - the learners will be able to reason and do proofs (1); they will be free to express themselves in their vernacular (1); the learners will be able to raise their questions and problems (1);
 - it will enhance the importance of the learners’ own language (1); because the parents emphasise the importance of English, the learners are not confident about the value of their own language (1); learners always prefer to be taught in their own language (1);
 - the learners can go through the glossary in their own time but the LoLT in the class should be English (1); the vernacular should only be used when important aspects have to be emphasized (1);
 - the learners will link it better with daily life (2);
 - it is easier to remember concepts or words in your own vernacular (3);
 - it must be done from the foundation phase (1).

Teachers who had the view that glossaries would be of no value, gave the following reasons:

- Nothing will help because the learners take nothing serious; they fail even their first languages (1);
- terminology in the vernacular is unnecessary as the examinations are in English (1);
- the teachers already give a glossary but it makes no difference (1);
- some words cannot be translated into the vernacular (8);
- the LoLT is English so the terminology must be in English (1);
- the learners must compete in a scientific world and the workplace and therefore the learners have to know mathematical English (2); scientific books (and textbooks) are written in English (1);

- learning in their vernacular would decrease the importance of English for the learners (1); they would rely too much on the vernacular glossary (1); they will become incompetent in English (1);
- because learners learn other subjects in English, increasing the use of the vernacular in Mathematics would make it difficult to integrate with other subjects (1);
- because it is a multicultural society it would create confusion if everybody learns Mathematics in his own language (1);
- it will confuse the learners to be taught in two languages (1); it is difficult to change things the learners are used to (1).

Reasons why teachers had the view that some notes in the learners' vernacular (as well as in English) would be helpful to promote the construction of concepts and understanding in Geometry, are the following:

- Learners will be able to understand the concepts better in their own vernacular (8); it will promote understanding (1); they will know exactly what is expected of them in Geometry/ what is taking place in the lesson (2); it helps the learners to discover for themselves and to do practical work (1);
- it will be easier to explain in the learners' vernacular (2); if the concepts were explained in two languages the learners would understand better (2);
- learners have a "deeper" understanding of their vernacular but it must be linked to the English terminology (1); whatever information they acquire has to be interpreted in their mother tongue first and then translated to English (1); the learner has to try hard to translate his thoughts into English (1); notes in both languages will help the learners to switch from their vernacular to English and vice versa (2); notes in their vernacular and English must be applied carefully and correctly (2);
- notes may help the learners to attempt problems during discussions and even while they are doing revision (2); notes will explain and emphasize important facts and can be kept for revision (1);
- the learners will link it better with real life (1);
- learners will prefer that things must be explained in their vernacular (1).

Teachers who were of opinion that notes in the vernacular would be of no value gave the following reasons:

- Some words cannot be translated into the vernacular (8); it is difficult to write Geometry in the vernacular (1); the vernacular should first be structured so that new words are created to address the inadequacies (1);
- learners must know the concepts in English (1); the LoLT is English (2);
- the examinations are in English, so the vernacular will not help (5);
- it is wise to use English because it is the medium of communication in South Africa (1);
- learners should learn and practice English so that they can understand better in future (1); textbooks are written in English (1); notes in the vernacular would make the learners negative towards English (1); they would rely too much on the vernacular (1); the learners will become incompetent in English (1); it will promote laziness for learning the English properly (1); learners would want to answer in the vernacular (2);
- it will confuse the learners (2);
- mathematical language and terminology is universal (1);

Reasons why teachers were of opinion that some tests in the learners' vernacular (as well as in English) will be helpful to relate what the learners really know, can be sorted as follows:

- some learners will be able to answer correctly (1) It will have a positive impact because the learners understand what is being asked (6); learners think in their own vernacular and answer correctly (2); learners will be able to understand the concepts better in their own vernacular and be able to interpret the questions (2);
- learners will be able to express themselves better in their vernacular (5); it will especially help if they are given notes in the vernacular (1); English seems to be a difficult language (1);
- learners will discover that Mathematics is not only in books or known by great mathematicians (1);

- if the glossary is given to them in the tests, they will remember most things and apply them (1).

Teachers who have the view that tests in the vernacular would be of no value gave the following reasons:

- learners will fail anyway (1);
- some words cannot be translated into the vernacular (2); if new words are found in the vernacular, "it will change everything in that language" (1); a language may be destroyed, the board of languages should first put forward a suggestion (1);
- the LoLT is English so the learners must master English (2); the learners must compete in a scientific world and the workplace and therefore the learners have to know the mathematical English (5); the learners should be competent in English "we are building not South Africa but the world" (2). "It won't take the learners anywhere because after school you have to be able to express yourself in English in interviews and everywhere" (2); the language of computers is English (1); if they do their tests in the vernacular they will not be able to understand in future when they have to do it in English (1); scientific books and textbooks are written in English (2); there is no help in the vernacular in tertiary education, "learners will struggle" (2);
- not too many tests must be given in the vernacular because the learners may want to resort to everything in their vernacular (1); learners will lose interest and become incompetent in English (1); giving tests in the vernacular will not help the learners (1); it will give the learners a negative attitude towards Geometry (1);
- the vernacular could be used in code-switching when the concepts are formed, but the tests must be in English (2);
- acquiring knowledge can take place in the vernacular but displaying knowledge should be in English (1); final examinations are in English, so tests should be in English (3).

When the teachers were asked to give their own proposal as to how language should be handled a wide variety of opinions were given ranging from:

"If it (*Mathematics*) can be taught in vernacular from foundation phase up to matric, it may be better for learners who will take Mathematics in their vernacular because I think if there are translation of maths books into different vernaculars (*it*) is easy (*easier*) for learners to learn (*in*) their vernacular than into other (*in another*) language"

to

"In Geometry classes only English should be used so that the learners should be acquainted with all concepts of Geometry in English. Switching to their mother tongue will make them to want to be taught in that language. Thus making it difficult to understand terms relating to Geometry."

Although quite a few teachers had the view that English should be used as far as possible, the most teachers expressed the opinion that English should be used as LoLT, but the vernacular should be used as a supplement wherever and whenever it is necessary in order to explain the Geometry better. The two languages should be used interchangeably and learners should be allowed to ask and discuss the Geometry in their own language.

A few interesting views are documented below.

Teachers that had the view that the vernacular could be of help gave the following views or proposals:

- "First a list of vernacular equivalent names and terms should be created to standardize its use. Then it can be piloted in a low scale and its effects evaluated. Generally it will boost the morale of learners, just for the fact that their language is recognised in the Sciences."
- "They will understand the subject matter easily and better but books are to be translated to the vernacular".

- “Everybody can think clearly and reasonably if he is relaxed and comfortable.” (This refers to the use of the learners own main language).
- “For laying the foundation, figures should be explained in the learner’s language and new English words should be added slowly as the learner progress from one grade to another”.
- “All the different languages, if possible, should be considered when presenting a lesson in class. The issue is not language teaching but Geometry teaching.”
- “If there are too many different languages in class to use the vernacular, it should be used after hours to help learners.”

The opinion of many of the teachers who want to use the vernacular in class is mirrored by the following view:

“Educators should explain geometric concepts in vernacular where possible. They should use the two languages interchangeably and allow learners to ask question in vernacular where possible. I think vernacular plays a very important role in the teaching of Geometry.”

Others had the view that teaching must be in English, but they caution that:

- “Learners will be well introduced to thinking in English, have clear understanding of terminology and will express themselves clearly, however this is not an overnight thing. Please be patient with them.”
- “As teacher you must learn to teach difficult terms so explicitly”.
- “Terminology of terms to be used should be clearly defined before the start of every chapter or lesson.”

The quest for English as LoLT is summed up clearly in the following remark: “I am not against the use of the vernacular, but English is used everywhere. Therefore students need to be taught in English to broaden their medium of instruction and being *(to be)* able to compete with other students of different nations.”

The middle ground is expressed in the following view:

“Educators have to explain concepts to the learners in their mother tongue, but emphasis the fact that they need to understand them also in English to enable them to be competent when they meet with other learners from different ethnic groups.”

5.5.9 Conclusions on the results of the secondary schools

In 67,8% of the secondary schools in the survey, code-switching was already official policy at the time of the survey. Although the teachers reported that in 26,4% of the schools the teacher was supposed to teach in English, only 14,8% indicated that they conduct their classes strictly in English. It is clear that in the North-West rural and township schools code-switching has made a huge inroad into the formal policies of the secondary schools *and even more so* into the daily practices of the teachers in the Mathematics classes. This was emphasized by the opinions the teachers gave. It is also clear that there is still an overwhelming support for English as LoLT, albeit including code-switching to the vernacular. It is therefore necessary that the official policies of the government and the training of the teachers should reflect both these sentiments.

Quite a large group of the teachers are multilingual (57,3%). They see themselves as competent in their own language; English and at least one other black language. Many teachers included Afrikaans, seeing themselves as competent in at least four languages. Although this is not a surprising result, it stresses the language resources available that could be put to use in teaching.

75,3 % of the teachers indicated that they switch to the main vernacular of the learners in their classes. However, only 34,8% were homogeneous groups where glossary, notes and tests in the vernacular could be applied. In the mixed groups that the teachers teach, it may be possible that some of the teachers' classes are homogeneous. However, this could not be determined from this study. Another aspect that was not in the scope of this study was the fact that for many of the learners whose vernacular differs from the main vernacular in a school, the school's

vernacular is his/her second language. In other words in such cases the learner may be more competent in the main vernacular of the school than in English, which is the LoLT. The implication is that although the main language of the school is not his vernacular, this learner may still benefit from code-switching, a glossary and notes in the main vernacular of the school.

10,8% of the teachers code-switched to more than one black language. It is true that in these classes it will become a mammoth task to supply glossaries and notes for all the learners in their different vernaculars and it would not be viable, except when we have progressed to a stage where resources would be commercially available.

5.5.10 Comparison between the primary and the secondary schools

5.5.10.1 Summary

A short summary was compiled to compare the situation in the primary and secondary schools:

	Primary school teachers	Secondary school teachers
The language policies of the schools	90% officially allows code-switching	67,8% officially allows code-switching 26,4% strictly English
The phenomenon of code-switching	94,2% of the teachers use code-switching	84,1% use code-switching
The mother tongue of the teachers	The mother tongue 77,7% of the teachers is Setswana 96,7% believed themselves competent in Setswana	The mother tongue of 63,5% of the teachers is Setswana 84,5% believed themselves competent in Setswana
The language composition of the classes	90,8% of the classes were mainly Setswana mother tongue learners 54,6% were homogeneous classes	68,8% of the classes were mainly Setswana mother tongue learners 34,7% were homogeneous classes
The language facilitating the geometry reasoning of the teachers	60% English 25% both 15% own vernacular	74,7% English 19% both 6,3% own vernacular
Views of the teachers on English as LoLT	48,7% detrimental 51,3% not detrimental	47,9% detrimental 52,1% not detrimental
<u>Setswana:</u> Glossary helpful Notes helpful Tests helpful	71,3% 53% 52,6%	65,2% 55 % 37,8%

Table 5.5.10.1 – The language situation in the primary and secondary schools

5.5.10.2 Discussion

The main difference between the primary schools and the secondary schools is that in the secondary schools the classgroups as well as the teachers are more diverse in their language composition. This is a complicating factor. It is noteworthy that even though this complicating factor exists, 84,1% of the secondary school teachers still indicated that they do code-switching. The number of schools where code-switching is officially recognized is also lower in the secondary schools.

It is interesting that English plays a larger role in secondary teachers' reasoning. This may be influenced by the fact that many of the terms used in the secondary school Mathematics do not have a vernacular equivalent.

Tests in the vernacular is another area where there is a more significant difference in the views of primary and secondary school teachers. Again this may possibly be ascribed to the fact that more of the terminology in the primary schools is available in the main language of the learners. Another contributing factor most possibly will be that official assessment from the Department of Education is only in English and Afrikaans and not in the different main languages of the regions.

In view of the results of this survey the researcher decided to compile a Geometry programme in English and Setswana. This was followed by a qualitative study of the impact of the added resource of their own main language on the learners in a rural school and a township school where the main language of the school is Setswana. The results of this study will be discussed in the next chapter.

CHAPTER 6

EMPIRICAL INVESTIGATION OF THE INFLUENCE OF SETSWANA NOTES AND AN ENGLISH/SETSWANA GLOSSARY ON THE CONCEPTUALISATION OF LEP BATSWANA GEOMETRY LEARNERS

6.1 INTRODUCTION

In chapter 5 two areas of interest were identified. The survey described in chapter 5 dealt with the first area of interest giving an indication of the language situation in Mathematics classrooms in the North-West. This formed the first phase of the empirical study, namely the diagnostic stage of the action research. The survey revealed that code-switching made great inroads into the primary as well as secondary school Mathematics classrooms. The literature study of the classroom culture in the ESL-Mathematics classroom discussed in chapter 4 disclosed the complexity of the language situation. This was also mirrored in the opposing views of the teachers who participated in the survey on the influence of English as LoLT. In view of these findings a qualitative study was undertaken to try to learn something about the second area of interest, namely the possible influence of notes and tests in both languages and an English/Setswana glossary on the conceptualisation of Batswana Geometry learners, as supplement to a strategy of code-switching.

6.2 DESIGN

The second phase of the collaborative action research was done by means of a qualitative study that involves the next three stages of action research, namely action planning, action taking and evaluating as discussed in 1.4.2.1 In the action planning stage a Geometry programme was developed for grade 8 learners. This programme was written in both English and Setswana In the third stage this programme was used to do an intervention in one rural school and one township school. At this period of time the two teachers who taught the programme became partners in the research. During the intervention the researcher made class visits and took fieldnotes as observer.

Collective case studies were done at the two schools (Creswell, 1997:61-64) in the evaluating stage of the action research. Semi-structured interviews and class visits with field notes were used to collect data. Interviews were conducted with the teachers before the intervention and again afterwards. Semi-structured interviews were also conducted with a sample of learners at each school. The data is interpreted and documented.

In the fifth and final stage, recommendations are made concerning the use of language aids to assist learners and the development of a Setswana mathematics register as discussed in 1.4.2.1. This will be reported in chapter 7

6.2.1 Study population and sample

The population for this part of the study is the grade eight Batswana Geometry learners in the Potchefstroom and Klerksdorp regions of the North-West. Grade eight learners were chosen because important new concepts that precede formal problem solving in Geometry are introduced in grade eight. One rural school (School A) and one township school (School B) were selected on the basis of convenience and feasibility. Two classgroups with main language Setswana and one with main language Sesotho were used for the intervention. At school A there was only grade eight class, and this class was used for the intervention. At School B the participating teacher's Setswana class followed the intervention programme. Since the teacher also teaches Mathematics to a class with main language Sesotho, this class was also included in the research, although the intervention was only partially executed.

Five learners were selected for interviews from School A and six from School B as sample for the qualitative study. At School A four learners were selected on the basis of their profile as reflected by their Mathematics-, Setswana- and English marks of the June yearmarks. The fifth learner was selected on basis of the fact that her mother tongue was isiXhosa. She was one of two learners in the class whose mother tongue was not Setswana. At School B two learners were selected randomly from the Sesotho class on the basis that their mother tongue is Sesotho. Four learners were selected from the Setswana class. Though the intention originally was to select learners whose mother tongue is Setswana, it became clear that this would not be a true reflection of the situation at School B since the learners at this school has a

mixed language profile regarding their mother tongue. The learners were therefore only selected on the basis of their profile as reflected by their Mathematics-, Setswana- and English test marks of the first semester, which meant that their language profile regarding their mother tongue was random. As it came about only one learner was selected whose mother tongue is Setswana. Two of the learners have been taught in schools with main language Setswana from grade one and their main language has become Setswana. The other learner came from a primary school with main language Sepedi, and was transferred to a school with main language Setswana in grade eight. Interviews were also conducted with the two teachers involved in the intervention.

6.2.2 Instruments

The researcher designed a Geometry teaching programme to use in the intervention. A part of didactical courses for the Sediba- and Nasop-programmes, was adapted for learners for the purpose of this research as intervention programme. These courses were originally developed to facilitate both the introduction of Euclidean Geometry to learners and the early reasoning processes necessary for problem solving in that domain. It included examples of worksheets for learners and was tested and refined over a period of four years. The research programme was translated into Setswana by The Translation World CC, who often does translations of Mathematics for various role players in the market of school Mathematics. The scheduled time for the programme was about three weeks. However, the teacher at the rural school took about five weeks to complete it, while the teacher at the township school took about three and a half weeks.

The study furthermore included semi-structured interviews with learners after the intervention, as well as semi-structured interviews with the teachers before and after the intervention. Class visits with field notes were also used. The teachers each set his\her own test after the intervention to keep the situation as natural as possible. The tests were only used as part of the support material to try and determine the views of the learners on Setswana/English tests.

6.3 RESEARCH PROCEDURE FOLLOWED IN THE EMPIRICAL RESEARCH IN THE SCHOOLS

The researcher visited the principals of the selected schools and asked permission to conduct the programme at their schools. Thereafter the researcher discussed the rationale for the research and the way in which it would be conducted with the grade eight teachers involved at each school. The Geometry programme used for the intervention was discussed in detail with each of the teachers, after which two teachers decided to participate. The teachers discussed the intervention with the learners and obtained their co-operation as participants in the research.

Each teacher completed the same questionnaire used in the survey, and this formed a basis on which the researcher conducted a semi-structured interview with each of teachers to establish their background and views before the implementation of the programme. Classroom visits were made to monitor the programme.

After the programme was completed, interviews were conducted with the sample of the learners at each school in Setswana. Pseudo names were used in the transcriptions and discussions. Interviews were also conducted with both the teachers after the programme was completed, without them knowing the outcome of the interviews with the learners.

The interviews were transcribed and translated into English. All the information gained from the interviews was interpreted and documented. The researcher discussed the findings with the participating teachers and interviewers. The principals of each school were visited and thanked.

6.4 THE METHODOLOGY

6.4.1 Interviews with teachers

The same questionnaire used in the survey was given to teachers at both schools and an interview was conducted on the basis of the questionnaire before they started to teach the Geometry programme. The Geometry programme was discussed with

the teachers and they were asked to explain the mathematical terminology in both English and Setswana to the learners and to feel free to use code-switching whenever they need it. After the conclusion of the teaching of the programme a second interview was conducted with both teachers. The interviews were recorded on tape and were transcribed (see Annexures 2-7).

6.4.2 Selection of the sample of learners for the interviews with learners

Interviews with five learners were conducted at the rural school and six at the township school. At School A one learner was selected whose mother tongue was not Setswana. The purpose of this was to look into the position of the learner that lives in a mainly Setswana environment, but whose *mother tongue* is not Setswana. The mathematical language context of these learners is that code-switching takes place between English and Setswana, while their own mother tongue is not Setswana.

At School B two learners from the Sesotho class were selected randomly. Their main language is Sesotho. This class was included on the grounds of availability of a special language context that may also occur in other schools. The Sesotho class was taught in English only, as the teacher could not speak Sesotho and the intervention only consisted of the learners doing the same Geometry programme with the Setswana notes available to them. In class, no attention was paid to the Setswana notes. The purpose of this was to look into the position of the learners in this class, whose *main language is not Setswana*, in a situation where the support material is only available in the main language of the school and region as sole aid to English as LoLT.

The other four learners at each of the schools were selected on the following basis: A class list with the English, Setswana and Mathematics marks were procured. Learners were then selected on account of their profile in the three subjects to ascertain a selection covering learners from different achievement spectra. The learners were selected as near as possible to the following criteria:

One learner that achieved good yearmarks in all three subjects.

One learner that performed below average in all three subjects.

One learner that is very good in Setswana, below average in Mathematics and English.

One learner that is good in English and Setswana and average in Mathematics.

At both schools interviewers that are fluent in Setswana conducted the interviews in the researcher's presence. The interviews were recorded on tape and transcribed and translated into English.

6.5 EMPIRICAL STUDY AT THE RURAL SCHOOL (SCHOOL A)

6.5.1 Profile of School A

School A is a rural school about thirty-four kilometres from the nearest city. It is a combined school, which accommodates grades 1-12. The buildings are prefabricated and provide only for the barest necessities. The school is well organised. The language policy of the school is that teaching mainly takes place in English. The teachers may switch to Setswana whenever they feel that it is necessary. There is only one grade eight class with 33 learners. The class consists mainly of learners whose mother tongue is Setswana. The mother tongue of only two of the learners is Xhosa. The learners live nearby and rarely visit other areas.

6.5.2 Profile of Miriam, the teacher at School A and the classroom culture

6.5.2.1 The teacher

Miriam's mother tongue is Setswana. Both Miriam's parents are Batswana. Her qualification is a four-year Diploma for teachers in the Foundation Phase. She teaches grade seven and eight Mathematics and has 17 years teaching experience. She started her career as teacher at School A and taught primary school classes as

well as various subjects in the senior classes. She taught grade eight Mathematics in 1991-1992, and again since 2003. She enjoys teaching Mathematics, but struggles a bit with the Geometry teaching. When she has problems with the Geometry teaching, she confers with Mr. M., who is the grade eleven and twelve teacher.

6.5.2.2 *Classroom culture*

Miriam's language policy is to teach Mathematics in English and to switch to Setswana whenever she feels that the learners do not understand. She usually uses more English than Setswana during teaching. From the class visits the following impressions can be documented:

The class is arranged in groups. Although there is some communication among the learners, it is subdued. The communication among the learners that was observed was in Setswana. The mother tongue of only two of the learners is isiXhosa, while the mother tongue of all the other learners is Setswana.

Group activities indicated in the programme, e.g. cutting and pasting, were done in the groups. At other times the learners worked mainly individually, although they were sitting in groups. The teacher pays much individual attention to the learners. After an exercise is finished each learner comes to the teacher's table and she corrects the work done, discusses problems that became apparent and explains the next exercise. Each learner has to read the instructions of the next questions in English and Setswana.

During the programme Miriam used mainly Setswana when explaining in the whole class situation. Although she explained the Setswana terminology in Setswana, and also used the terminology and its explanation to explain the concepts in Setswana, she tended to use the English terminology often. After teaching in Setswana she moved to the formal English definitions of terms, which became coined sentences that she often repeated. The learners often answered questions in the whole class situation in English, using these coined phrases. Even when speaking Setswana, Miriam often used code-mixing, using the English terminology in a Setswana sentence.

Some of the learners read the English fluently, but others could not manage well in English, while reading fluently in Setswana. As a group English seemed to be a foreign language to the learners, although many of them could manage the coined English mathematical phrases well.

On the whole the atmosphere in classroom was that of relaxed engagement with the work. Miriam assessed the learners' work by means of evaluation of their individual classwork, small tests during the course, as well as a final test in both Setswana and English after the course was completed.

6.5.3 The teacher's views as expressed before and after the intervention (see Annexures 2-4)

6.5.3.1 *Miriam's views before the intervention*

Miriam expressed the view that the learners' English is not very good "but they are trying". It is sometimes difficult for the learners to do their Mathematics in English because they do not always understand the questions. They sometimes fail, not because they do not understand the Mathematics, but because they don't understand the question. She also expressed the view that new Setswana terminology would be helpful to some of the learners, but for others it would be difficult because learners differ. She was of opinion that it would help the learners if they could learn in both languages. Even if they do their final matriculation examination in English only, she felt that the learners would be able to cope because by that time they will know the terminology well in both languages.

6.5.3.2 *Miriam's views after the intervention*

Miriam was very enthusiastic about the Geometry programme itself and taught it with confidence. She expressed the feeling that it was of great help to her and the learners. Miriam felt that the learners did not make use of the Setswana terminology. She was of opinion that the code-switching was of great value to the learners, but

that the Setswana terminology was difficult and that the learners preferred the English terminology. The learners also preferred to use English in their answers to questions in class and in the test.

Although this was not so clear in the final interview, Miriam explained at a previous occasion that she used the Setswana terminology as a scaffold to explain the concepts. This was also apparent during the class visits. Miriam was of opinion that the learners did not really use the glossary. The interviews with the learners revealed that it was not quite correct.

6.5.3.3 Comments

Although Miriam used mainly Setswana in the explanation of the concepts and when discussing and explaining problems the learners encountered in their exercises, she still “frontstaged” the English terminology. She also tended to use the English version of short descriptions which was developed in the programme both in English and in Setswana e.g. “on the same side of the transversal and between the horizontal lines”. Furthermore, a strong feeling of pride in their knowledge of English could be detected in the interviews with the learners. These two factors may have contributed to the learners’ choice to answer in English both in class and in the tests.

It was clear that Miriam found the Setswana terminology more difficult than she expected before the intervention and that she was of opinion that the learners also found it difficult. This was true for some of the learners, as can be seen in the interviews.

6.5.4 Interviews with the learners at School A (see Annexure 8)

A teacher who was present at the initial discussions about the research project conducted the interviews. The teacher conducted the interviews in Setswana and constantly gave feedback to the researcher of what the learners were saying. The interviewer firstly discussed the purpose of the interviews with the learners and asked them to be frank in their opinions as it was in the best interest of future learners that

have to benefit from the research. Individual interviews with the five learners followed:

6.5.4.1 Joseph

Profile: Boy. Mathematics yearmark 58, Setswana 81, English 69. Mother tongue: Setswana.

Although Joseph's mother tongue is Setswana, and he and his family sometimes speak English at home, he feels more comfortable in Setswana. The learner volunteered the opinion that both Setswana and English should be used in Mathematics. He liked the programme because he could understand the teacher. He felt that Setswana was sometimes needed to explain English terms like *transversal line*. He said that it was better for him if a test is in Setswana, because there are some English words that he does not understand. He would like everything in Setswana, but he thinks that the glossary is necessary because he sometimes needs the English words to understand the Setswana.

6.5.4.2 Gladys

Profile: Girl. Mathematics yearmark 67, Setswana 74, English 39. Selected because her mother tongue is isiXhosa.

The learner and her family use isiXhosa as well as Setswana at home, but she uses more Setswana, and feels more comfortable in it. It is clear that the *main language* of the learner has become Setswana and that her mother tongue, isiXhosa, has degenerated. Her experience is that Mathematics is not difficult if you practice regularly. She is of opinion that the Setswana used in the programme made it easier to understand. She said: "I used Setswana to understand". She found the glossary useful in the tests because it is "short" and she can look at it quickly.

6.5.4.3 Sanna

Profile: Girl, Mathematics yearmark 40, Setswana 76, English 21.

The learner and her family speak Setswana and she knows no other indigenous language. Sanna understands the Geometry and was aided by the Setswana. She is of opinion that the Setswana helped her in the tests, because when she did not understand the English she referred to the Setswana. She found the Mathematics terminology in Setswana difficult and used primarily English in the tests, but referred to the Setswana when she didn't understand the English. She holds a strong view that both languages must be used.

6.5.4.4 Stephen

Profile: Boy. Mathematics yearmark 36, Setswana 55, English 35. Mother tongue: Setswana

The learner's home language is Setswana. His parents can also speak Sesotho, but he speaks only Setswana and English. Stephen does not always understand the English very well ("I don't understand it all") and feel more confident in Setswana. He feels that he understands Mathematics better in English and finds the Setswana difficult, because he has been doing Mathematics in English for a long time. However, he concedes that the Setswana was also important and is of opinion that both languages must be used.

6.5.4.5 Lina

Profile: Girl. Mathematics yearmark 87, Setswana 98, English 69, Geometry 92.

Mother tongue: Setswana

Lina and her family only speak Setswana at home, but she can also speak and write English and Afrikaans. Lina understands the Mathematics better in English and finds the terminology in Setswana very difficult. However, she wants the both languages in the tests because if “you don’t understand it in English you must be able to understand it in Setswana”.

6.5.4.6 Vignette School A

School A		Mother Tongue	Main Language	English	Notes and glossary	tests	view
2	Gladys	isiXhosa	Setswana		Uses Setswana to understand the English. Glossary is useful because it is concise		Use both languages
4	Stephen	Setswana	Setswana	Not good	Prefers Mathematics in English. Setswana is also important		Prefer mathematics in English because he is used to it, but both languages are necessary

6.5.5 Comments

Some of the learners experienced the new Setswana terminology as difficult. They are used to English terminology in Mathematics, although most of the concepts involved are new to them and they had to master the new English terminology as well. The teacher is used to the English terminology and therefore frontstaged it, which may have contributed to some learners' preference for the English terminology. Two learners clearly stated that they understood Mathematics better in English. Despite this, and the preference for the English terminology, all the learners were of opinion that the Setswana notes and glossary, as well as the Setswana in the test, helped them. From the interviews it was clear that the learners use the Setswana notes as well as the glossary as a scaffold to help them to understand the English and the Geometry better. The learners were not required to memorise the Setswana terminology. The English/Setswana glossary is therefore necessary to get the full benefit of the Setswana as educational aid.

Gladys's main language has become Setswana, although her mother tongue is isiXhosa. This results from the fact that she is in a Setswana environment and has been in a Setswana school from grade one. She also benefited from the Setswana.

The class is therefore homogeneous with main language Setswana (except for the one other learner whose mother tongue is isiXhosa and of whom no further information is known). This class forms an ideal situation for code-switching between Setswana and English and Setswana as aid through means of notes, tests and a glossary in conjunction with English.

6.6 EMPIRICAL STUDY AT THE TOWNSHIP SCHOOL (SCHOOL B)

6.6.1 Profile of School B

The township school (School B) is a large well-equipped secondary school. There are five grade eight classes and two Mathematics teachers. One of the classes is a class for learners with Sesotho as main language. According to the two teachers Vusi and Peter the learners often mix languages in their informal communication. Different languages are used as they come in handy, including Afrikaans. The language policy of the school is that the teachers are required to teach in English *as far as possible*, but may switch to the main language when really necessary.

6.6.2 Profile of Peter, the teacher at School B and the classroom culture

6.6.2.1 *The teacher*

Peter's mother tongue is isiZulu which was his only language from grade one to six. His mother is Mandebele and his father Zulu. The languages that Peter sees himself as competent in are Setswana, isiZulu and English. He also understands Sesotho. His secondary schooling was in a Setswana School and he has been teaching at Setswana schools since he started his teaching career. Peter has a HED (S) qualification, which is a four-year teaching diploma. Peter teaches grade eight and grade eleven Mathematics and has been teaching at School B since 1996. It is the 2nd year that he has been teaching Mathematics to grade eight learners. He feels confident about teaching Mathematics and Geometry.

6.6.2.2 *Classroom culture*

Peter teaches one class where the main language of the learners is Setswana and one class where the main language of the learners is Sesotho.

The Setswana class

The Setswana class accommodates 56 learners. Peter's language policy is to teach the Mathematics in English and to switch to Setswana when he feels that the learners really do not understand. His classes are usually conducted mainly in English, although some codes-switching takes place. During the intervention Peter explained more in Setswana than usually, but still used a fair amount of English and the English terminology was frontstaged. He used the new Setswana terminology as tool to do some language teaching of the Setswana Mathematics register. He explained new concepts in Setswana and then linked it to the English.

The seats in the classroom are arranged in pairs, but not in groups. During the class visits Peter used mainly whole class teaching, but learners answered questions freely and good communication was established. This was linked to diagrams that Peter reproduced on the chalkboard. The learners seemed to have mastered the Setswana terminology and answered questions mainly in Setswana. The communication between the learners was in Setswana in so far as it was possible to observe.

Peter experienced some difficulties with the group activities indicated in the programme, e.g. cutting and pasting. The learners were not used to group activities and the arrangement of the class may have contributed to the difficulties Peter experienced to manage the group work. It is a very large class which complicates the initial organisation of group work and there was not time to pay individual attention to all the learners.

The Sesotho class

The Sesotho class consists of 45 learners and is arranged in the same way as the Setswana class. The Sesotho class differed from the Setswana class therein that the class was conducted mainly in English. Only in cases where a learner really had trouble to understand, the learner would ask a question in Sesotho. Peter understands Sesotho, but is not conversant in it. Peter would then answer in Setswana, which the learner understands. The Sesotho/Setswana communication facilitated better understanding than English communication in these specific cases. This may be an indication that even though the specific learners' main language was

Sesotho, they understood Setswana better than English. In one incident the teacher indicated on the side to the researcher that he thinks the learners' wrong answer was due to language problems. The learner was asked to repeat what he said in Sesotho and the learner then described the positions of the angles correctly.

The Sesotho class did the same programme as the Setswana class. As planned, no effort was made to explain the Setswana terminology or draw their attention to the Setswana in the notes. They were given the same test as the Setswana learners. Interviews were conducted with two learners from this class, randomly chosen.

6.6.3 Peter's views as expressed before and after the intervention (see Annexures 5-7)

A combined interview was done with the two teachers who teach Mathematics at School B. As Vusi teaches more classes and his mother tongue is Setswana, Vusi was initially selected as the teacher who would help with the research. However, after the interview with the two teachers and the discussions on the Geometry programme and after Vusi had time to study the content he decided not to participate. He was of opinion that he would not be at ease with the new Setswana terminology because he was used to the English terminology and would not feel confident to teach the programme using the Setswana Mathematics register. Peter was willing to participate. Since he had all his secondary schooling and conducted his teaching in a Setswana environment, he has become bilingual regarding to Setswana and isiZulu. Therefore, the fact that his mother tongue is isiZulu posed no problem.

6.6.3.1 *Peter's views before the intervention*

Peter expressed the opinion that the learners are not very good in English and therefore it is sometimes difficult for the learners to understand the Mathematics concepts when the LoLT is English. It would be easier for the learners if they are taught in Setswana and if the tests are in Setswana, because the concepts will be easier for them in their main language. A Setswana/English glossary will be of use for

the time being because the learners are facing Setswana terminology for the first time. However, Peter was of opinion that if the two languages are used simultaneously, like in code-switching and with the notes in both languages, it will create confusion.

6.6.3.2 *Peter's views after the intervention*

The method of teaching used in the programme made Peter uncomfortable. It was not methods that he was used to. Peter also had to get used to the Setswana Mathematics register used in the notes ("the lingo itself"). Learners who visited the class "wanting this and that" were amazed to hear Peter teaching Mathematics in Setswana and he had to explain what was going on. Even so, Peter "enjoyed" himself. He experienced the fact that he had an extra chance to explain the concepts and to link part of the Setswana terminology to words that the learners are acquainted with, positively.

Peter expressed a problem with the assessment during the programme. The time of the programme was a busy time in the term, which made it difficult to spend time on assessment. It may also be due to the fact that Peter is not experienced in group work and its assessment methods, especially taking into account that it is a very large class. Consequently, Peter is careful to make a judgement on whether the learners really understood the concepts better than without the Setswana in this more formal fashion. He did not do Geometry with his learners the previous year and it is difficult to compare understanding of Algebra concepts to that of Geometry.

The learners participated more in the class than usually. Because Peter was afraid that the notes with English and Setswana would disturb the learners' concentration in reading, he asked them to highlight the Setswana. In conclusion, he is of opinion that it was beneficial for the learners to have the Setswana notes and glossary, especially because some of the Setswana terminology was new and the learners did not know it.

6.6.4 Interviews with learners at School B (see Annexure 9)

The interviews at school B was conducted by an independent interviewer in Setswana and English. The interviewer firstly interviewed the learners as a group and explained to them that it is in the best interest of future learners if they are not shy and explain their real views.

The first two learners, Kealeboga and Prudence, are in the class for learners whose main language is Sesotho. The LoLT is English and as planned, the teacher made no special reference to the Setswana notes during teaching. Little code-switching occurred. When code-switching was used in the class, the learner spoke in Sesotho and the teacher answered in Setswana.

6.6.4.1 *Kealeboga*

Profile: Girl. Mother tongue: Sesotho. Selected randomly.

Kealeboga speaks mainly Sesotho at home, but also Setswana and English. She understands Setswana better than English. Kealeboga says that she understands the teacher's explanations, but has a problem when she has to formulate something "on her own" (in English). Although Kealoboga is not confident about her skills to read Setswana ("I can try") she did read the Setswana notes and she indicates that the notes helped her to understand the Geometry better, although she feels that she has a lot of problems with the Geometry.

Kealoboga indicated that she would like to have notes and tests in Sesotho and be able to answer a test in Sesotho.

6.6.4.2 *Prudence*

Profile: Girl. Main language Sesotho. Selected randomly.

Prudence and her family speak Sesotho at home. She can speak and write Setswana, but don't know Setswana very well. She understands it "here and there". She understands the English better than Setswana. However, she did refer to the Setswana notes and list of words when she did not understand an English term.

6.6.4.3 *Comments on the interviews with the Basotho learners*

Although, according to the two teachers, the language that the learners use among themselves in the school is mixed, the main language environment is still Setswana. These learners are in a class with main language Sesotho, but they hear a lot of Setswana. The learners were not encouraged, or discouraged, to use the Setswana notes. Even though it is clear that the learners do not feel comfortable with Setswana, they still used it as a crutch to understand the English better. Although this was not originally planned, the opportunity presented itself to look at the situation where a learner is in a school and his *main language* differs from that of the majority of learners in the school. These learners' mother tongue has not degenerated and is still their main language, but they are in a position where another language wherein they may be more competent than in English is available to them, as in the case of Kealeboga. It seems as if she experienced the Setswana notes as beneficial. It is interesting that Prudence, who felt more confident in English, also referred to the Setswana notes for assistance. It comes as no surprise that Kealeboga would like to have the notes in Sesotho.

6.6.4.4 Thandi

Profile: Girl. Mother tongue: Sesotho/Setswana. Setswana 44, English 38, Mathematics test average 30.

Thandi communicates with her mother in Setswana and with her father in Sesotho. She understands Setswana the best, although she likes Sesotho and English, and is able to read and write all three languages. She started school in grade one in a school with main language Setswana. Thandi feels that the Setswana helped her in the Geometry programme, because she understands Setswana much better than English. She experienced the Setswana terminology positively as well as the glossary. She said: "It helped me very much". Thandi would like the tests to be in both Setswana and English.

6.6.4.5 Thabo

Profile: Boy. Mother tongue: isiXhosa. Setswana 75, English 45, Mathematics test average: 48.

Thabo and his family speak isiXhosa at home. Thabo started school in grade 1 in a school with main language Setswana, because no isiXhosa schools were available. Setswana has become his main language. He finds the Geometry very interesting. Thabo said that the two languages "was not a problem". He expressed a clear opinion that he wants the tests to be in both English and Setswana, and that he would prefer to answer in Setswana.

6.6.4.6 Lebo

Profile: Boy. Mother tongue: Sepedi. Setswana 59, English 85, Mathematics test average 35.

Lebo and his family speak Sepedi at home. He did his primary education in a Sepedi school and was confronted with a Setswana environment for the first time this year. He did encounter Setswana in the Northern Province where he came from. He speaks Setswana better than English. He experienced the Setswana notes as “sharp!”, and referred to the Setswana when he did not understand an English word. He has no problems with the new Setswana terminology. However, he would like the tests to be in English.

6.6.4.7 Sam

Profile: Boy. Mother tongue: Setswana. Setswana 83. English 71. Mathematics test average 47.

Setswana is Sam's mother tongue. He also speaks isiXhosa because he has relatives whose language is isiXhosa. Sam has problems with the Setswana terminology and finds the English terminology easier. He finds that if both Setswana and English are used he understands better, but his preference for English is quite clear. Sam prefers especially the Mathematics terminology to be in English. The test should therefore also be in English only.

6.6.4.8 Vignette School B

School B		Mother tongue	Main language	Proficiency in English	Notes and glossary	tests	view
2	Prudence (Sesotho class)	Sesotho	Sesotho	English is better than Setswana	Referred to Setswana when she did not understand the English.		
4	Thabo	IsiXhosa	Setswana			Wants tests in both languages and to answer in Setswana.	Has "no problem" with the two languages.

6.	Sam	Setswana	Setswana	Had to refer to Setswana to explain concepts to the interviewer.	Used notes in both languages to understand the Mathematics better. Glossary was unnecessary. Setswana terminology is difficult.	Should be in English only.	Prefer English, especially English terminology. Simultaneously concedes that both English and Setswana is necessary.
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6.6.4.9 *Comments on the interviews with the learners in the Batswana class*

The views of the learners

Similar to the rural school, some of the learners felt that the Setswana terminology is difficult, but that they were of opinion that they benefited from the Setswana code-switching and notes. They differ on whether the tests should be in English only or in both languages.

The learners' different mother tongues did not have a great impact on the benefit that the learners in the Setswana class felt they gained from the Setswana aids. Setswana has become both Thabo and Thandi's main language. Thandi's mother is Setswana although their home language is Sesotho. Lebo, who has started in a school where the main language is Setswana only in grade eight, also strongly felt that he benefited. This may be due to the fact that he has encountered Setswana earlier and that Sepedi is a related language.

None of the learners indicated that the use of the two languages together was confusing as Peter feared. On the contrary, they found it useful because they understood neither the mathematical Setswana nor the English perfectly.

6.7 COMMENTS, PROBLEMS EXPERIENCED AND RESTRICTIONS OF THE EMPIRICAL INVESTIGATIONS AT SCHOOL'S A AND B

6.7.1 The teachers' different views as mirrored in the test

The learners wrote a test after the programme was completed. The test was set in English, and only the main question was provided in both languages. The sub-questions were only formulated in English, because it is Peter's view that they could determine the Setswana equivalents from the glossary. An example of one of the questions is:

Describe in your own words the following angles:

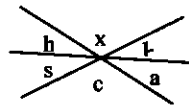
Tlhalosa ka mafoko a gao dikhutlo tse di latego:

1. adjacent angles
2. corresponding angles
3. co-interior angles
4. vertically opposite angles

The style of the question concurs with Peter's view, expressed in the first interview, that the simultaneous use of two languages may create confusion. He did not supply the Setswana terminology in the sub-sections. The learners mainly experienced it as an "English" test.

Miriam's test was set in fully in both languages. An example of a question is:

Answer the following questions/ Araba dipotso tse di lateleng:



Three lines intersect in one point, as shown/Mela e le meraro e e thlamelelantseng e segagana mo lifelong le le lengwe jaala go bontshitwe:

a). Which angles are adjacent to angle s?/ Ke dikuthlo dife tse di bapileng le khutlo s?

b) Explain why you cannot say that $\hat{x}$ is adjacent to $\hat{a}$ /Tlhalosa gore goying o ka seke ware $\hat{x}$ e bapile le $\hat{a}$

More sub-sections followed

Miriam's view that the learners need the Setswana to understand is reflected in the way she set the questions. In the interviews, Miriam's learners were sure that they want the tests in both languages, while some of Peter's learners (2) chose an all-English test.

6.7.2 Problems experienced

6.7.2.1 *Problems experienced with the interviews*

The language barrier between the researcher and the learners caused a problem. It was a definite disadvantage that the researcher could not understand Setswana. The interviewers gave feedback to the researcher of what the learners were saying during the interviews. However, because the researcher could not understand the Setswana, it was only when the interviews were transcribed and translated that the researcher realised that some of the questions were leading questions. One or two on-the-spot interpretations were made that did not always follow the learners' thought processes. Sometimes an interviewer posed more than one questions at once and the learner only answered the last question. These factors had to be taken into account in the interpretation of the interviews. Despite this drawback, it was possible to get a clear picture of the learners' views regarding the research question.

6.7.2.2 *Organisational problems at School B*

The fact that three of the classes in grade eight did not participate in the research complicated matters, since Peter had to wait until it was convenient for the other teacher to do the Geometry. Furthermore, all the learners had to write the same test at the same time. This contributed to the less convenient time of the year for assessment that Peter indicated. It was difficult to get access to the learners for the interviews and for class visits. Less class visits could be fitted in than in the rural school. This was due to organisational problems and not to a negative attitude on the side of the teacher, learners or principal.

6.7.3 Restrictions

The study was a qualitative study including only five learners in one rural school and seven learners in one township school. The experience of only two teachers could be documented. Results cannot be generalised, although valuable information has been gained into the views and experiences of these learners and teachers.

6.8 CONCLUSIONS ABOUT THE EMPIRICAL RESEARCH AT SCHOOL A AND SCHOOL B

The teachers found the Setswana terminology difficult as could be expected. However, they did use the terminology to try to link the concepts to words and concepts that the learners knew. Although some of the learners preferred the English terminology and found the Setswana terminology difficult, the main impression is that the learners' view is that they benefited from the availability of the Setswana notes and the glossary. The learners differed in their views on whether Setswana/English questions in the tests were necessary, but most of them welcomed it. It must be stressed that the learners made it clear that they used both the English and the Setswana to clarify what they did not understand in the other language. Both languages are needed in parallel so that the learners can continuously oscillate between the two.

It has to be noted that it was the learners' own choice which language they used at any given time. No pressure was put on the learners to memorise the Setswana terminology, hence the need of the constant availability of the glossary in the class work and the tests.

It should be kept in mind that the purpose of the study was not to establish whether English as LoLT should be substituted by Setswana, and it was not attempted. The learners' preference for English terminology is therefore not a negative feature,

because in the end the aim is to facilitate the journey to the formal English register. It was positively established that it would at least benefit some Batswana learners if these Setswana language-aids are available, namely code-switching in class, notes, a glossary and tests with Setswana provided as an addition to the English.

The fact that the teachers are used to the English terminology and find it easier than the new Setswana terminology will have to be taken into account if a new Setswana register is developed. Workshops on the language journey in the Mathematics class to introduce teachers to a new Setswana Mathematics register and to facilitate them to become conversant with new terminology will be necessary. However, it also seems that the notes in Setswana and Setswana terminology may facilitate effective code-switching. If better conceptualisation could be facilitated through effective code-switching and a strong link can be established to the English, as seemed to be happening in both classes, it would be a step forward. Further research on this issue can be a valuable contribution.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

7.1 INTRODUCTION

Initially the problem was raised that a vast number of the Geometry learners in the North-West are LEP-learners in schools where the LoLT is English. Many Geometry teachers are therefore confronted with the problem that most of the learners in their classes do not have the necessary English language proficiency to cope with the Mathematics register of English when the LoLT is English. Although the strategy of code-switching is developing spontaneously, more language support is needed to help the LEP-Motswana learner in the process of conceptualisation. These concerns gave rise to the following:

- To what extent has code-switching taken root in Mathematics classrooms of the North-West?
- What is the language profile of Mathematics classrooms in the North-West?
- What are the views of Mathematics in the North-West teachers regarding to the influence of English as LoLT on the conceptualisation of Batswana Geometry learners?
- What are the views of Mathematics teachers in the North-West on the possibility of a Setswana/ English glossary and Setswana support materials as an aid to teaching Geometry?
- Will grade eight Batswana Geometry LEP-learners experience a Setswana/ English glossary and Setswana support materials as a positive aid to understanding geometric concepts better?

In this chapter the research questions are discussed in view of the theoretical study and the findings and the restrictions of the empirical study. The chapter offers a final conclusion, recommendations and areas for further research.

7.2 INSIGHTS GAINED FROM THE THEORETICAL STUDY

Since each of chapters 2-4 included conclusions, only a synopsis of the most important conclusions will be given.

A study of Vygotsky, Piaget and Van Hiele's learning theories, relating to language and thought reveals the close connection between language and thought, and therefore between language and conceptualisation. If this is placed against the background of the Network Theory of Learning, it becomes clear that the well-established network of the mother tongue is an important scaffold for the conceptual development of the learner. Some learners' mother tongue degenerates because they live in communities where another language is the main language of the region. In such cases the main language becomes the most extensive language network available to the learner to facilitate conceptual development. Word sense and word meaning are dependent on the cultural context of the learner.

Language plays an important role in Mathematics. The journey between natural English, the educational and the educated Mathematics registers can cause problems for learners, especially the LEP-learners. In the struggle to negotiate meaning in Mathematics, language interacts with the affective domain and stress can contribute to misunderstanding. Language teaching has to take place in all the Mathematics classes whether visibly or invisibly. Special attention should be paid to language teaching in Mathematics classes where LEP-learners are accommodated.

In the bilingual classroom where the learner's main language is Setswana and the LoLT is English, natural Setswana as well as the educational and educated Setswana Mathematics registers are added to the language environment. This results in a complex language scenario.

Government policies, parents, teachers and learners' views play a role in the school's language policies and the language strategies of the teachers. The vicinity where the school is situated, whether it is urban, sub-urban or a rural school, also influences the language environment. In conjunction with these factors the language profile of the

specific school, teacher and learners determine the language culture in the Mathematics classroom.

The learners' main language is a natural medium of communication with peers and the teacher and forms an integral part of the ESL-classroom. Different language techniques and strategies are used, of which code-switching is the most important. This powerful tool to aid conceptualisation is not uncomplicated. Setswana can be used front stage or back stage, or the extent of the code-switching may be restricted to code-mixing.

Different problem areas exist in the use of code-switching. The first problem area is how to negotiate the journey between the different Mathematical registers of Setswana and English. Theories on how this journey should be undertaken have not been developed and each teacher negotiates the journey in his own way. The availability of Setswana Mathematics terminology, or lack thereof, influences this language journey. This constitutes the second problem area, which emerged from the questionnaires of the quantitative study, namely that the Setswana Mathematics register is not adequately developed. The question whether time and energy should be spent to develop a Setswana register is under dispute.

The learner's main language should be upheld, because it complements and stimulates the further development of the learners' proficiency in English. There is research that indicates that LEP-learners assessed in both languages achieve better results than when assessment takes place only in English.

7.3 DISCUSSION ON THE RESEARCH QUESTIONS

Detailed statistics has been documented in chapter five and only a cursory overview will be given to underwrite the conclusions on the first four research questions.

7.3.1 Code-switching in Mathematics classrooms of the North-West

94,2% of the primary school teachers and 84,1% secondary school teachers (97) reported that they use code-switching. This is an indication that code-switching has become an important factor in the Mathematics classrooms of the North-West. However, the survey did *not reflect the nature* of the code-switching. It is not known whether the code-switching that a teacher reported was applied back stage or front stage, neither how much of the time Setswana was used nor exactly for which purposes. Furthermore, the questionnaire made no distinction between code-switching and code-mixing.

7.3.2 The language profile of Mathematics classrooms in the North-West

In 90,8% of primary school classgroups and 68,8% of secondary school classgroups, the mother tongue of *most of* the learners is Setswana, with 54,6% and 34,7% of the classgroups in the sample homogeneous. From the results of the survey it was clear that this could differ significantly from region to region (see 5.4.4). *It could not be determined* how many of the learners can understand and speak Setswana better than English, although Setswana is not their mother tongue. In the qualitative study there were four of the twelve learners in the sample that fell into this category.

A large language resource exists among the teachers, and it should be applied to the benefit of the learners. Most of the teachers (97,7% of the primary and 84,1% of the secondary school teachers) believed themselves competent in Setswana and would be able to do code-switching effectively. Therefore, a possibility exists that language strategies for classes where all the learners can understand Setswana can be applied fairly widely, especially in the primary schools, but also in a sector of the secondary schools. Further research in this regard is necessary.

7.3.3 The Mathematics teachers in North-West's views regarding the influence of English as LoLT on the conceptualisation of Batswana Geometry learners

51,3% of the primary school teachers and 52,1% of the secondary school teachers in the sample are of opinion that English as LoLT does not affect learners' conceptualisation negatively. However, for a strong contingent of these teachers the motivation is that English is very important for the learners, which actually *circumvent* the question of whether the learners really understand Mathematics adequately when the LoLT is English. Furthermore, some of the teachers motivated their view by saying that they already use code-switching and are of opinion that this strategy overcomes possible negative effects. The implication is that English as LoLT *has a negative effect*, but a remedy has already been found in the form of code-switching. Another reason given is that there is a shortage of terminology in Setswana. This does not indicate that English as LoLT facilitates understanding of Mathematics adequately, but only highlights the inadequacy of the Setswana Mathematics register, and offers English as a better alternative at present (see 5.4.6 and 5.5.7).

The reasons sighted as motivation that English as LoLT does not influence Mathematics conceptualisation negatively, emphasise the role that teachers' views play. These teachers' views on the importance of English will also affect their language strategy when teaching Mathematics.

48,7% of primary school teachers and 47,9% of secondary school teachers in the sample are of opinion that English as LoLT does affect the achievement of the learners negatively.

7.3.4 The views of Mathematics teachers in the North-West on the possibility of a Setswana/ English glossary and Setswana support materials as an aid to teaching Geometry

71,3% of the primary school teachers and 65,2% of secondary school teachers respectively are of opinion that a English/Setswana glossary will be helpful, while only 53% and 55% respectively of the primary and secondary school teachers are of

opinion that notes in the main language will be helpful, and a still lower percentage, namely 52,6% of the primary school teachers and 37,8% of the secondary school teachers are of opinion that tests in main language would benefit the learners (see table 5.5.9). Strong arguments for the main language as aid in notes and tests, is that learners will understand content and questions better. Some teachers in the secondary school warned that the terminology should be linked to the English. Strong arguments against it was that it may confuse learners, it would discourage them to learn English, the fact that final examinations and textbooks are in English and the overpowering importance of English in the national and international communities.

The lack of Mathematics terminology in Setswana presented itself as a complicating factor in all the sections. Not only would it make it difficult to compile glossaries, notes and tests but it also renders Setswana as scientific language inadequate (see 5.4.7 – 5.5.8).

7.3.5 The views of Batswana Geometry LEP-learners on English/Setswana support materials

All twelve learners were of opinion that the Setswana notes helped them to understand better. They want the notes in both English and Setswana so that they can refer to English if they do not understand the Setswana and vice versa. The learners found the Setswana Mathematics terminology difficult, but from the ten learners in the Batswana classes only one learner was of opinion that only the English terminology should be used and that the glossary was superfluous. Two learners said that it was not necessary to give the test in both languages, while the others were of opinion that it helped them to understand the questions better. It can therefore be said that at least some learners may benefit from these Setswana support materials.

7.4 RECOMMENDATIONS

- A real effort has to be made to expand the Setswana Geometry register and to extend it to other sections of Mathematics.
- Final examinations should be set in both English and Setswana, with an English/Setswana glossary of the essential concepts included in each question. This may motivate teachers to employ strategies to use the resource of Setswana to facilitate better understanding of Mathematics for LEP-learners.
- Teachers should be orientated with regard to the use of a Setswana register because they are schooled in English. They should also be educated in the effective use of new Setswana terminology in their Mathematics teaching.
- Code-switching is employed in an informal and intuitive manner. This important strategy should be given formal recognition. Courses should be included in the education of pre-service teachers to help them understand the complex language environment. They should be empowered to apply the best strategy for the specific environment and to travel the language journey in the most effective way. Workshops could be employed to reach the same goal for in-service teachers.
- Support materials in both English and Setswana, should be supplied to Setswana learners. They need both languages.

7.5 RESTRICTIONS OF THE RESEARCH

7.5.1 Restrictions of the quantitative research

The sample of teachers was a sample of convenience. The primary school teachers were selected from certain regions of the North-West, while the secondary school teachers are scattered through the area. The teachers' views cannot be generalised to that of the teachers of the whole North-West. The research showed that language

contexts differ from region to region. However, it does give some idea of the language context in the region.

7.5.2 Restrictions of the empirical research in School A and School B

The study was a qualitative study which included only five learners in one rural school and seven learners in one township school. Results therefore cannot be generalised.

It was not attempted to determine whether the learners actually achieved better marks as result of the Setswana support materials and code-switching. Too many variables were at stake to try and do a quantitative evaluation in a study of this magnitude. The insights gained from this intervention are therefore only regarding these specific learners' views and is in the affective domain.

7.6 AREAS FOR FURTHER RESEARCH

- A study to determine to what degree English, as the LoLT, really is an obstacle to effective conceptualisation for Batswana Mathematics learners will be illuminating.
- A larger study that determines whether code-switching and Setswana support materials and tests set in both English and Setswana impacts on the achievement of learners should be undertaken.
- The possibility exists that language strategies for classes where all the learners can understand Setswana can be applied fairly widely. Further research in this regard is necessary and if viable, the best language strategy to apply should be researched.
- A study could be undertaken to determine how new Setswana Mathematics terminology could be used effectively to aid conceptualisation by linking it to an existing language structure in the main language.

- Another area of research that would support effective code-switching is how much the learners will benefit from the aid of the main language of the region, even if it is not their own main language, in other words, whether they understand the main language of the region better than English.
- In the field of language and learning the question arises of how the thought processes of a learner are influenced when he is taught in a language that he has not properly mastered.
- The complex language environment gives rise to a further area of interest in the field of language and learning namely how the intercultural situation in townships impacts on the thought processes of a learner.

7.7 FINAL CONCLUSION

Against a theoretical background it seems that the main language of the learner is an important resource to facilitate understanding in Mathematics.

The language scenario in the schools is complex. If the whole picture is reviewed, it is clear that according to the view of a large contingent of teachers, English as LoLT is one of the factors that complicates Mathematics teaching and learning. Furthermore, teachers perceive it as having a negative influence on the learners' achievement. Different strategies for different contexts will be necessary to improve performance of the learners.

Code-switching has become an established strategy to cope with the situation, but teachers apply it intuitively and in different ways. The journey from the informal Setswana Mathematics register to the formal English register is not clear. The lack of terminology in Setswana is a stumbling block for using the important source of this main language as support structure. From the limited qualitative study it emerged that at least some learners experience the aid of their main language in code-switching, notes, a glossary and tests as positive. They are of opinion that it helps them to understand the concepts better and they can interpret questions more easily when the questions are posed to them in both languages. As one learner put it in an informal remark, "it raised my I.Q." However, the Setswana should be used in

conjunction with English and not as substitute, given the strong feeling of the importance of English. It is also clear that teachers are schooled in the English terminology and will need assistance to apply new Setswana terminology to the greatest benefit of the learners.

Urgent attention should be paid to this field because it poses a possibility for a concrete contribution to better achievement in Mathematics for learners who are hampered by English as LoLT. If such a strategy is implemented a major effort will have to be made to educate teachers to employ it effectively.

It is necessary to make a real effort to develop the Geometry register in Setswana to facilitate the better use of code-switching to the fullest benefit of the learners. If this goal can be met, tests set in both languages and notes in Setswana and English, together with the aid of a glossary, will only benefit struggling Setswana Geometry learners.

7.8 VALUE OF THE RESEARCH

The theoretical study highlighted the importance of the main language for Mathematics learning and teaching. The quantitative study reveals the views and classroom culture regarding language issues of a contingent of Setswana teachers in the Norht-West. Although one cannot generalise, it gives a good indication of what is going on in this field. Lastly, the small qualitative study indicated a direction for further research into finding a real concrete way to contribute to better achievement in Mathematics for Batstwana LEP-learners.

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ANNEXURE 1: THE QUESTIONNAIRE FOR THE SURVEY

Please complete the following questionnaire:

RESEARCH NUMBER:

3		
---	--	--

(1-3)

1. My mother tongue (vernacular) is:

Setswana	1
Zulu	2
Xhosa	3
South Sotho	4
North Sotho	5
English	6
Afrikaans	7
Other (name the language)	8

(4)

2. I am competent in all the following languages

Setswana	
Zulu	
Xhosa	
South Sotho	
North Sotho	
English	
Afrikaans	
Other (name the language)	

(5-12)

3. I teach Geometry for grades:

gr.4	
gr.5	
gr.6	
gr.7	
gr.8	
gr.9	

(13-18)

- 4.1 The vernacular of my learners is **mainly**:
(Mark only the vernacular of the **largest** group)

Setswana	1
Zulu	2
Xhosa	3
South Sotho	4
North Sotho	5
English	6
Afrikaans	7
Other (name the language)	8

(4)

- 4.2 Mention **all** the languages of which a significant group of learners are present in your classes:

Setswana	
Zulu	
Xhosa	
South Sotho	
North Sotho	
English	
Afrikaans	
Other (name the language)	

(20-27)

5. The language strategy at the school where I am teaching is: (only mark **the one** appropriate description)

- (i) There is no official language strategy.....
(ii) The teaching language and all discussions in class are strictly in English
(iii) The teacher must teach in English but may switch to a vernacular.....
(iv) The teacher must teach in English without switching, but the learner may use his own vernacular.....
(iv) Other (explain).....

	1
	2
	3
	4
	5

(28)

6. In class I apply the following strategy: (choose only one)

I teach strictly in English and all discussions in class are in English.....
 I teach mainly in English but switch to a vernacular when necessary.....
 I teach and answer in English without switching, but the learner may use his own vernacular.....
 Other (explain).....

	1
	2
	3
	4

(29)

7. If you use a strategy of switching, which languages do you use? I switch from English to: (choose one)

I do not switch		1
The main vernacular of the group. It coincides with my own		2
The main vernacular of the group. It does not coincide with my own		3
Different vernaculars of learners in the group		4

(30)

8. When you do Geometry, in what language do you think? (Choose only one answer)

My own vernacular		1
English		2
In any of the two		3
Other (state which)		4

(31)

9. Do you ever supply your learners with Geometry notes in their own vernacular?

yes	1
no	2

(32)

10. Do your learners ever write a Geometry test or examination in their own vernacular?

yes	1
no	2

(33)

11. Do you think the fact that learners in your classes are taught and have to write exams in English, is in any way hindering their performance in Geometry?

yes	1
no	2

(34)

Motivate

12. In the teaching/learning process an **English vs. Vernacular glossary** of Geometry terminology (with short sentences where necessary) will: (choose one)

Be helpful in promoting the construction of concepts/understanding Geometry		1
Be of no real value/ unnecessary		2
Have a negative effect on the learners' competence in English as scientific language		3
Be impossible to attain		4

(35)

Motivate your answer:

13. In the Geometry teaching/learning process **some notes** in the learners' vernacular (as well as in English) will: (choose one)

Be helpful in promoting the construction of concepts/understanding Geometry		1
Be of no real value/ unnecessary		2
Have a negative effect on their competence in English as scientific language		3
Be impossible to attain		4

(36)

Motivate your answer:

14. In the Geometry teaching/learning process **some tests** in the learners' vernacular will: (choose one)

Help the learners to relate what they really know		1
Be of no real value/ unnecessary		2
Have a negative effect on their competence in English as scientific language		3
Be impossible to attain		4

(37)

Motivate your answer:

.....

15. Give your own proposal as to how language should be handled in Geometry classes.

.....

.....

.....

.....

.....

ANNEXURE 2: THE QUESTIONNAIRE COMPLETED BY THE TEACHER, MIRIAM, AT THE RURAL SCHOOL (SCHOOL A)

1. My mother tongue (vernacular) is:

Setswana	☒
----------	-------------------------------------

2. I am competent in all the following languages

Setswana	☒
----------	-------------------------------------

South Sotho	☒
-------------	-------------------------------------

English	☒
---------	-------------------------------------

3. I teach Geometry for grades:

gr.7	☒
------	-------------------------------------

gr.8	☒
------	-------------------------------------

- 4.1 The vernacular of my learners is **mainly**:
(mark only the vernacular of the **largest** group)

Setswana	☒
----------	-------------------------------------

- 4.2 Mention the different languages of all the learners are present in your class:

Setswana	☒
----------	-------------------------------------

Xhosa	☒
-------	-------------------------------------

5. The language strategy at the school where I am teaching is: (only mark the **one** appropriate description)

The teacher must teach in English but may switch to a vernacular	☐
--	--------------------------

6. In class I apply the following strategy: (choose only **one**)

I teach mainly in English but switch to a vernacular when necessary	☒
---	-------------------------------------

7. If you use a strategy of switching, which languages do you use? I switch from English to: (choose one)

The main vernacular of the group. It coincides with my own	☐	☒
--	--------------------------	-------------------------------------

8. When you do Geometry, in what language do you think?
(Choose only one answer)

My own vernacular	☐	1
English	☐	2
In any of the two	☐	3

9. Do you ever supply your learners with Geometry notes in their own vernacular?

no	☐	☒
----	--------------------------	-------------------------------------

10. Do your learners ever write a Geometry test or examination in their own vernacular?

no	☐	☒
----	--------------------------	-------------------------------------

11. Do you think the fact that learners in your classes are taught and have to write exams in English, are in any way hindering their performance in Geometry?

yes	☐	☒
-----	--------------------------	-------------------------------------

Motivation: Sometimes they don't understand some words properly

12. In the teaching/learning process an **English vs. Vernacular glossary** of Geometry terminology (with short sentences where necessary) will: (choose one)

Be helpful in promoting the construction of concepts/understanding Geometry	☐	☒
---	--------------------------	-------------------------------------

Motivation: Some of the old terms will be easier for the learners to understand if they are explained in vernacular.

13. In the Geometry teaching/learning process **some notes** in the learners' vernacular (as well as in English) will: (choose one)

Be helpful in promoting the construction of concepts/understanding Geometry	☒
---	-------------------------------------

Motivate your answer:

(36)

14. In the Geometry teaching/learning process **some tests** in the learners' vernacular will : (choose one)

Help the learners to relate what they really know	☒
---	-------------------------------------

Motivate your answer:

15. Give your own proposal as to how language should be handled in Geometry classes.

.....

ANNEXURE 3: INTERVIEW WITH THE TEACHER, MIRIAM, AT THE RURAL SCHOOL (SCHOOL A) BEFORE THE PROGRAMME STARTED

R= Researcher

M=Miriam is the teacher at the rural school (pseudo name).

R: Are there any learners in your class whose mother tongue is not Setswana?

M: Yes, they are Xhosa and one Sesotho. But they always speak Setswana with their friends.

R: How good are their English, is it as good as their Setswana?

M: No, not that good.

R: The Xhosa learners also speak Setswana and you feel that they don't speak English ..., do you mean that their English is not that good?

M: Yes, not that good, but they they are trying.

R: They are trying. OK. I want you to explain to me how you teach. What language do you use, how much English and how much Setswana do you use in class.

M: Mma ...?

R: Do you speak mostly English or mostly Setswana? When do you speak English, for which purposes?

M: Yes. I speak English when I teach. I use Setswana if they don't understand or if I want to express ... to express what I am saying, I speak Setswana. Then I also use the English Mathematics book.

R: Yes ...

M: The textbook ... their textbook is the English book.

R: Yes ...

M: If they don't understand I use their language so that they must understand.

R: Yes ...

M: Some terms.

R: And do you sometimes find that there is not a Setswana word for the English, for the maths? That, If you want to talk about maths you don't have a Setswana word for the maths, or do you mostly have a Setswana word for it?

M: No, only the English word.

R: So if we take a class of say half an hour, how much of the time do you think that you speak Setswana?

M: Mma?

R. If you take thirty minutes, do you speak twenty minutes English and ten minutes Setswana or will you speak twenty minutes Setswana and ten minutes English?

M. Twenty minutes English and ten minutes Setswana.

R. Do you ever speak Sesotho? Do you ever explain to the learner in Sesotho?

M. No. I'm don't explain in Sesotho, because they do Setswana not Sesotho.

(NOTE: The teacher does not speak Xhosa, therefore the researcher did not enquire whether the teacher switched to Xhosa)

R. Yes, yes. O.K. Now if you think about Geometry or any Mathematics you say that you think in both languages (Note: this information was from the questionnaire)

M. Yes.

R. When you have a really, really difficult problem, what language do you think?

M. If I have a real, real problem?

R: Yes

M. Setswana, their language.

R. Yes, for yourself - I mean when you are thinking at home where you don't have learners.

M. O.K. Setswana, my language.

R. You think in your language?

M. Yes.

R: O.K. You say here (in the questionnaire) that you think it is sometimes difficult for them because they have to do the Mathematics in English.

M: Yes. Sometimes the learner failed because he didn't understand the question part, even if he knows what he must do, because of the term.

R: Because of the term ... But what about the new terms that we are going to use, that they don't know. Do you think it will still be easier because it is Setswana? Or is it going to give them extra work to learn the new things, for example corresponding angles, also in Setswana?

M: Because the learners are not equal, for some of them its going to be difficult to ... to know new terms, but the other its going to be helpful for them.

R: So for some learners you think it will be difficult because they have the English and the Setswana and for other learners it will be helpful.

M: Yes

R: Do I understand you correctly?

M: Yes.

R. Is there anything else that you want to talk about?

M: What I ... I like to say that the learners ... yes if the learners can use the both languages they'll be fine when coming to Geometry, because it is only the terms, yes. Or if you give the instruction in English, sometimes the learner doesn't understand that instruction even if he knows the the ... it can be the sum or whatever. Yes. Then the instruction, because it is in English ... yes.

R: And ... and so another thing that I must ask you is, if we teach the learners ... now say in your school, we teach them the whole time in both languages. But now they get to the matric exam, and there is only English, what's going to happen?

M: No, because it is in both languages, Setswana and English, I think it is going to be helpful for them.

R: But say that we come to the end of matric and they now get, for the first time ... or you can perhaps practice it a bit, but they now get an English only question paper, what is going to happen, because they don't have both languages?

M: I think it is not going to be difficult for them, because they know this corresponding angles ... corresponding angles in English, in Setswana it is dikuthlo-tsaemelano, they're going to know that corresponding angles are dikuthlo tsaemelano, even if they are in grade twelve. I think nothing is going to change.

R: Yes, but now I don't give them dikuthlo-tsaemelano, I just give them corresponding angles.

M: Yes.

R: Do you think they will still know it because they have known it from the start?

M: Yes

R: O.K O.K. That's fine. And your own background? What is your qualifications? Do you have a three-year diploma, or ...?

M: Four-year.

R: Do you have maths major?

M: No, its foundation phase.

R: O, foundation phase.

M: But I like maths very much. That's why I teach grade 7 and grade 8.

R: So you have foundation phase, but you have a four-year diploma. And your parents were they both Setswana?

M: Yes.

R: Did you like Mathematics at school?

M: Yes very much.

R: Did you have a good teacher, or teachers?

M: Yes, we had teachers, but sometimes from January up to June, then the maths teacher was Ye, in grade 12, we didn't have a math teacher from June up to December. In grade 10 from June up to December.

R: So, you sometimes did not have a Mathematics teacher. Now what part of maths do you like the most to teach, and what part don't you like to teach?

M: I like Algebra very much. I also like Geometry, but I'm not as clear in Geometry as Algebra. But I like them both.

R: You like them both, but it is more difficult for you to teach the Geometry because you don't feel so confident in Geometry?

M: It is difficult, but if I have a difficult problem, I consult mr. H. Yes.

R: Yes.

M: Then he helps me, if I need help from him.

R: Yes then you ask him for help?

M: Yes then I ask him for help.

R: I hope you're going to like to teach this Geometry.

M: Yes very much.

R: I'm very thankful that you are going to help me.

ANNEXURE 4: INTERVIEW WITH THE TEACHER, MIRIAM, AT THE RURAL SCHOOL (SCHOOL A) AFTER THE PROGRAMME HAS BEE FINISHED

R. M. you have presented a Geometry programme for quite a few weeks now, how do you feel about this specific Geometry programme?

M. Yes. This programme, it has helped us a lot. We have learnt a lot from it, this programme.

R. Do you feel the way the programme presented activities and so on, helped you?

M. Yes, it helped us a lot.

R. What in the programme helped you? What aspects of the programme helped you?

M. In this Geometry programme I think all the aspects, yes, they have helped us. How to find corresponding angles, alternate angles, vertically opposite angles ...

R. And the activity of the learners perhaps, because the learners were actively involved?

M. Yes, they were active.

R. Did the learners like the programme?

M. Yes

R. Miriam, this Geometry programme also was in English and in Tswana, how did this affect the whole programme?

M. Yes, because I was explaining in Setswana. When I explain in Setswana, then the learners, they understand better. But the problem is that when they are supposed to answer, they don't choose Setswana, they answer in English. Even if can ask them to answer in Setswana they prefer to answer in English. Especially the terms. Then I saw the Setswana terms are so difficult for them, then because they were used to this English terms.

R. Do you think the fact that we had the notes in Setswana helped the learners? Or do you think code-switching without the notes would have been better?

M. Yes, I think that this Setswana, some not the whole, I don't know how can I explain But let me say the Setswana also helped them.

R. Because it was written down?

M. Yes, because it was written down.

R. Although the Setswana terminology was a bit difficult

M. Only the terminology ... was difficult for them. Only the terminology. Like corresponding angles. This term corresponding angles was easy for them, like

dikuthlo-tsaemalano, dikuthlo-tsaemalano to say dikuthlo-tsaemalano it was so difficult.

R. It was difficult for them.

M. But if I explained what is dikuthlo-tsaemalano in Setswana they understand. But they could not say dikuthlo-tsaemalano, they preferred to say corresponding angles.

R. But what I want to know is whether you think that because dikuthlo-tsaemalano was there and you explained what it means they remembered corresponding angles better and understood corresponding angles?

M. Yes. Yes. Yes. Dikuthlo-tsaemalano ... Dia tsamalana. That means they are the same, they are in the same position. Then I understand things ... e ... I explain in Setswana. Then I say those ... e ... those angles, we call them dikuthlo-tsaemalano in Setswana then in English it is corresponding angles. Then they are going to say corresponding angles, they are not going to say dikuthlo-tsaemalano. They are going to choose this English.

R. English, term. But do you think the concept that it was better for them because you explained ... even if it is difficult terminology?

M. I explained in Setswana?

R. Using that new term?

M. Yes.

R. So did the new term; did the new term help you to explain ... in Setswana?

M. Yes.

R. So if that term was not there what words would you have used in Setswana to explain it?

M. With the "dikuthlo-tsaemalano"?

R. Yes did the term "dikuthlo-tsaemalano" give you some way to help you to explain in Setswana?

M. Yes, if the term was not there, I was not going to use the term but the explanation, yes the explanation, but not the term.

R. But if you did not know about the term? Was it better for you to know about the term and then use it to explain ...

M. Yes.

R. Or was it better not to have the term?

M. It was better to have the term.

R. Miriam, did you give the learners the glossary in the test? Do you think that it helped them in any way or didn't they use it?

M. I think that they didn't use the glossary, because they know these terms in English. Then they answered my question ... test in English.

R. So you don't think they have used the glossary at all?

M. Or let me say not ... maybe some, some have used the glossary because I have given the glossary.

R. Miriam is there something else that you want to add?

M. Yes what I want to say is that, as I have already said. This programme has helped us a lot. Me and the learners, because the learners when they are in grade 10, 11 and 12 they have difficulties in Geometry. The I called mister M. one day to come and witness them. Then he was so grateful to see what the learners have done. He was very, very happy.

R. Do you think it was only the way in which the Geometry was set out or do you think that the language also contributed?

M. Yes, I think that the language also contributed because I used their language to explain.

R. I want to thank you very much for all the help that you have given me Miriam, and all the hard work that you have done.

ANNEXURE 5. QUESTIONNAIRES COMPLETED BY THE TEACHERS PETER AND VUSI AT THE TOWNSHIP SCHOOL

A. QUESTIONNAIRE OF PETER

1. My mother tongue (vernacular) is:

Zulu	☒
------	-------------------------------------

2. I am competent in all the following languages

Setswana	☒
Zulu	☒
English	☒

3. I teach Geometry for grades:

gr.8	☒
gr.11	☒

- 4.1 The vernacular of my learners is **mainly**:
(mark only the vernacular of the **largest** group)

Setswana	☒
----------	-------------------------------------

- 4.2 Mention the different languages of all the learners are present in your classes:

Setswana	☒
South Sotho	☒

5. The language strategy at the school where I am teaching is: (only mark **the one** appropriate description)

The teacher must teach in English but may switch to a vernacular	☒
--	-------------------------------------

6. In class I apply the following strategy: (choose only **one**)

I teach mainly in English but switch to a vernacular when necessary	☒
---	-------------------------------------

7. *If you use a strategy of switching, which languages do you use? I switch from English to: (choose one)*

The main vernacular of the group. It coincides with my own	☒
--	-------------------------------------

8. When you do Geometry, in what language do you think?
(Choose only one answer)

English

9. Do you ever supply your learners with Geometry notes in their own vernacular?

no

10. Do your learners ever write a Geometry test or examination in their own vernacular?

no

11. Do you think the fact that learners in your classes are taught and have to write exams in English, is in any way hindering their performance in Geometry?

yes

Motivation: Because I thought that are not so much good in English as language, therefore it will be difficult to understand math concept in English

12. In the teaching/learning process an English vs. Vernacular glossary of Geometry terminology (with short sentences where necessary) will: (choose one)

Be helpful in promoting the construction of concepts/understanding Geometry

Motivation: I suspect it might create a situation of confusion

13. In the Geometry teaching/learning process some notes in the learners' vernacular (as well as in English) will: (choose one)

Be helpful in promoting the construction of concepts/understanding Geometry

Motivation: I have learned that when learners are given a situation where they could move from it, they rather takes their situation as it is without digest it and apply logic.

14. In the Geometry teaching/learning process some tests in the learners' vernacular will: (choose one)

Help the learners to relate what they really know		
---	--	--

Motivation: Because the concepts will be in their mother tongue, therefore it will be easier for them.

15. Give your own proposal as to how language should be handled in Geometry classes.

Because of the fact that in the past vernacular was not introduce or not been used, therefore glossary will be solution for know.

B. EXTRACT OF QUESTIONNAIRE OF VUSI

11. Do you think the fact that learners in your classes are taught and have to write examinations in English, is in any way hindering their performance in Geometry?

No answer marked

yes	
no	

Motivation: opinion reserved

12. In the teaching/learning process an English vs. Vernacular glossary of Geometry terminology (with short sentences where necessary) will: (choose one)

Be helpful in promoting the construction of concepts/understanding Geometry		
Be of no real value/unnecessary		
Have a negative effect on the learners' competence in English as scientific language		
Be impossible to attain		

No answer marked

Motivation: Perhaps given a chance can yield desired results

13. In the Geometry teaching/learning process some notes in the learners' vernacular (as well as in English) will: (choose one)

Be helpful in promoting the construction of concepts/understanding Geometry		
Be of no real value/unnecessary		
Have a negative effect on the learners' competence in English as scientific language		
Be impossible to attain		

No answer marked

Motivation: If learners could be exposed to it, perhaps it can broaden their learning scope.

14. In the Geometry teaching/learning process some tests in the learners' vernacular will : (choose one)

Help the learners to relate what they really know		
Be of no real value/unnecessary		
Have a negative effect on the learners' competence in English as scientific language		
Be impossible to attain		

No answer marked

Motivation: I don't have a clue.

15. Give your own proposal as to how language should be handled in Geometry classes.

Learner must be first exposed to learning the concepts using both English and vernacular, explaining difficulties or words which are unfamiliar to them with their mother tongue.

ANNEXURE 6. INTERVIEW WITH THE TEACHERS, VUSI AND PETER, AT THE TOWNSHIP SCHOOL (SCHOOL B) BEFORE THE PROGRAM STARTED

R. How long have you been teaching grade 8 learners?

V. For the past five years.

R. Thanks. Right, so if you go into this research, how do you feel at this stage about giving the learners some Tswana notes?

V. Well I think it will be a new exposure for the learners in semantics. We don't know the outcomes, the outcomes will at least be just giving or exposing the learners to the whole semantic programme might ...?..... desired results.

R. O.K. and I see that you have three significant different groups in your classes. So you have different classes. Are there some of the classes that are only Tswana learners? Or there Zulu's, and Xhosa's and Sotho's in every class?

V. Ja, with us it is a mixture of that three languages. Tswana speaking and Xhosa and Zulu in one class.

R. But in every one of your classes? Or are there some of you classes where there are only Tswana learners.

V. There are only one class with Sotho learners.

R. With only Sotho's?

V. Sotho learners. But the rest of the classes are Tswana but learners from their home language is probably Xhosa or Zulu.

R. O.K. so you said that you are code-switching also to different languages? Do you speak more than one language in the class?

V. No, its only Setswana.

R. Only Setswana and English.

V. and English.

R. So you don't talk Sotho in class?

V. No, not at all

R. So only Tswana ...

V. and English.

R. O.K. you said that you are reserving you opinion on the idea of whether the learners will benefit ...or is hindered by the fact that they are taught in English. And you said that you have a lot of problems with the language. Can you explain a little bit?

V. Mm with the language we have a bit of a problem because most of our learners in the class were never exposed to the vernacular in the presentation

of the subject itself. Or what I can say the instruction of the subject. So really I think it is really going to present us with a bit of a problem.

R. Yes. And do you feel that the learners' own language is strongly developed or do they speak a mixture of languages or how do...

V. Ja, learners' languages are not strongly developed, because I mean from the environment that our learners are coming from, there is different groupings in terms of a... groupings in terms of language so that contribute in making them not to be mastering even their own language because they have a bit of their language a bit of Xhosa, a bit of Zulu. So more or less they can't even stick to their language as such, or develop their skill in their language, because of the environment, because of their friends.

R. Right. Now Peter, you heard what he said about the language environment of the learners. Do you want to add something to that? How do you feel about the language, giving the learners Tswana notes and so on?

P. Yes, for now because of this was not introduced in the past and now even for us to now start learning that concepts like ...? or vertices it might give us a problem. But I think because of.. I think it will be interesting, I feel this language problem .. English hinders the learners from achieving their best.

R. And what do you think about whether the learners are strong in their own language or not?

P. Well that one I have not yet discovered because of personally I am a Zulu. But I have been in a Setswana school from grade one.

R. From grade one you were in a Setswana school?

P. I think for them, I think they are very good in their own language.

R. Do you perhaps also find that they mix their languages between Zulu and Sotho and Setswana?

P. Ja, because of, ja. Another thing is that they are not actually speaking even their mother tongue they even mix with other language Afrikaans. They use Afrikaans and they use the other vernacular languages, you see. Even just as it occurs.

R. And your personal best language, which language do you feel is for yourself the strongest language that you want to think in and communicate in?

P. Now I think having using Setswana ... but I am good in Zulu.

R. Especially in Zulu?

P. Ja, but now because Tswana (.....) a lot of (.....) and being examined as well

R. So you had Tswana language at school. And you have also been taught through meium Setswana at school?

P. Yes.

R. O.K. So you expect a situation of confusion with this new .. this thing that we want to introduce here.

P. Yes.

R. O.K. The glossary and the notes that we are going to give to the learners.

P. Yes.

R. I Am not really clear on what you have said here: "I have learned that when learners are given a situation where they could move from it, they rather take their situation as it is without digesingt it and applying logic." I am not sure what you want to say here.

P. Ye, Ye .. what I am trying to say is that as (..) that now (....) gives them something that work and the obviously they a have to support, build the other of something (...) you'd rather don't want to (...) of that and you'd rather take that as (...) and implement it.

R. O.K. M. you have another opinion. So you think that if we give it a chance, perhaps we can help them. Is that what I can understand from you?

V. Yes.

R. So it can help them perhaps. O.K. so Vusi you said that you don't know what is going to happen if we give the tests in Setswana, or in the language that they could choose. Do you want to explain something on that?

V. Ja, for now as I was commenting it, if they can be given a test and they are tested on vernacular as their mother tongue it might have undesirable effect now that they have never been exposed.

R. But if we, if we give them a test in both languages and they can read both languages, so we don't give them a test in the vernacular, they get a test in both languages. Do you think it will confuse them?

V. You know the problem is that they're much adapted to English and probably somewhere, somehow, they might have it very difficult if they have to switch to I think if they can be much exposed to Tswana, there could be others that could choose not to do the test in English and use their vernacular as platform for ..

R. So if they are exposed to their vernacular more, for a longer time, if I understand you correctly. If they are exposed to their mother tongue more and they have used it over a longer time then they would perhaps choose to write the test in their own language?

V. Mmmmm... Mam, you see transition is not easy, perhaps they can or perhaps they cannot, it will be a fifty-fifty chance.

R. And Peter you say that "because the concepts will be in their mother tongue, therefore it will be easier for them to achieve" You think it will be easier if they have the test in their own language also?

P. Yes, like M. explained that maybe if they been exposed to that language for about some time, there's not there is not that problems, and indeed if they are at home now with Geometry in their vernacular language you see, not like it intruduced as two languages, with that one I see a problem.

R. Mm...a problem with the two languages..

P. A yes mam, ye.

R. O.K. So the fact that we are going to try, if I understand you correctly, the fact that we are going to try to do both languages is a bit of a problem.... the two languages....that they switch between the two languages.....

P. Yes, that is what I am saying, that is likely to create a big problem.

R. O.K. now we'll see, we will see when we are finished.... what happened. That is what we said it's all about, hey?

P. Mom.....

ANNEXURE 7: INTERVIEW WITH THE TEACHER, PETER, AT THE TOWNSHIP SCHOOL AFTER THE INTERVENTION

Interview with Peter after the intervention.

R. Tell me just in short how you feel about the programme. Two things I want to know: the Geometry side of it and then the English and Setswana, the language side of it.

P. Orraait basically I think what ... the problem was, orraait but I think...it was well planned, but the way us teachers were used to impart the learning the knowledge to them, it was something totally new for me as a teacher. Well, for the learners they always have to receive anything that the teachers they are teaching them. And then the English and Setswana part of it, well....I could not say that it give me some problem I'm (..) from, it was something fifty-fifties, fifty-fifties.

R. How do you mean fifty-fifty?

P. Well I didn't excel that much in Tswana and the English also. Some of the things I had to get used to, to the lingo (language) itself.

R. The Tswana?

P. The Tswana...

R. So it wasn't so good for you to teach in Tswana?

P. Well I won't say that it wasn't good because I tried my utmost best, you see I was trying my utmost best, and then I was speaking the Tswana, but now it was like something, very, very, very unusual for the learners, because they're now speaking Tswana. I would just look at them... and some of them would just come to class, wanting, the ones... that and that and they would look at us: What are you now teaching, because we know you are teaching Mathematics in English in the school, and you are teaching Setswana now, what the problem? I'll explain them normally and they'll understand some.

R. But I don't mean that you didn't teach well, but was it difficult for you to teach in Setswana, were you not very comfortable?

P. No, no I enjoyed it, it didn't have any problem. It was something very positive, I enjoyed myself. It give me another chance of trying to put the knowledge or the concept very clear for them. It like that.

R. Do you think the Setswana helped you to put it clearly to them?

P. Ja, ja, like, its like the "alternate angles", it's like the "alternate" its like is given another chance, its almost like that, and then you say "refosano ...tefosano". You say "tefosano...dikutlho tefosano" and then tefosano is like from the word "refosano" its like "just for two", you see. Some of the words that they are acquainted to.

R. So how do you think the learners reacted? Do you think they understood better because you used the Setswana or do you think it was more difficult for them because of the terminology.

P. The assessment part of it, you see, I was not able to carry out very well. Why because of you find out that those learners that normally in class, do not participate, you see and then some they don't want to do their homeworks. The handout was prepared and then they just leave them. You see and the time factor that you plan of the term, was another factor that.... Now as a result I was not able to assess their (.....) on their task.

R. So you couldn't assess very well whether they have understood the concepts better?

P. Yes. It makes it much easier for them to understand than in English, ja.

R. So you think that it was easier for them to understand. Is that correct?

P. No, I'm not saying it made them to understand, it made them easier to understand. Ja. But you see not the majority of class speak. Half of the class was participating.

R. Yes. But did they participate less or more than in the English class?

P. Meaning that comparing the Setswana class and the other class of English?

R. Yes.

P. Well I can say they speaking more than in the other class when I was teaching in English.

R. So you think they participated more?

P. Yes.

R. So on the whole what do you think? Was the language a positive factor for them or would you go back just to the English?

P. You say the Setswana class?

R. Yes.

P. Positive factor... Well....That one I'm not quite sure that..., can I say strictly, yes or no. Because of normally, usually with all the aspects..., besides this Geometry part, ja, normally some of the concepts if they do not understand them very well, then I normally switch, and then try I to explain in their mother tongue, you see.

R. Yes.

P. But to an extent I can say, to some extent, to some extent...ja.

R. You think the language helped.

P. Ja.

R. Do you think the fact that is was written down, so that they could go and read again afterwards, when they studied for the tes,. do you think it helped them or don't you know?

P. I can say some of the learners they normally don't participate, then some were able ..(.....).. to participate, see. And now, well, normally the response..., I think it was normal as I used to.

R. This was as you were used to usually?

P. Ja, in class.

R. But some responded a little bit more?

P. Yes, some, well...

R. While others just responded the same?

P. Ja, the same, I can say with a prospect or two. Those who will bring their share only (...) they came back(..) much earlier

R. But the fact that it was written down.....Say, if we didn't have the notes in Tswana, would it make a difference? If we just gave them the English notes but you still explained in Tswana... Do think the fact that it was written down also helped them in any way?

P. I think of yes, because what I have indicated to them was, that because of our focus in this case is to read this in their mother tongue.

R. Yes.

P. And the what I have said to them because of the English and the Tswana it was almost ... it can disturb their view of concentration in reading, you see, then what I just said is that they should highlight the Tswana part with any colour of their choices, you see, so that now when reading or writing or whilst I am reading it, then now they must be able just to identify what part they ..(...)

R. Yes.

P. Ja, I'm also doing it now, it was drawing attention on a on hand information.

R. Yes. So, if you have to do it, again the programme, would you like to take out the Tswana or do you think it was a positive thing for the learners to have the notes?

P. I think if I have to do it again then the Tswana, I will need to have it, because of some of the words that you might be using they might not know some of the words, you see, it will give a problem if you cannot have the notes. But I don't see what you want to achieve, what you want to address, with the previous question.

R. I want to understand whether...you see when we take the Tswana there are words that they are not used to, and what I want to understand is whether this actually made it very difficult for everybody to have this Tswana that was new, or was it still.... Although it was new, was it still valuable for you to explain through means of that new terminology, and did the learners benefit from the fact that it was written down so that they could go back to it, and not only seemingly the Geometry, it was a concept that they started to understand since they have been in high school.

R. Yes.

P. Then its another part of Maths which is almost isolated, if I can put it that way, and then it is not so much easier for me to even can measure the success of the programme itself.

R. O.K. so it's difficult for you because you can't measure it against previous work.

P. Ja, ja.

R. Thank you very much. I really appreciate it that you worked together with me on this programme and for all the trouble that you have taken.

ANNEXURE 8: INTERVIEWS WITH LEARNERS AT THE RURAL SCHOOL (SCHOOL A) AFTER THE INTERVENTION

Interview with the group of all the learners:

Morutabana: Dumelang!
 Baithuti: Agee!
 Morutabana: Ke lebogetse go bua le lona gompiano.
 Baithuti: Ee
 Morutabana: Sa ntlha go a itsegale gore le ya boikhutsong.
 Baithuti: Ee.
 Morutabana: Fela le fa go le jalo, re tshwanetse go bua le mme (Mme Vorster) ona pele ka sengwe le sengwe ka ga porokeramo ya gagwe, neeh?
 Baithuti: Ee.
 Morutabana: Se se leng botlhokwa ke gore le iketle le bue le phuthologile le buele kwa godimo. Ke ya go dira se ka Setswana ena (moeng- Mme Vorster) dipotso di tla tlhaga mo go ena tsa Sekgoa.
 Baithuti: Ee.
 Morutabana: Se se leng botlhokwa ke gore re thusaneng go dira Dipalo botlhofo, neeh?
 Baithuti: Ee.
 Morutabana: Re thusane jalo, ga re na re kgona re le banosi. Se se leng teng ke gore le re thuse go fitlhelela sengwe ka Dipalo, a ke re?
 Baithuti: Yes.

INTERVIEW WITH JOSEPH

Profile: Maths 58, Setswana 81, English 69

Morutabana: Dumela mosimane.
 Moithuti: Agee, morutabana
 Morutabana: Le kae?
 Moithuti: Ke teng.
 Morutabana: Ga go na diphoso, ne?
 Moithuti: Ee, teacher – ga go na

Interview with the group of all the learners:

Teacher: Good morning!
 Learners: Good morning!
 Teacher: I am grateful that I can speak to you, today.
 Learners: Yes.
 Teacher: Firstly, I know that you are about to take a vacation.
 Learners: Yes.
 Teacher: Firstly, we must speak with Mrs. Vorster concerning her programme. Is it clear?
 Learners: Yes.
 Teacher: It is important that you stay calm and speak loudly. I'll speak in Setswana and Mrs Vorster will ask questions in English.
 Learners: Yes.
 Teacher: The main issue is to work together to make Mathematics interesting. Is it clear?
 Learners: Yes.
 Teacher: We won't make it on our own. We need each other to reach Mathematics objectives. Do you understand?
 Learners: Ee.

INTERVIEW WITH JOSEPH

Profile: Maths 58, Setswana 81, English 69.

Teacher: Morning boy.
 Learner: Morning teacher.
 Teacher: How are you?
 Learner: I'm fine.
 Teacher: Are there any problems?
 Learner: Yes, there are no problems,

diphoso. Morutabana: A o ke o mpolelele, o nna le bagolo kwa gae? Rre le mme. Moithuti: Ke nna le mme fela. Morutabana: Rre ga a teng? Moithuti: Ee, teacher. Morutabana: Aubuti, ausi? Moithuti: Ba teng, teacher. Morutabana: Ohoo, go monate fela. Moithuti: Ee, teacher. Morutabana: Jaanong, ko ga lona le bua se kae? Moithuti: Setswana. Morutabana: Ke sona fela, ga go na English, Afrikaans le Xhosa. Learner: Re tlhola re di bua teacher. Morutabana: English? SeXhosa? Moithuti: Le English. Morutabana: English? Moithuti: Ee, teacher. Morutabana: Jaanong, o itumelela go bua puo efe? Moithuti: Leng? Jaanong jaana, teacher? Morutabana: Ee. Moithuti: Setswana. Morutabana: Ko gae le a itumela fa le bua Setswana? Moithuti: Ee. Morutabana: Go siame. Go na le puo e nngwe gape? Moithuti: Nnyaa, teacher. Morutabana: OK. Ke English fela mo go tlhokegang teng? Moithuti: Ee, teacher. Morutabana: OK. Mistress M. o ne a dira porokeramo e nngwe mo phaposing. Wa e gopola. Moithuti: Ee. Morutabana: O ka reng fela ka porokeramo e Mma M. a neng a e dira? Sengwe le sengwe se o ka se buang ke sona se se tlhokegang. Moithuti: Nna ke ne ke rata gore Maths, re bue English le Setswana, ka gonne go na le bana ba bangwe ba ba sa itseng mafoko a English.	teacher. Teacher: Do you live with your parents? Tell me about your father and mother. Learner: I live with my mother only. Teacher: Is your father not present? Learner: Yes, teacher. Teacher: Brother, sister? Learner: They are there, teacher. Teacher: Oh, it sounds good. Learner: Yes, teacher. Teacher: What language do you speak at home? Learner: Setswana. Teacher: Setswana only. What about other languages? (E.g. English, Afrikaans and Xhosa). Learner: We do, but not on a regular basis, teacher. Teacher: English and/or Xhosa? Learner: And English. Teacher: English? Teacher: Yes, teacher. Teacher: Which language do you understand the best? Learner: When, do you mean now teacher? Teacher: Yes. Learner: Setswana. Teacher: Do you feel happy when you speak Setswana at home? Learner: Yes. Teacher: OK – Do you speak any other language? Learner: No, teacher. Teacher: OK. Do you speak English when you need it? Learner: Yes, teacher. Teacher: You did a certain programme with Mistress M. in the classroom. Do you remember? Learner: Yes. Teacher: What can you tell me about Mrs M's programme, anything interesting? Learner: I would like to be taught Mathematics in English and Setswana. It is necessary to have the
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<i>Jaanong ke ne ke rata gore re bue English le Setswana.</i> <i>Morutabana: Wena ka bowena porokeramo e, o e tsaya jang? A e tswelele pele le gore e mosola jang mo go wena.</i> <i>Moithuti: E tswelele pele.</i> <i>Morutabana: E mosola mo go wena? Ka yona porokeramo e go ne go dirwa Geometry. A ke re?</i> <i>Moithuti: Ee.</i> <i>Learner: Yes.</i> <i>Morutabana: O na le mathata ka Geometry?</i> <i>Moithuti: Nnyaa.</i> <i>Morutabana: Ga o na mathata ka Geometry?</i> <i>Moithuti: Ee.</i> <i>Morutabana: Go reng?</i> <i>Moithuti: Ke ne ke kgona go tlhaloganya teacher fa a bua le rona.</i> <i>Morutabana: Go reng o ne o mo tlhaloganya?</i> <i>Moithuti: Fa re dira selo mo classeng le fa a bua ke ne ke kgona go tlhaloganya.</i> <i>Morutabana: O ne a dirisa lefoko le lengwe le le lengwe?</i> <i>Moithuti: Ee.</i> <i>Morutabana: Go ya ka wena, Geometry mokgwa oo e leng ka teng, o e tlhaloganya sentle fa go dirisiwa mafoko a Setswana?</i> <i>Moithuti: Ee.</i> <i>Morutabana: Go nnile le mo o neng o na le mathata a lefoko la English moo o neng o batla gore le tlhalosiwe ka Setswana?</i> <i>Moithuti: Ee .</i> <i>Morutabana: O gopola le le feng?</i> <i>Moithuti: Transversal line.</i> <i>Morutabana: O bo o e tlhaloganya botoka fa teacher a e tlhalosa ka Setswana?</i> <i>Moithuti: Ee.</i> <i>Morutabana: Go ya ka wena</i>	<i>notes and glossary in those languages because some learners does not understand all the English words. I would like it if we speak English and Setswana</i> <i>Teacher: What did you like about this programme? Should it be continued?</i> <i>Learner: It should be continued.</i> <i>Teacher: Does ist help you? Have you done Geometry in this programme?</i> <i>Moithuti: Ee.</i> <i>Learner: Yes.</i> <i>Teacher: Do you have problems with Geometry?</i> <i>Learner: No.</i> <i>Teacher: You don't have problems with Geometry?</i> <i>Learner: Yes.</i> <i>Teacher: Why?</i> <i>Learner: I was in the position to understand the teacher.</i> <i>Teacher: Why did you understand her?</i> <i>Learner: I was able to understand what she said and did in the classroom.</i> <i>Teacher: Was it easier for her to explain everything?</i> <i>Learner: Yes.</i> <i>Teacher: Do you understand Geometry better in Setswana?</i> <i>Learner: Yes.</i> <i>Teacher: Did you encounter difficulties in the English word list, would you like it to be explained in Setswana?</i> <i>Learner: Yes (Setswana explanations).</i> <i>Teacher: Which one do you remember?</i> <i>Learner: Transversal line.</i> <i>Teacher: Did it help you to understand better when the teacher explained it in Setswana?</i> <i>Learner: Yes.</i>
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Geometry kgotsa Maths ga di dirwa go nne le mo Setswana se tsenang gona? Moithuti: Ee. Morutabana: Le ne le kwala ditlhatlhobo? Moithuti: Ee. Morutabana: Ee. Morutabana: Jaanong, go ya ka wena tlhatlhobo e le neng le e kwala go ne go le botoka gore e kwadiwe ka English kgotsa Setswana? Moithuti: Ka Setswana. Morutabana: Go reng ka Setswana? Moithuti: Ka gonne ke sa itse dilo tse dingwe, mafoko a mangwe. Morutabana: Jaanong go botlhokwa gore e kwalwe ka Setswana le English? Moithuti: Ee. Morutabana: Wena o bo o itlhophela gore o tla araba ka English kgotsa Setswana? Moithuti: Ee. Morutabana: Teste e le neng le e kwala, e ne e le mo English le Setswana? Moithuti: Ee. Morutabana: O arabile ka eng? Moithuti: Teacher o rile re e arabe ka English le Setswana. Morutabana: Le ka Setswana? Moithuti: Ee. Morutabana: Wena o arabile ka English le Setswana? Moithuti: Ee. Morutabana: Jaanong o ne o eletsa gore mo nakong e e tlang, e nne mo English le Setswana? Moithuti: Mo Setswaneng fela. Morutabana: OK. Jaanong o buile wena gore o e arabile ka English le Setswana, questionpaper fa e tla o ne o eletsa gore go nne le lenaane le le tshwanang le le, mo e leng gore go na le English, e tlhalosiwa ka Setswana. A o ne o eletsa gore le nne teng lenaane le fa o kwala tlhatlhobo?	Teacher: Do you think that Setswana should be used in Geometry or Mathematics? Learner: Yes. Teacher: Did you write test? Learner: Yes. Teacher: Yes. Teacher: Would you like the test to be in English or Setswana? Learner: In Setswana. Teacher: Why in Setswana? Learner: I do not know all the words in other languages. Teacher: is it important for you to write it in Setswana and English? Learner: Yes. Teacher: Will you choose to answer in English or Setswana? Learner: Yes. Teacher: Was the written test in English and Setswana? Learner: Yes. Teacher: In which language did you answer? Learner: The teacher said we could answer in English and Setswana. Teacher: Also in Setswana? Learner: Yes. Teacher: Did you write in English and Setswana? Learner: Yes. Teacher: Would you like it to be in English and Setswana in future? Learner: In Setswana only. Teacher: OK. You have answered in English and Setswana. Would you like to have a question paper in English and Setswana, and a list of words with Setswana explanations?
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Moithuti: Ee, teacher. Morutabana: Le nne teng? Moithuti: Ee teacher. Morutabana: Le nne mo English fela kgotsa Setswana, kgotsa le nne ka moo e leng ka gona? Moithuti: E nne mo English le Setswana. Morutabana: E ka thusa? Moithuti: Ee. Morutabana: Jaaka o tthalosa gore list e dirwe mo English le Setswana, go ya ka wena e e ka thusa jang? Go reng o re e nne mo English le Setswana? Moithuti: Ka gone morutabana a ka nna a kwala dilo di bo di tla go kwadiwa ka Setswana go bo go tlhokega mafoko a English. Ee, teacher le ka Setswana. Morutabana: Le ka Setswana nee? Moithuti: Ee teacher, fela go nne go tsenngwa English. Teacher: OK.	Learner: Yes, teacher. Teacher: Should it be available? Learner: Yes teacher. Teacher: Should it (the list) be in English only or Setswana, or the way it is? Learner: In both English and Setswana. Teacher: Would it help? Learner: Yes. Teacher: Would it help you if the list was in English and Setswana? Why must be in English and Setswana? Learner: Because the teacher writes things in Setswana, the English words are needed. Yes teacher even in Setswana. Teacher: Even In Setswana? Learner: Yes teacher. Sometimes, English should be included. Teacher: OK.
<u>INTERVIEW WITH GLADYS</u> Profile: Girl. Maths 67, Setswana 74, English 39 <u>Mother tongue</u> isiXhosa Morutabana: Dumela ngwanake. Moithuti: Agee! Teacher. Morutabana: Re kae? Ga go na diphoso? Moithuti: Ga go na diphoso teacher. Morutabana: Ke kopa o buele kwa godimo. A o na le bagolo ko gae? Moithuti: Ee, teacher. Morutabana: Rre? Moithuti: O tlhokafetse teacher. Morutabana: Oho, ke mme fela. Morutabana: Ee, morutabana. Morutabana: Aubuti? Moithuti: O monosi le boausi ba babedi. Morutabana: Le boausi ba babedi? Jaanong le bua eng ko gae? Tswana, English, Xhosa? Moithuti: Xhosa.	<u>INTERVIEW WITH GLADYS</u> Profile: Girl. Maths 67, Setswana 74, English 39 <u>Mother tongue</u> isiXhosa Teacher: Morning my child. Learner: Morning, teacher. Teacher: How are you? Do you have any problems? Learner: There are no problems, teacher. Teacher: Can you please speak louder. Do you live with your parents? Learner: Yes, teacher. Teacher: Father? Learner: He passed away, teacher. Teacher: Oh, it's mother only.. Learner: Yes, teacher. Teacher: Brother? Learner: One brother and two sisters. Teacher: Two sisters? What language do you speak at home? Tswana, English, Xhosa? Learner: Xhosa.

Morutabana: Sona, fela? Moithuti: Le Setswana. Morutabana: Thata thata le bua eng? Moithuti: Setswana. Morutabana: O rile le bua SeXhosa le Setswana ko gae. Moithuti: Ee, teacher. Morutabana: Jaanong puo e o e kgonang that ke efe? Moithuti: Ke Setswana, teacher. Moithuti: O kgona Setswana go feta Sexhosa? Moithuti: Ee, teacher. Morutabana: OK. Jaanong o rata Maths? Moithuti: Ee, teacher. Morutabana: Fela o bokete? Moithuti: Ga o thata teacher. Morutabana: Goreng? Moithuti: Fa o dula o dira dipalo ga o nne thata, fela fa o dula o sa di dire ke gona o nna thata. Morutabana: OK. Ke kgang ya gore o nne o ikatisa fela, nee. Moithuti: Ee, teacher. Learner: Yes, teacher. Morutabana: OK. Jaanong mpolelele, mo bekeng e e fetileng le ne le dira porokeramo le Mma M.. Wa gopola? Moithuti: Ee, teacher. Morutabana: Le ne le dira eng? Moithuti: Geometry. Morutabana: Mpolelele, go ne go le jang mo Geometry? Go ne go le thata? Moithuti: Go ne go se thata, teacher Morutabana: Go reng go ne go se thata? Moithuti: Fa o nna o reetsa le go lebelela ga go nne thata. Morutabana: Jaanong leleme le le neng le diriswa e ne e le lefe? Moithuti: Ka Setswana le English, teacher. Morutabana: O ikutlwa jang fa o e dirile ka Setswana le English? Go nnile thata kgotsa wena ga wa bona diphetogo?	Teacher: Xhosa only? Learner: And Setswana. Teacher: Which language do you speak better? Learner: Setswana. Teacher: You said you speak Xhosa and Setswana at home. Learner: Yes, teacher. Teacher: Which language do you understand the best? Learner: Setswana, teacher. Learner: Do you understand Setswana better than Xhosa? Learner: Yes, teacher. Teacher: OK. Do you like Maths? Learner: Yes, teacher. Teacher: Is it difficult? Learner: It is not difficult teacher. Teacher: Why? Learner: If you do your work in Mathematics there is no problem. If not – then it becomes a huge problem. Teacher: OK. It means that you will have to practice regularly. Learner: Yes, teacher. Teacher: OK. Now tell me, last week you did this programme with Mrs M. Do you remember? Learner: Yes, teacher. Teacher: What have you done? Learner: Geometry. Teacher: How was Geometry, tell me? Was it difficult? Learner: It was not difficult, teacher. Teacher: Why was it not difficult? Learner: If you were listening and concentrating - it wouldn't be difficult. Teacher: What was the medium of instruction? Learner: Setswana and English, teacher. Teacher: Did it help to use both Setswana and English, or was it difficult or is there no difference?
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Moithuti: Go ne se thata. Morutabana: O lemogile jang gore go ne go se thata. Sengwe le sengwe se siame. Re bolelele gore ke eng se se neng se dirwa gore porokeramo kgotsa se morutabana a neng a se dira gore se nne botlhofo. Moithuti: Ke Setswana. Morutabana: Ke lantlha go diriswa Setswana ne? Moithuti: Ee, teacher. Morutabana: OK. Jaanong se go thusitse jang Setswana? Moithuti: Mo ke neng ke sa tlhaloganye teng ke ne ke buisa ka Setswana go tlhaloganya. Morutabana: Ke sona se dirang gore go bo go le botlhofo kwa bofelong? Moithuti: Ee, teacher. Morutabana: OK. Le ne le kwala ka English le Setswana? Moithuti: Ee. Morutabana: Pampiri ya dipotso e ne e tlhaga ka English le Setswana, seo se go thusitse jang? Mo o neng o sa tlhaloganye teng e ne e le mo Setswaneng. Moithuti: Ee, teacher. Morutabana: Jaanong a o ke o mpolelele, o ne o rata gore dipampiri tsa dipotso di dirwe ka English le Setswana jaaka e e dirilwe? Moithuti: Ee, teacher. Morutabana: OK. Ka gonne ga o sa tlhaloganye ka Setswana o ya ko English, fa o sa tlhaloganye ka English o ya ko Setswaneng. Moithuti: Ee, teacher. Morutabana: Jaanong o ne o rata gore mo tlhatlhobong le fiwe list le mafoko e leng ya English le Setswana, o ne e rata gore list le fa o kwala o e fiwe? Moithuti: Ee, teacher. Morutabana: OK. Botlhokwa ba yona ke eng go ya ka wena? Moithuti: O ka bala ka bonako. Morutabana: O kgona go bona mafoko a English fa o sa tlhaloganye Setswana le a Setswana fa o sa	Learner: It was not difficult. Teacher: How did you notice that it was not difficult? Everything is fine. Tell us about the programme or what did the teacher has done to make it interesting? Learner: It was taught in Setswana . Teacher: Taught in Setswana for the first time, is it true? Learner: Yes teacher. Teacher: OK. How did Setswana help you? Learner: Where I did not understand, I used Setswana to understand. Teacher: Is this the reason why it was easier in the end? Learner: Yes, teacher. Teacher: OK. Were you writing in English and Setswana? Learner: Yes. Teacher: Was the question paper in both English and Setswana and how did it help you? You used the Setswana explanations when you did not understand? Learner: Yes, teacher. Teacher: Would you like to have the question papers in both English and Setswana? Learner: Yes, teacher Teacher: OK. Do you think it will help to use both English and Setswana to understand better? Learner: Yes, teacher. Teacher: Would you like to have the list of words in English and Setswana for the examinations? Learner: Yes, teacher. Teacher: OK. Do you think that it is necessary? Learner: You can read it in short. Teacher: You can see English and Setswana words to understand.
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tlhaloganye English.

Moithuti: Ee, teacher.

Morutabana: A re bue ka lereo la Setswana, dikhutlotsamaelano, a lefoko le le thata. Wa le utlwa gore le thata jang.

Moithuti: Ee, teacher.

Morutabana: Fela o le na le karolo mo go reng le tlhaloganye gore dikhutlotsamaelano ke tse di feng. A o a itse gore dikhutlotsamaelano ke tse di feng?

Moithuti: Ee, teacher.

Morutabana: Ke tse di feng? O ka nna wa bua le ka English.

Moithuti: Ke tse di mo maamong a a tshwanang.

Morutabana: Ee, jaanong ka ntlha ya gore go dirisitswe Setswana, seo se nnile botlhofo mo go wena?

Moithuti: Ee, teacher.

INTERVIEW WITH SANNA

Profile: Girl. Maths 40, Setswana 76, English 21

Morutabana: Dumela. ngwanaka.

Moithuti: Agee, teacher.

Morutabana: Wa reng?

Moithuti: Ga ke bue teacher.

Morutabana: O nna le bagolo ko gae?

Moithuti: Ee, teacher.

Morutabana: Rre o teng?

Moithuti: ee, teacher.

Morutabana: Mme?

Moithuti: O teng teacher.

Morutabana: Boausi?

Moithuti: Ga ba teng.

Morutabana: Ke bo aubuti fela?

Moithuti: Ga ba yo teacher.

Morutabana: Ke rre le mme fela?

Moithuti: Ee, teacher.

Morutabana: Le bua eng ko gae?

Moithuti: Re bua Setswana teacher.

Learner: Yes, teacher.

Teacher: Let us talk about the Setswana term, corresponding angle, is this word difficult? Do you hear how difficult it is?

Learner: Yes, teacher.

Teacher: You have the responsibility to understand the corresponding angles. Do you understand them?

Learner: Yes, teacher.

Teacher: Name them? You can speak in English.

Learner: They are in the same position.

Teacher: Was it easy for you - now that Setswana has been used?

Learner: Yes, teacher.

INTERVIEW WITH SANNA

Profile: Girl. Maths 40, Setswana 76, English 21

Teacher: Morning, my child.

Learner: Morning, teacher.

Teacher: How are you?

Learner: I am fine.

Teacher: Do you live with your parents?

Learner: Yes, teacher.

Teacher: Does your father live with you?

Learner: Yes, teacher.

Teacher: Mother?

Learner: She is there teacher.

Teacher: Sisters?

Learner: They are not there..

Teacher: Is it your brothers only?

Learner: I don't have brothers, teacher.

Teacher: Is it your father and mother only?

Learner: Yes, teacher.

Teacher: What language do you speak at home?

Learner: We speak Setswana,

Morutabana: Setswana fela? Moithuti: Ee, teacher. Morutabana: Ga le nke le bua English kgotsa Afrikaans? Moithuti: Le go ka, teacher. Morutabana: Ke Setswana fela? Moithuti: Ee, teacher. Morutabana: SeXhosa? Moithuti: Ga re se itse, teacher. Morutabana: Lo itse Setswana fela? Moithuti: Ee, teacher. Morutabana: Dipalo o a di rata? Moithuti: Ee, teacher. Morutabana: O jang? O thata? Moithuti: Ga o thata jalo, teacher. Morutabana: Go reng di se thata? Moithuti: Ke di itse fale le fale. Morutabana: OK. Jaanong mpolelele, mo bekeng tse di fetileng le ne le dira porokeramo le Mma M. Wa e gopola? it? Moithuti: Ee, teacher. Morutabana: E ne e le ya eng? Le ne le dira ka eng? Moithuti: Ka difraction. Morutabana: Fela e Mma M. a neng a e dira wa gopola e e neng e na le Setswana e ne e le efe? Ya Geometry, wa e gopola? Moithuti: Ee, teacher. Morutabana: O e lebetse ka pele jaana? Moithuti: Ga ke a e lebala, teacher. Morutabana: Ohoo! Jaanong go ya ka wena, porokeramo o e bone e le jang? Sengwe le sengwe se o ka se buang. O e bone e le jang? Moithuti: Ke e bone e siame fela, teacher. E le bonolo. Morutabana: Go reng o re e ne e le bonolo? E go thusitse ka eng? Moithuti: Ke ne ke e tlhaloganya, teacher. Morutabana: Gopola gore e ne e kwadiwa ka Setswana le ka English.	teacher Teacher: Setswana only? Learner: Yes, teacher. Teacher: What other languages do you speak English or Afrikaans? Learner: Not at all, teacher. Teacher: Is it Setswana only? Learner: Yes, teacher Teacher: SeXhosa? Learner: We don't understand that language, teacher. Teacher: You understand Setswana only? Learner: Yes, teacher. Teacher: Do you like Maths? Learner: Yes, teacher. Teacher: How do feel about it? Is it difficult? Learner: It is not very difficult, teacher. Teacher: Why isn't it difficult? Learner: I know Mathematics here and there. Teacher: OK. Tell me, in the past weeks you were doing programme with Mrs M. Do you remember it? Learner: Yes, teacher. Teacher: What was all about it? What have you done? Learner: Fractions. Teacher: Did you remember that Mrs M's programme has Setswana explanations? Do you remember the programme-Geometry? Learner: Yes, teacher. Teacher: Did you forget the programme so soon? Learner: I didn't forget it, teacher. Teacher: Oh! What did you like about the programme? Say anything you want Learner: It was fine, teacher. It was easy Teacher: Why do you say it was easy? How did it help you? Learner: I did understand it, teacher. Teacher: Remember that it was written in both Setswana and English.
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Ga o ne o sa tlhaloganye lereo ka English o ne o dirisa Setswana. Moithuti: Setswana, teacher? Morutabana: E go thusitse thata? Moithuti: Ee, teacher. Morutabana: Jaanong a o ke o mpolelele. O ne o ratile gore Setswana se dule se ntse se le teng mo dipampiring tsa dipotso mo dipalong fa o di dira? Moithuti: Ee, teacher. Morutabana: Goreng? Moithuti: Ga ke sa tlhaloganye ka English ke ya ko Setswaneng. Morutabana: Pampiri e ya dipotso e ne e tlhagile ka English le Setswana. Wena o arabile ka eng? Moithuti: Ko godimo ka English, go gongwe ka Setswana. Morutabana: Jaanong mpolelele, o ne o rata gore dipampiri tsa dipotso di kwalwe ka English le Setswana? Moithuti: Ee, teacher. Morutabana: Go ya ka wena, wa go araba ka eng? Moithuti: English, teacher. Morutabana: Go reng e se ka Setswana? Moithuti: Ka Setswana o thata, teacher. Morutabana: Ohoo! o thatanyana? Moithuti: Ee, teacher. Morutabana: OK. Jaanong mafoko a a dirisiwang mo, fa go kwadiwa teko le ona o ne o batla gore a nne gona. Moithuti: Ee, teacher. Morutabana: Goreng? Moithuti: Gongwe go ka batliwa straightline, ke bo ke lebetse gore ke eng (ka Sekgoa), ke bo ke ya go leba fale (Setswana). Morutabana: OK. O bo o tlhaloganya? Moithuti: Ee, teacher. Morutabana: OK. Mo Setswaneng re na le mareo jaaka khutlotsamaelano. A lefoko leo le thata go ya ka wena? Ga o le lebisa le la English.	If you did not understand the English term - did you refer to Setswana? Learner: Setswana, teacher? Teacher: Did it help you much? Learner: Yes, teacher. Teacher: Now tell me. Would you like to have the question papers in Mathematics in Setswana? Learner: Yes, teacher. Teacher: Why? Learner: if I don't understand the English I go to the Setswana Teacher: The test was in both English and Setswana. What language do you use? Learner: English is on top and it was also in Setswana. Teacher: Now tell me. Would you like the tests to be written in both English and Setswana? Learner: Yes, teacher. Teacher: What language are you going to use to answer the questions? Learner: English, teacher. Teacher: Why not Setswana? Learner: Mathematics is difficult in Setswana, teacher. Teacher: Oh! Is it difficult? Learner: Yes, teacher. Moithuti: OK. Do you like to have these words as part of your written exam? (the glossary) Learner: Yes, teacher. Teacher: Why? Learner: If I don't remember what a straight line is in English – then I can refer to Setswana. Teacher: OK. Would you understand? Learner: Yes, teacher. Teacher: OK. There are words for the geometry in Setswana such as corresponding angles. Did this word make it difficult for you, comparatively speaking, with English?
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Moithuti: Le thata teacher.
 Morutabana: Ee.
 Moithuti: Corresponding angle e botoka ka English.
 Morutabana: Ee. Goreng fa o ntse o tswelela o bo o itse gore go buiwa ka eng? Porokeramo o ka reng ka yona?

Moithuti: E ne e ntshiametse, teacher.
 Morutabana: Ka English, Setswana o ka reng ka tsona? Di dirisiwe tse tsotlhe kgotsa ka bongwe ka bongwe ba tsona.
 Moithuti: Di dirisiwe tsotlhe.
 Morutabana: Ka goreng?
 Moithuti: Ka gore ga ke filwe ka English ke sa tshaloganye ke tlile go leba ka kwa Setswaneng.
 Morutabana: Jaanong di fiwe fela jalo ka English le ka Setswana?
 Moithuti: Ee, teacher.

INTERVIEW WITH STEPHEN

Profile: boy Mathematics 36, Setswana 55, English 35

Morutabana: O ka re bolelela eng ka ga gago? O nna le bagolo (batsadi)?
 Moithuti: Ee.
 Morutabana: O na le boaubuti kgotsa boausi?
 Moithuti: Ee, ba teng.
 Morutabana: Le bua puo efe kwa gae?
 Moithuti: Setswana.
 Learner: Setswana.
 Morutabana: Sona (Setswana) fela?
 Moithuti: Ee.
 Morutabana: Ga le bue Sexhosa?
 Moithuti: Nnyaa, bona (batsadi) ke bona fela ba ba buang Sesotho.
 Morutabana: Sesotho le Setswana?
 Moithuti: Ee.
 Morutabana: OK. Go na le puo e nngwe e o e buang? Setswana?
 Moithuti: Ee.
 Morutabana: OK. O tshaloganya efe gape, English le Afrikaans?
 Moithuti: Ke tshaloganya English teacher, fela ga ke e tshaloganye

Learner: The word is difficult teacher.
 Teacher: Yes.

Learner: Corresponding angle is better in English.
 Teacher: Yes. Why do you all of a sudden understand what we are talking about? What can you tell me about the programme?
 Learner: It was good for me, teacher.
 Teacher: What do you think about English and Setswana? Do you think it is better to use both languages only one language?
 Learner: Both languages.
 Teacher: Why?
 Learner: For reference – both in English and Setswana.

Teacher: In both languages - English and Setswana?
 Learner: Yes, teacher

INTERVIEW WITH STEPHEN

Profile: boy Mathematics 36, Setswana 55, English 35

Teacher: What can you tell us about yourself? Do you live with your parents?
 Learner: Yes.
 Teacher: Do you have brothers or sisters?
 Learner: Yes, they live with us.
 Teacher: What language do you speak at home?
 Learner: Setswana.
 Teacher: Setswana only?
 Learner: Yes.
 Teacher: Do you speak Xhosa?
 Learner: No, my parents speak Sesotho.
 Teacher: Sesotho and Setswana?
 Learner: Yes.
 Teacher: OK. What other languages do you speak, e.g. Setswana?
 Learner: Yes.
 Teacher: OK. Do you understand also English and Afrikaans?
 Learner: I understand English but not so well, teacher.

yotlhe. Morutabana: OK. Jaanong a o ko o mpolelele, o bua English mo classeng le fa o sa e tšhaloganye. Potso ke gore o tšhaloganya English go feta Setswana kgotsa Sesotho? Moithuti: Ke tšhaloganya Setswana botoka, teacher. Morutabana: OK. O tšhaloganya Setswana go feta English. Moithuti: Ee, teacher. Morutabana: Kana re lebeletse mo Maths, dintlha dingwe tsa Setswana o di lebagantse le tsa English, o tšhaloganya dife thata? Moithuti: Ke di tšhaloganya tsotlhe, teacher. Morutabana: OK. Mo porokaramong e Mma M. a neng a e dira le moeti wa rona, a ke re mo teng re ne re dira ka Geometry? Moithuti: Ee, teacher. Morutabana: Jaanong o tšhaloganya botoka se se kwadilweng ka English kgotsa ka Setswana? Moithuti: Ka English. Morutabana: Ka porokeramo, fa e sale Mma M dira porokeramo e, o ka reng fela ka yona, sengwe le sengwe se o ka se buang ka yona? Moithuti: E ntse sentle fela Meneer, e bile ke e tšhaloganya thata go na le gore ke dire distudy fa ke le ko gae. Jaanong mo sekolong ke e tšhaloganya thata gone Mistress M. o a re e tšhalosetsa. Morutabana: Jaanong a ke re e ne e dirwa ka Setswana le ka English. Moithuti: Ee. Morutabana: Jaanong o ka reng ka seo? Ka English e ne e le jang? Ka Setswana e ne e le jang? Moithuti: Ka English ke kgona go e tšhaloganya sentle but ka Setswana ga ke kgone go e tšhaloganya sentle. Ka English e siame sentle fela. Morutabana: Ka mantswe a mangwe e tšhwaelegile ka English?	Teacher: OK. Now tell me, do you speak English in the classroom even though you don't understand it. The question is, do you understand English better than Setswana and Sesotho? Learner: I understand Setswana the best, teacher. Teacher: OK. You understand Setswana better than English. Learner: Yes, teacher. Teacher: The Mathematics notes are in both Setswana and English. Do you understand Setswana better than English or do you understand English the best? Learner: I understand both languages, teacher. Teacher: OK. You did the geometry programme with Mrs M. and our visitor. Is it true? Learner: Yes, teacher. Teacher: Which do you understand better English written work or Setswana? Learner: In English. Teacher: What did you like about the programme that you did with Mrs M.? Learner: It is good teacher. It helped me understand when Mrs. M. explains, unlike studying at home. Teacher: Now, it was taught in both Setswana and English. Learner: Yes. Teacher: What did you like about it? English or Setswana? Learner: I understand it in English, but in Setswana I don't understand if well. English is just fine. Teacher: In other words, English is commonly used.
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Moithuti: Ee. Morutabana: OK. Jaanong a o ke o re tlhalosetse gore jaaka e ne e dirwa ka English le Setswana, ga go botlhalenyana gore go nne go tlhalosiwa ka Setswana, kgotsa o lemoga jang selo seo? Setswana ka mantswe a mangwe go ya ka potso ya me se ne se sa go thuse mole le mole? Moithuti: Se ne se nthusu. Morutabana: Ee. Jaanong o lemoga gore Setswana se tlogelwe go dirwe ka English? Kgotsa o lemoga jang? Moithuti: Go dire ka English that fela ba nne ba tsenya Setswana. Morutabana: Ee, ka mantswe a mangwe le sona se botlhokwa. Moithuti: Ee. Morutabana: OK. A re bue ka Setswana mo porokeramong. Titjhere o ne a tlhalosa ka Setswana. Jaanong wena o lemoga jang gore a go ka kwadiwa le ka Setswana? Moithuti: Morutana o ne a re ba itlhophela gore a o kwala ka Setswana kgotsa English. Morutabana: Go ne go se botlhale gore o ka kwala ka English. Goreng o ne o sa kwale ka Setswana? Moithuti: Maths ga ke kgone go o tlhaloganya ka Setswana, ka gonne ke kgale ke o dira ka English. Morutabana: Ka English? Moithuti: Ee, menner. Morutabana: OK. A re boele gape mo Setswaneng mo porokeramong. Potso ya ka ke gore go ya ka wena Setswana se ka dirisiwa go thusa go tlhaloganya botoka le ga o sa kwale ka Setswana o kwala ka English? Jaanong go ya ka wena o bona Setswana se le botlhokwa jang. A se ntshiwe go ya ka wena kgotsa se tlogelwe se le jalo se diriwe le fa o sa arabe ka Setswana kgotsa o sa kwale ka Setswana?	Learner: Yes. Teacher: OK. Tell me about the English and also the Setswana notes. Would it help you to do the programme in Setswana? According to my question - Is Setswana explanations not necessary at all for you? Learner: Setswana makes things easy. Teacher: Yes. Do you think that Setswana should be cancelled out and provides a focus for English? Learner: English should be used with Setswana explanations. Teacher: Yes, in other words Setswana also plays an important role. Learner: Yes. Teacher: OK. Let's talk about the Setswana programme. The teacher explains in Setswana. What makes you think that Setswana is also vitally important to use? Learner: The teacher gave us a choice to write either in Setswana or English. Teacher: It was not wise for you to write in English. Why didn't you write in Setswana? Learner: I can't do Mathematics in Setswana because we have been taught the subject for quite a long time in English. Teacher: In English? Learner: Yes, teacher. Teacher: OK. Let's go back to the Setswana programme. My question is this – Do you think that Setswana should be used to help the learners to understand better, and English should be used for writing? Do you feel that Setswana is easier to understand than English? Should Setswana be used or not?
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Moithuti: Se dirisiwe. Morutabana: Se dirisiwe? Moithuti: Ee. Morutabana: Go botlhokwa gore se dirisiwe? Moithuti: Ee. Morutabana: OK. Mosimane a o ke o mpolelele, go na le mafoko a a dirisitsweng jaaka corresponding angles, fa go ne go sena Setswana mo a o ne o tla tlhaloganya gore ga go buiwa ka corresponding go buiwa ka eng? Fa go ne go sena lefoko la Setswana le le go tlhalosetsang gore corresponding ke eng, a o ne o ka tlhaloganya botoka. Moithuti: Ke ne ke sekitla ke tlhaloganya. Morutabana: O ne o ka se tlhaloganye? Moithuti: Ee. Morutabana: Jaanong go ya ka wena fa go kwadiwa go botlhokwa gore le neiwe dilisti tse go nang le Setswana mo go tsona kgotsa Setswana se ntshiwe gotlhelele. Moithuti: Nnyaa, se sa ntshiwa. Morutabana: Go nne le Setswana le English (mo dipalong)? Moithuti: Ee. Morutabana: OK. Kwa bokhutlong mosimane wa ka, a o ke o mpolelele ka Geometry ka kakaretso. Go tloga ga Mrs Mosipidi a simolola ka yona. E ne e le jang program e ebile Mme M. o e tsamaisitse jang? Moithuti: O e tsamaisitse sentle e bile ke e tlhalogantse. Morutabana: O e tlhalogantse botoka go gaisa nako tse di ntseng di feta? Moithuti: Ee. Morutabana: OK.	Learner: Setswana should be used. Teacher: Be used? Learner: Yes. Teacher: Is it important for Setswana to be used? Learner: Yes. Teacher: OK. Tell me my boy, there were words for Geometry in Setswana such as corresponding angles. If there were no Setswana terminology, would it help you to understand better what corresponding angles mean? Learner: No, I wouldn't be able to understand better. Teacher: You wouldn't understand? Learner: Yes. Teacher: Do you feel that you will like Setswana explanations and list of words with all your Mathematics or should Setswana be taken out completely? Learner: No, Setswana should not be taken out Teacher: Would you like Mathematics in both Setswana and English? Learner: Yes. Teacher: OK. Lastly my boy, tell me about Geometry in general. You did this programme with Mrs M., what did you like about it? Learner: It was well done and understandable. Teacher: You understood it better than previous time? Learner: Yes. Teacher: OK.
<u>INTERVIEW LINA</u> Profile: Girl. Maths 87, Setswana 98, English 69 Morutabana: Dumela ngwanaka. Moithuti: Agee teacher. Morutabana: Lina, re bolelele ka ga	<u>INTERVIEW LINA</u> Profile: Girl Maths 87, Setswana 98, English 69 Teacher: Morning my child. Learner: Morning teacher. Teacher: Lina, tell us about yourself.

gago. A o dula le batsadi? Moithuti: Ee, teacher. Morutabana: Le bua leleme lefe ko gae? Moithuti: Setswana. Morutabana: Setswana? Moithuti: Ee, teacher. Morutabana: Ke sona fela? Moithuti: Ee, teacher. Morutabana: Ga le bue le Sesotho le Sexhosa? Moithuti: Nnyaa, teacher. Morutabana: Jaanong a o ke o mpolelele, ke leleme le lefe le o kgonang go le kwala, go le bala? Moithuti: English. Morutabana: Yona fela? Afrikaans? Moithuti: Le yona. Morutabana: OK. Jaanong ke Setswana, English le Afrikaans? Moithuti: Ee, teacher. Morutabana: Kana fa di le tharo jaana ke efe e o e tihaloganyang thata? Ke leleme le fe le o le tihaloganyang sentle? Moithuti: English. Morutabana: O tihaloganya English go feta Setswana? Moithuti: Nnyaa, teacher. Morutabana: OK. A o ke o re bolelele, a Maths o thata kgotsa o siame fela? Moithuti: O siame fela teacher. Morutabana: Ga o thata? Moithuti: Ee, teacher. Morutabana: OK. Re tihalosetse gore programm e tsamaile jang? Se o ka se buang ke eng ka Geometry? O ka re raya o reng ka Geometry? Moithuti: E monate teacher. Morutabana: Go na le mathata a o kopaneng le ona fa o ntse o dira Geometry? Learner: Yes, teacher. Morutabana: Ke afe? Moithuti: Ke ne ke sa itse dicorresponding angles le diacute angles, le dicointerior angles. Morutabana: OK. Jaanong o a di itse?	Do you live with your parents? Learner: Yes, teacher. Teacher: What language do you speak at home? Learner: Setswana. Teacher: Setswana? Learner: Yes, teacher. Teacher: Is it Setswana only? Learner: Yes, teacher. Teacher: What other languages do you speak like Sotho and Xhosa? Learner: Not one of them, teacher. Teacher: What language can you write and read better, tell me? Learner: English. Teacher: English only, and what about Afrikaans? Learner: And Afrikaans also. Teacher: OK. Is it Setswana, English and Afrikaans? Learner: Yes, teacher. Teacher: What language do you understand the best? Learner: English. Teacher: Do you understand English better than Setswana? Learner: No, teacher. Teacher: OK. Tell us, is Mathematics difficult or not? Learner: Mathematics is fine, teacher. Teacher: Is Mathematics not difficult? Learner: Yes, it is not difficult teacher. Teacher: OK. Tell us about the geometry. What did you like about the programme? Learner: It is interesting teacher. Teacher: Did you encounter any problems in Geometry? Learner: Yes, teacher. Teacher: Which problems? Learner: I didn't know the corresponding angles, acute angles and co-interior angles. Teacher: Do you understand the angles, now?
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Moithuti: Ee, teacher. Morutabana: Ke eng se se dirileng gore o di tlhaloganye? Moithuti: Mistress M. o re tlhaloseditse tsona teacher. Morutabana: O di tlhalositse ka eng? Moithuti: Corresponding angles are on the same line of the transversal line. Cointerior angles are between the horizontal lines. Alternate angles are on the vertical opposite of the transversal line. Morutabana: OK. Kwa tshimologong Mrs. M. o tlhalositse. O bone gore go a tlhaloganyega fela fa a dirisa English? Moithuti: Ee. Morutabana: O lemogile gore programm e ne e dirwa le ka Setswana? A Setswana se ne se go thusa gore o tlhaloganye Geometry? Moithuti: Ee, teacher. Morutabana: Se ne se go thusa? Moithuti: Maar ke ne ke tlhaloganya thata ka English teacher. Morutabana: O tsaya jang kang ya gore Maths o bo o dirwa ka English le ka Setswana? A go go thusitse? Moithuti: Ee, teacher. Morutabana: Fa e le gore se go thusitse, o arabile o dirisa leleme lefe? Moithuti: English teacher Morutabana: English? Moithuti: Ee, teacher. Morutabana: Goreng o ne o sa dirise Setswana? Moithuti: Go na le mafoko a mangwe a a thata mo Setswaneng teacher. Morutabana: OK. Go na le mafoko mangwe a a leng bokete? Moithuti: Ee, teacher. Morutabana: Jaanong go ya ka wena, go ne go na le listi e e tshwanang le e ya mafoko, mo go neng go dirisiwa English le Setswana.	Learner: Yes, teacher. Teacher: What has happened that you understand the angles? Learner: Mistress M. explained the angles to us, teacher. Teacher: How did Mrs. M. explain the angles? Learner: Corresponding angles are on the same side of the transversal line. Co-interior angles are between the horizontal lines. Alternate angles are on the vertical opposite of the transversal line. Teacher: OK. Do you think that it easier to understand if Mrs. M. explain in English from the beginning? Moithuti: Ee. Teacher: Are you aware that the programme was conducted in Setswana also? Do you understand Geometry better in Setswana? Learner: Yes, teacher. Teacher: Did it help you to understand? Learner: But, I understand the geometry better in English teacher. Teacher: Do you like Mathematics in both languages - English and Setswana? Did it help you to understand? Learner: Yes, teacher. Teacher: What language do you use to answer the questions, if it helps? Learner: English teacher. Teacher: English? Learner: Yes, teacher. Teacher: Why not Setswana? Learner: There are some of the words that are very difficult in Setswana teacher. Teacher: OK. Are there any problematic words? Learner: Yes, teacher. Teacher: According to you, you had a list of words in both languages English and Setswana.
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<i>Moithuti: Ee, teacher.</i> <i>Morutabana: O bona go le botlhokwa gore go ntshiwe listi e fa o dira Maths go na le English le Setswana kgotsa wena o ne o bona gore Setswana se tlogelwe se se ka sa dirisiwa?</i> <i>Moithuti: Di dirisiwe di le pedi.</i> <i>Morutabana: Di dirisiwe di le pedi?</i> <i>Moithuti: Gore ga o sa tlhaloganye ka English o kgone go tlhaloganya ka Setswana.</i> <i>Morutabana: Ka Setswana?</i> <i>Moithuti: Ee, teacher.</i> <i>Morutabana: Jaanong le fiwe listi e fa le dira Maths?</i> <i>Moithuti: Ee, teacher.</i> <i>Morutabana: OK</i>	<i>Learner: Yes, teacher.</i> <i>Teacher: Should the list be left out when you write a Mathematics test that is set in English and Setswana. Or should the Setswan be left out altogether.</i> <i>Learner: Both languages should be used.</i> <i>Teacher: Do you like both languages to be used?</i> <i>Learner: If you don't understand it in English you may be able to understand it in Setswana.</i> <i>Teacher: In Setswana?</i> <i>Learner: Yes, teacher.</i> <i>Teacher: Do you feel that you will like a list of words when writing the Mathematics?</i> <i>Learner: Yes, teacher.</i> <i>Teacher: OK</i>
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ANNEXURE 9: INTERVIEWS WITH LEARNERS AT THE TOWNSHIP SCHOOL (SCHOOL B) AFTER THE INTERVENTION

A. SETLHOPHA SA BAITHUTI M: Morutabana (Teacher) L: Moithuti (Learner) R: Researcher) M. Dumelang. L. Agee, morutabana. M. Ke itumelela go buisana le lona gompieno. La ntlha ke rata go le itsise gore re batllang fa gompieno. Ke batla go thusa baithuti go dira Mathematics ka tsela e e bonolo go bona. Gantsi ga re itse gore ga jaang le gore leng re leka go dira selo go bona gore se a thusa. Re batla gore lona le re thuse go tihaloganya gore baithuti ba ikutlwa jang. Le tshwanetse go mpoletela se se ka mo pelong ya lona, le seka la ba la nna ditlhong. Ka jalo le tla re thusa go dira Mathematics botlhofo go baithuti. Le seke ra le bolelela se le akanyang gore re batla go se reetsa. Fela re batla go itse gore o ikutlwa jaang, gonne re ka se tihaloganye go thusa baithuti.	A. GROUP. T.: Good morning. L.: Good morning, teacher. T.: Thank you for talking to us today. I first want to tell you why we are talking to you today. I want to help the learners by making Mathematics easier for them. We do not always know how and then we try something to see whether it helps you. We want you to help us to understand how the learners feel. You must tell me what really is in your heart and you must not be shy, for then you will help us to make Mathematics easier for the learners. You must not tell us what you think we want to hear, but really how you feel, because otherwise it will not help us to understand how to help the learners.
B. MOITHUTI YO MONGWE LE O MONGWE 1. KEALEBOGA (No profile -randomly chosen) M. Leina la gago ke mang? L. Kealeboga M. A o nna le batsadi ba gago? L. Yes. M. A o nna le dikgaitsemi? L. Yes. M. O bua puo efe ko gae? L. Sesotho. M. Ke puo dife gape tse o di buang?	B. INDIVIDUALS: 1. KEALEBOGA (No profile -randomly chosen) T.: What is your name? L.: Kealeboga T.: Do you live with your parents? L.: Yes. T.: Do you have brothers and sisters? L.: Yes. T.: What language do you speak at home? L.: Sesotho. T.: What other languages do you speak at home?

L. Setswana le English. M. Ke puo efe e o e tlhaloganyang go gaisa English kgotsa o tlhaloganya English botoka? L. Sesotho botoka. M. A o rata Mathematics kgotsa go na le mathatanyana a a rileng? L. Go na le mathatanyana. M. A bue. L. Sometimes fa Menneer a re ruta ke a tlhaloganya ga re tlo go kwala tse dingwe ga ke sa tlhaloganya sentle. M. Mo magareng a English le Setswana ke puo efe e o e tlhaloganyang botoka? L. Ke Setswana. M. A o rata go kwala Sesotho , Setswana kgotsa English, ga o kwala Mathematics? L. Ka Sesotho. M. Sesotho! A o bua Setswana? L. Ee. M. A o ka buisa Setswana, go se bala? L. Nka se traya. M. A o tlhaloganya Setswana botoka go gaisa English, a kgotsa o tlhaloganya English botoka? L. Setswana. M. A o dira lenaane le la Geometry le Rre Mr. P. Ke rata go itse gore o mpolelele ka Geometry. Le dira eng? O rata eng ka ga yone? Ke eng dilo tse di dirileng bokete, tse o fitlhelang ele mathata ga o dira Geometry. L. Di dintsinyana. M. Di dintsinyana? L. Ee. M. Ke tse di feng tse e leng gore di a go paella go na le dicorresponding angles, alternate angles, adjacent angles. Ke gore ke di kgotlamabapi le dikhutlotsamaelano, ke tse di feng tse o ka reng di go fa bothata? L. Dicorresponding angles. M. Ke tsona tse di go fang bothata? Dinotes tse o di kreilemg tsa	L.: Setswana and English. T.: Do you understand it better than English or do you understand English better? L.: I understand Sesotho better. T.: Do you like Mathematics or is it difficult for you? L.: There are few problems. T.: Name them. L.: Sometimes, when the teacher presents a lesson, I understand quite well – when it comes to writing, especially on my own – it is potentially problematic. T.: What language do you understand better between English and Setswana? L.: Setswana. T.: Would you like to write your Mathematics in Sesotho, Setswana or English? L.: Sesotho. T.: Sesotho! Do you speak Setswana? L.: Yes. T.: Can you read Setswana? L.: I can try. T.: Do you understand Setswana better than English, or do you understand English better? L.: Setswana. T.: You did this geometry programme with Mr. P. I want you to tell me about this geometry. What did you like about it, and what was difficult for you? L.: There are many problems. T.: Many problems? L.: Yes. T.: Which angles are problematic - corresponding, alternate and/or adjacent? L.: Corresponding angles. T.: They are problematic? The geometry notes also had Setswana
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Geometry di kwetswe ka Setswana. A o ile wa tlhaloganya dilo tse o di arabileng tsa Geometry, mme ba kwetse ka Setswana? L. Ee. M. Tse dingwe wa tlhaloganya, ok. Not everything, ka gonne o tlhaloganya Sesotho. Di botoka ga di kwetswe ka Setswana kgotsa Sesotho? L. Ka Sesotho. M. So, Setswana se problem gore o se tlhaloganye. A dinotes tse o di filweng tsele di ne tsa go thusa gore o tlhaloganye demonstration ya Geometry botoka. L. Ee – di thusitse. M. So, the answer is yes. Go ne go na le mafoko a mang a a kwetsweng ka Setswana jaaka bo dikhutlotsamaelano le dikhutlomabapi. A dilo tse di kwetsweng ka Setswana di ne tsa go thusa go tlhaloganya le gore o gopole Geometry botoka kgotsa di ne tsa go direla mathata? L. Di ne tsa ntirela mathata mare actual it was interesting. M. So, English is the best? A o na le list ele ya mafoko ya diterm tsele tsa mafoko a English? L. Ee. M. A di go thusitse? L. Yes. M. O rata gore ga o kwala teko o kwale ka Setswana kgotsa e tla nna mosola mo go wena kgotsa nnyaa? L. Ga e nthuse ka gonne ga ke tlhaloganye sentle. M. O batla ba kwale ka... L. Sesotho. M. Ko ntle ga puo e re e dirisang mo Geometry, go jang ka Geometry, o fitlhela o e rata kgotsa o rata puo e e dirisiwang mo Geometry? L. Ga e bonolo mare gape ga e thata ke gore e sentle fela. M. So, it's fine. You can't say it's	explanations. Did you read the Setswana notes at all? L.: Yes. T.: You understand other angles OK. You do not understand all the angles because you understand Sesotho. Would you like to have the notes in Setswana or Sesotho? L.: In Sesotho. T.: So, you do not understand Setswana, did the notes help you to understand the geometry better or not? L.: Yes – the notes helped me. T.: So, the answer is yes. There were new words for the geometry in Setswana such as “dikhutlotsamaelano” for corresponding angles and “dikhutlomabapi” for adjacent angles. Did this Setswana terminology help you to understand and remember the geometry better, or did it make it more difficult? L.: They were more difficult and sometimes interesting. T.: So, English is the best? You also had a list of words in English? L.: Yes. T.: Did the list of words help you? L.: Yes. T.: Would you like to write your test in Setswana. Or do you think it is unnecessary? L.: It won't help me because I do not understand. T.: You would like to write it in ... L.: Sesotho. T.: Except for the language we also did the Geometry in a different way. How do you feel about it? Was it easier or more difficult? Was it interesting to you or did you like it? L.: It is fine. T.: So, it's fine. You can't say it's
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difficult or it's easy. It's just neutral. It's fine and than a o utlwa e go natefela. L. Ee. M. Jaanong ke tlo go go botsa selo se le senosi. L. Ee. M. Ga ke titjhere ya Maths niks, ke tlo go kopa gore o ntlhalosetse gare bua ka co interior angles ke khutlhotharo, re bua ka eng? O understand eng ga re bua ka di adjacent angles? L. Dico interior angles ke diangles tse di mo gare. M. A go na le se o batlang go mpolelela sona gape ka program ya Geometry? L. Ya Mathematics? M. Ya Geometry. A o rata gore mo bukeng ko bofelong gonne le tlolontswe ka Sesotho mo potsong, gore co interior angles ke eng ka Sesotho, jalo jalo. L. Ee. M. A o bona go le botlhokwa? L. Ee. 2. PRUDENCE (No profile-randomly chosen) M. Prudence, ke go botse ka English kgotsa ka Sesotho? Lp. Ka English. M. O.K. Do you live with you parents? Lp. Yes M. Do you have brothers and sisters? Lp. I have one brother. M. One brother. What language do you speak at home? Puo e le e buang kwa gae. Lp. Sesotho. M. Do you understand it better than English or do you understand English better? Lp. I understand Setswana or Sesotho or English? M. Ee. Ga kere ko gae le bua Sesotho, so o understand Sesotho go feta English kgotsa Sesotho? Lp. Sesotho. M. Setswana sona se jang?	difficult or it's easy. L.: Yes. T.: So, I am going to ask you one thing. L.: Yes. T.: I am not a Mathematics teacher; can you explain to me what co-interior angles are? Or what do you understand by adjacent angles? L.: Co-interior angles are the angles that are in the middle. T.: Is there anything else you want to tell me about the geometry programme? L.: You mean Mathematics? T.: Yes, Geometry. Would you like to have the notes and glossary in Sesotho, so that you can understand the meaning of the co-interior angles and the other? L.: Yes. T.: Is it necessary? L.: Yes. 2. PRUDENCE (No profile-randomly chosen) T.: Can I speak to you in English or Sesotho, Prudence? L.: In English. T.: OK. Do you live with your parents? L.: Yes. T.: Do you have brothers and sisters? L.: I have one brother. T.: One brother. What language do you speak at home? L.: Sesotho. T.: Do you understand it better than English or do you understand English better? L.: I understand Setswana or Sesotho or English? T.: Yes. Sesotho is your home language. So do you understand Sesotho better than English? L.: Yes, Sesotho. T.: What about Setswana?
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Lp. Ke se understand mole le mole.
M. Do you speak Setswana?
Lp. Yes.
M. Can you read Setswana?
Lp. I can. I don't know, I don't know Setswana.
M. Do you understand Setswana better than English or do you understand English better?
Lp. I understand English better than Setswana.
M. Than Setswana. You did this Geometry programme with Mr. P. You did the Geometry?
Lp. Yes.
M. I want you to tell me about Geometry. What do you like about it, and what was difficult for you?
Lp. Go ne go sena selo se se thata.
M. E ke gore e batla a lot of commitment. Geometry notes also had Setswana explanations. A di go thusitse go tshaloganya botoka?

Lp. Ee, di nthusitse.
M. So, o tshaloganya mafoko a English go gaisa Setswana?
Lp. Yes, than Setswana
M. Than Setswana. O bone dinotes di go thusa kgotsa di go senyetsa nako?
Lp. Go na le mantswe a e leng gore ga ke a tshaloganye ka English and then ke a kraya ka Setswana se be se nthusana.
M. So, ke gore fa o sa tshaloganye lefoko la English o leba la Setswana. If Setswana se bora o kgona go ya ko English. So it is like fifty-fifty. Di a thusana jalo.
Lp. Ee.
M. There were new words for the Geometry in Setswana such as "dikutlomabapi" ka Setswana ke diterm tse dintsha tsa Setswana le bo adjacent angles, dikutlo-tsaemelano for corresponding angles. Did this Setswana terminology help you to understand better? And learn Geometry better kgotsa di ile tsa go direla more difficult gore o

L.: I understand here and there.
T.: Do you speak Setswana?
L.: Yes.
T.: Can you read Setswana?
L.: I can but I don't know Setswana very well.
T.: Do you understand Setswana better than English or do you understand English better?
L.: I understand English better than Setswana.
T.: Than Setswana? You did this Geometry programme with Mr. P.. Is it true?
L.: Yes.
T.: I want you to tell me about Geometry. What do you like about it and, what was difficult for you?
L.: There was nothing difficult.
T.: It needs a lot of commitment. Geometry notes also had the Setswana explanations. Did it help you to understand and remember the geometry better?
L.: Yes, it helped me.
T.: So, you understand English terms better than Setswana?
L.: Yes, than Setswana
T.: Than Setswana. Did the notes help you or did they waste your time?
L.: If I do not understand English terms – I refer to the Setswana list of words. So, the notes are helpful.

T.: So in other words, you can use both English and Setswana notes. If you encountered any problem with an English term, you use a Setswana list of words. It is like fifty-fifty.
L.: Yes.
T.: There were new words for the geometry in Setswana such as "dikutlomabapi" for adjacent angles, "dikhutlo-tsaemelano" for corresponding angles. Did this Setswana terminology help you understand and remember the geometry better, or did it make it more difficult?

<i>tlhaloganye ga di le pedi jaana ele English le Setswana.</i> <i>Lp. Di ile tsa nthusa.</i> <i>M. Did you like it that the test was also in Setswana? Did it help you or was it not of any help to you. Fa test ene e le ka Setswana e go thusitse kgotsa jang?</i> <i>Lp. Test?</i> <i>M. Ee, test.</i> <i>Lp. Ee, e nthusitse.</i> <i>M. Except for the language we also did the Geometry in a different way. O ikutlwa jang, e ne e le bokete kgotsa thata? Ke gore tlhatlhobo e le ntseng le e kwala o utlwile go le thatanyana or go le easy go e kwala.</i> <i>Lp. Ke utlwile go le easy.</i> <i>M. Ka gonne le ne le kwala ka ...</i> <i>Lp. Ka English.</i> <i>M. So, o akanya gore English e ne e le botoka go gaisa Sesotho fa o kwala ka Sesotho. Ke tlo go botsa potso ele nosi. Ke kopa o ntihalosetse di alternate angles. O tlhaloganya eng ka tsona.</i> <i>Lp. Alternate angles di bonolo.</i> <i>M. So, go tla nna botoka fa o kwala alternate angles in Sesotho than in English.</i> <i>Lp. Yes.</i> <i>M. Is there anything else you want to tell me about the programme e le e dirileng?</i> <i>Lp. No.</i> <i>M. A o rata kwa morago go kwalwa lefoko le bo le tlhaloswa ka Sesotho term, ya kwalwa e be e tlhaloswa ka Sesotho. Do you think that is necessary?</i> <i>Lp. Yes, because go na le mafoko a English a o sa a tlhaloganyeng ga ba a tlhalosa ka Setswana o be o a tlhaloganya.</i> <i>M. So, it's necessary for difficult words to understand. Thank you.</i>	<i>L.: They've helped me.</i> <i>T.: Did you like it that the test was also in Setswana? Did it help you or was it not of any help to you?</i> <i>L.: Test?</i> <i>T.: Yes, the test.</i> <i>L.: Yes, it helped me.</i> <i>T.: Except for the language we also did the geometry in a different way. How do you feel about it? Was it more interesting or was it more difficult to you?</i> <i>L.: It was easier for me.</i> <i>T.: The reason is that, you were writing in</i> <i>L.: In English.</i> <i>T.: So, you think that English was better than Sesotho. I am going to ask you one question. Can you explain to me what alternate angles are?</i> <i>L.: Alternate angles are easy.</i> <i>T.: So, it would be easier if you write the alternate angles in Sesotho than in English.</i> <i>L.: Yes.</i> <i>T.: Is there anything else you want to tell me about the programme, something you have done?</i> <i>L.: No.</i> <i>T.: Would you like to have the notes and glossary in Sesotho. Do you think it is necessary?</i> <i>L.: Yes, because I can alternate between English and Setswana to understand better.</i> <i>T.: So, it is necessary to help you to understand difficult words. Thank you.</i>
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3. THANDI

Profile: Girl. Mother tongue: Sesotho/Setswana. Setswana 44 English 38 Mathematics 30

M. O bua Sesotho kwo gae, mare mo sekolong o bua Setswana.

Lw. Yes.

M. E re ke go botse ka English le Setswana. Do you live with your parents?

Lw. Yes.

M. Do you have brothers and sisters?

Lw. Yes.

M. How many brothers and sisters?

Lw. Two brothers.

M. And sisters?

Lw. No sisters.

M. What language do you speak at home?

Lw. Ga ke bua le mama wa ka ke bua Setswana and ga ke bua le papa wa ka ke bua Sesotho.

M. OK Your mother Setswana, with your father Sesotho. Which one do you prefer?

Lw. I like Sesotho

M. OK. What other language do you speak?

Lw. Ke rata English.

M. Do you understand it better kgotsa o tlhaloganya English kgotsa Setswana botoka?

Lw. Setswana.

M. Do you like Mathematics or is it difficult for you, Maths?

Lw. Ke a o rata.

M. You enjoy it. O startile leng mo sekolong sa Batswana?

Lw. Ko grade 1.

M. Ok, grade 1 Tswana. O startile grade 1 o dira Setswana even now, but you like Setswana or Sotho?

Lw. Ke rata Sotho.

M. Can you write Sesotho?

Lw. Yes.

M. Can you read Sesotho?

Lw. Yes.

M. Can you write Setswana?

Lw. Yes.

M. Can you read Setswana?

3. THANDI

Profile: Girl. Mother tongue: Sesotho/Setswana Setswana 44 English 38 Mathematics 30

T.: You speak Sesotho at home and Setswana at school.

L.: Yes.

T.: I will ask you questions in English and Setswana. Do you live with your parents?

L.: Yes.

T.: Do you have brothers and sisters?

L.: Yes.

T.: How many brothers and sisters?

L.: Two brothers.

T.: And sisters?

L.: No sisters.

T.: What language do you speak at home?

L.: I communicate with my mother in Setswana and with my father in Sesotho.

T.: OK. Your mother – Setswana and your father - Sesotho. Which one do you prefer?

L.: I like Sesotho.

T.: OK. What other languages do you speak?

L.: I like English.

T.: Do you understand it better than Sesotho or do you understand English or Setswana better?

L.: I understand Setswana better.

T.: Do you like Mathematics or is it difficult for you?

L.: I like Mathematics.

T.: You enjoy it. When did you start to learn in a Batswana school?

L.: When I was doing Grade 1.

T.: You have started Grade 1 in Setswana. Do you like Setswana or Sesotho?

L.: I like Sesotho.

T.: Can you write Sesotho?

L.: Yes.

T.: Can you read Sesotho?

L.: Yes.

T.: Can you write Setswana?

L.: Yes.

T.: Can you read Setswana?

Lw. Yes. M. Ke puo efe e o ka kwalang le go e buisa botoka? Lw. Setswana. M. Because you started grade one with Setswana? Lw. Yes. M. You did this Geometry programme with mr. P... Lw. Yes. M. I want you to tell me about the Geometry. You like it kgotsa go ne go le difficult. Lw. Ke a e rata, especially fa go tliwa mo diadjacent angle. M. Mr Mr. P. used much more Setswana than English, how do you feel about it? Did it help you to understand Geometry better? So o nagana gore ya go thusa kgotsa go betere a dirisa English? Lw. Nna ya nthusa ka Setswana. M. So it helps to speak Tswana. You don't prefer English? Lw. Ke a kgona go e tlhaloganya but ke rata thata Tswana. M. This Geometry notes also has Setswana part go na le Setswana. How did you feel about it? Did it help you or do you think it was unnecessary? Did you understand it better? Lw. Ke tlhaloganya botoka. M. So, both languages di go thusa gore o tlhaloganye? Lw. Yes. M. So, she prefers both languages. So we have dikhutlotsamaelano le di corresponding angles, dikwetswe ka Setswana a di ne tsa go thusa gore o tlhaloganye much better kgotsa o bone o kare ga di thuse ka sepe? Lw. Di a thusa.	L.: Yes. T.: Can you read and write English or Setswana the best? L.: Setswana. T.: Because you started grade one in Setswana? L.: Yes. T.: You did this Geometry programme with Mr. P.. L.: Yes. T.: I want you to tell me about the Geometry. Do you like it or is it difficult for you? L.: I like Geometry, particularly the adjacent angles. T.: Mr Mr. P. used much more Setswana than English. How do you feel about it? Did it help you to understand Geometry better or do you think it is better to do it only in English? L.: The Setswana helped me T.: So it helps to speak Tswana. You don't prefer English? L.: I understand Setswana much better than English. T.: The Geometry notes also had Setswana explanations. How do you feel about it? Did it help you or do you think it was unnecessary? Did you understand it better? L.: It helped me because I understand much better. T.: So, did the usage of both languages help you to understand better? L.: Yes. T.: You prefer the usage of both languages – Setswana and English. There were new words for the geometry in Setswana such as "dikhutlotsamaelano" for corresponding angles and "dikhutlomabapi" for adjacent angles, did this Setswana terminology help you to understand and remember the geometry better or did it make it more difficult? L.: They helped me.
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M. You also had a list of words. Did the list of words help you in the test and when did your sums or was it unnecessary? Lw. E nthusitse thata. M. O ne o na le list. Did you like it that the test was also in Setswana? Did it help you or was it unnecessary? In future o batla go dira Tswana kgotsa Sesotho. Lw Ke batla ka Setswana. M. Setswana? Lw Yes. M. Would you like it all the tests were in Setswana? If the test were in this way, English only no Setswana, at the end of the year would you be able to answer all the questions? O nagana o tla kgona go answer dipotso tseo tsotlhe? Lw. Yes nka kgona go araba dipotso fa ditest di le ka Setswana. M. Setswana se betere go gaisa English fa e le test? Lw. Both. M. A mo testeng ba a botsa gore selo se ke eng ka Setswana? Lw. Yes, ba a botsa. M. Ke eng adjacent angles kgotsa corresponding angles? Lw. Mmm ... M. A o na le bothata? Lw. Ee ks corresponding. Angles. M. So in your next class test before you write the Geometry o dire revision, wa utlwa? Lw. Yes. 4. THABO Profile: Boy. Mother tongue: isiXhosa.. Setswana 75 English 45 Mathematics 48 M. Do you live with your parents? Ls. Yes. M. Do you have brothers and sisters? Ls. Yes.	T.: You also had a list of words. Did the list of words help you in the test and when you did your sums or was it unnecessary? L.: It helped me very much. T.: Yes, the list of words helped you. Did you like it that the test was also in Setswana? Did it help you or was it unnecessary? What language do you like to use in future, Setswana or Sesotho? L.: I would like Setswana. T.: Setswana? L.: Yes. T.: Would you like it if all the tests were in English and Setswana? If the test on this work is in English only, without the Setswana, at the end of the year will you still be able to answer all the questions? L.: Yes, I would be able to answer all the questions if all the tests were in Setswana. T.: Did you like that the test was in Setswana than in English? L.: Both languages. T.: Did your teacher use Setswana in the test? L.: Yes, he used Setswana. T.: Can you explain to me what are adjacent angles or corresponding angles. L.: Mmm T.: Do you have a problem? L.: Yes, with corresponding angles. T.: So in your next class test before you write the geometry, you must do your revision? L.: Yes. 4. THABO Profile: Boy. Mother tongue: isiXhosa.. Setswana 75 English 45 Mathematics 48 T.: Do you live with your parents? L.: Yes. T.: Do you have brothers and sisters? L.: Yes
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M. How many brothers? Ls. One. M. Sisters? Ls. Two sisters. M. What language do you speak at home? Ls. Xhosa. M. What other language do you speak? Ls. Setswana M. Setswana. O understander Setswana better than English or do you understand English better? Ls. Setswana. M. Do you like Mathematics or is it difficult? Ls. O thata. M. Can you write and read seXhosa? Ls. Nka se bala. M. Ca you speak Xhosa? Ls. Yes. M.OK, Can you speak and read Xhosa? Would you like Mathematics to be in Xhosa or Setswana or English? Ls. Setswana M. Setswana? Ls. Yes M. O.K. Setswana. You speak Xhosa? Ls. Yes M. When did you start to learn Setswana? Ls. Here. M. Why? Ga ke re le Maxhosa ko gae? Ls. Go ne go sena dikolo tsa Xhosa. M. So, in other words you have started Setswana in grade 1? Ls. Yes. M. OK. You did this Geometry programme le Mr. P. Ls. Yes. M. I want you to tell me about this Geometry. Do you like it or was it difficult? Ls.It was neutral. M. Mr. P. used much more Setswana than usual in the class? How do you	T.: How many brothers? L.: One. T.: Sisters? L.: Two sisters. T.: What language do you speak at home? L.: isiXhosa. T.: What other language do you speak? L.: Setswana T.: Setswana. Do you understand Setswana better than English or do you understand English better? L.: Setswana. T.: Do you like Mathematics or is it difficult? L.: It is difficult. T.: Can you write and read isiXhosa? L.: Yes, I can read isiXhosa. T.: Can you speak isiXhosa? L.: Yes. T.:OK. So you can speak and read isiXhosa. Would you like Mathematics to be in isiXhosa or Setswana or English? L.: Setswana T.: Setswana? L.: Yes. T.: OK. Setswana but you speak isiXhosa? L.: Yes. T.: When did you learn Setswana? L.: Here. T.: Why, because you speak Xhosa at home? L.: Xhosa schools were not available. T.: So, in other words you have started Setswana in Grade 1? L.: Yes. T.: OK. You did this geometry programme with Mr. P. L.: Yes. T.: I want you to tell me about this geometry. Do you like it, or was it difficult ? L.: It was neutral. T.: Mr. P. used much more Setswana than usual in the class? How do you
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feel about it, o ikutlwa jang ? Ls. Go ne go le monate fela. M. Is it O.K.? Ls. Yes. M. Mr Mr. P. o dirisa English mme o ikutlwa jang? Ls. Go a tshwana, go siame. M. Mr Mr. P. o dirisa English go gaisa Setswana? O dirisa puo e e efeng? Ls. O dirisa English more than Setswana M. English? Ls. Yes. M. Do you understand the language? Are you happy about it? Ls. Yes. M. Geometry notes di na le Setswana explanations. Ls. Yes. M. How do you feel about it? Did it help you to write or ga ba kwetse ka Setswana go ne go se necessary? Ls. Di siame di le pedi. M. Did it help you to remember and understand Geometry better if dikwetswe ka both English le Setswana di dira gore o gopole? Ls. Yes. M. You can remember? Ls. Yes. M. So, if you don't understand English term you go to Setswana? Ls. Yes. M. And if you don't understand the Setswana you go back to... Ls. English. M. In other words, you are comfortable with the usage of both languages, English and Setswana? Ls. Yes. M. There were new words for the Geometry such as dikhutlomabapi for adjacent angles, and then dikuthlo-tsaemelano for corresponding angles. Ls. Yes. M. This Setswana terminology di go	feel about it? L.: It was very interesting. T.: Is it OK? L.: Yes. T.: Mr.P used also English? How do you feel about it? L.: Still the same – very interesting. T.: What language did Mr. P. use more – English or Setswana? L.: He used English more than Setswana. T.: English? L.: Yes. T.: Do you understand the language? Are you happy about it? L.: Yes. T.: Geometry notes also had the Setswana explanations. L.: Yes. T.: How do you feel about it? Did it help you to have the Setswana written down or do you think it was unnecessary? L.: It was not a problem to have two languages. T.: Did it help you to remember and understand geometry better? L.: Yes. T.: You can remember? L.: Yes. T.: So, if you don't understand the English you go to Setswana? L.: Yes. T.: And if you don't understand the Setswana term, do you go back to...? L.: English. T.: In other words, are you comfortable with the usage of both languages, English and Setswana? L.: Yes. T.: There were new words for the Geometry such as "dikhutlomabapi" for adjacent angles, and then "dikuthlo-tsaemelano" for corresponding angles. L.: Yes. T.: Did this Setswana terminology
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<i>thusitse go understand and remember the Geometry better. O nagana gore o tlhalogantse?</i> <i>Ls. Yes.</i> <i>M. A ga wa bona mathata a a rileng?</i> <i>Ls. Yes.</i> <i>M. A o rata Setswana explanations, se se kwetsweng mo testeng?</i> <i>Ls. Ee.</i> <i>M. O na le list mo go wena ya mafoko?</i> <i>Ls. E ko go teacher.</i> <i>M. A list ya mafoko help you in the test and when you did your sums? Ga o dira tiro ya gago e a go thusa?</i> <i>Ls. Ee, e a thusa.</i> <i>M. Kana o rile o a e rata, so would you like it if the test would be in Setswana, English, or di dule fela ka English or Setswana?</i> <i>Ls. Ka Setswana.</i> <i>M. Ka Setswana fela?</i> <i>Ls. Le ka English.</i> <i>M. So, you would like both English and Setswana ga teste e kwetswe ka English fela without Setswana at the end of the year. Would you be able to answer all the questions?</i> <i>Ls. Yes.</i> <i>M. O araba dipotso tsa gago ka English kgotsa Setswana.</i> <i>Ls. Ka Setswana.</i> <i>M. So, you would answer your questions in Setswana. Geometry o e fitlhela ele jang, difficult or interesting or wa e rata?</i> <i>Ls. E interesting and ke a e rata.</i> 5. LEBO Profile: Boy. Mother tongue: Sepedi. Setswana 59 English 85 Mathematics 35 <i>M. Do you live with your parents?</i> <i>Lb. Ee.</i> <i>M. Do you have brothers and sisters?</i> <i>Lb. A brother and sister.</i> <i>M. What language do you speak at home?</i> <i>Lb. Sepedi.</i>	<i>help you to understand and remember the Geometry better?</i> <i>L.: Yes.</i> <i>T.: Did it make it more difficult?</i> <i>L.: Yes.</i> <i>T.: Did you like it that the test was also in Setswana?</i> <i>L.: Yes.</i> <i>T.: Did you receive a list of words?</i> <i>L.: No, the teacher had the list.</i> <i>T.: Did the list of words help you in the test and when you did your sums?</i> <i>L.: Yes, it helped.</i> <i>T.: Would you like it if all the tests were in Setswana and English?</i> <i>L.: In Setswana.</i> <i>T.: In Setswana only?</i> <i>L.: And in English.</i> <i>T.: So, you would like both English and Setswana in your test. If the test on this work is in English only, without Setswana, at the end of the year, will you be able to answer all the questions?</i> <i>L.: Yes.</i> <i>T.: Would you answer your questions in English or Setswana?</i> <i>L.: In Setswana.</i> <i>T.: So, you would answer your questions in Setswana. How do you feel about Geometry? Was it easier or more difficult?</i> <i>L.: I like it because it's interesting.</i> 5. LEBO Profile: Boy. Mother tongue: Sepedi. Setswana 59 English 85 Mathematics 35 <i>T.: Do you live with your parents?</i> <i>L.: Yes.</i> <i>T.: Do you have brothers and sisters?</i> <i>L.: One brother and sister.</i> <i>T.: What language do you speak at home?</i> <i>L.: Sepedi.</i>
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M. O bua puo mang fa? Lb. Setswana M. Why not Sepedi? Lb. Ga se rutiwe. M. OK. when did you start to learn with Setswana? Lb. This year. M. This year! So, for all these years – o ntse o dira Sepedi. Lb. Mm! M. O dirile Sepedi kae? Where? Lb. Northern Province. M. So Setswana, its not difficult for you? Lb. No. M. O a se rata. Lb. Yes. M. So when you were in the Northern Province - did you speak Setswana or not? Lb. Yes, ke ne ke se bua. M. A ka tota Setswana ga se bothata? Lb. Ee, ga se bothata. M. Actually Sesotho, Setswana le Sepedi di mo setlhopheng se le esi. Ke tota, ga se bothata. Lb. Ee. M. Ja. What other languages do you speak? Sepedi, Setswana. Do you understand English better than Sesotho, or Sepedi? Lb. No, I do not understand English go gaisa Sesotho kgotsa Sepedi. M. Do you like Mathematics or is it difficult for you? Lb. Yes o difficult. M. So you say it's a difficult? M. So you can read and write Sepedi? Lb. Yes. M. So you did this Geometry programme with Mr. P. Lb. Yes. M. I want you to tell me about this Geometry. Did you like it or is it difficult?	T.: What other languages do you speak at school? L.: Setswana. T.: Why not Sepedi? L.: Sepedi is not a medium of instruction in our school. T.: OK, when did you learn Setswana? L.: This year. T.: This year! So, you were doing Sepedi for the past few years. L.: Mm! T.: Where? L.: Northern Province. T.: So Setswana, its not difficult for you? L.: No. T.: So, it sounds interesting. L.: Yes. T.: Did you speak Setswana in the Northern-Province? L.: Yes. T.: Are you sure that Setswana is not problematic? L.: Yes, it is not. T.: Actually Sesotho, Setswana and Sepedi fall in the Sotho group and the difference is not so big. L.: Yes. T.: What other languages do you speak – besides Sesotho and Setswana? Do you understand English better than Sesotho or Sepedi? L.: No – I do not understand English better than Sesotho or Sepedi. T.: Do you like Mathematics or is it difficult for you? L.: Yes, it is difficult. T.: So you say it's difficult? T.: So, can you read and write Sepedi? L.: Yes. T.: You did this Geometry programme with Mr. P. L.: Yes. T.: I want you to tell me about this Geometry. Did you like it or is it difficult?
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Lb. I liked it. E ne e ese difficult. M. So it was not difficult. Mr. P. used much more Setswana or English? Lb. Both. M. Both. How do you feel about it? Does it help you, to use both languages? Lb. Yes. M. Do you speak English or Sepedi much better than ...? Researcher. No, not Sepedi, Setswana M. Setswana or English, which one is better? Lb. Setswana M. Setswana is better than English. These Geometry notes also has the Setswana explanation. How do you feel about it? Wena o ikutlwa jang or e difficult? Lb. Ke a e tthaloganya. M. So you understand it. Lb. Ee M. A o ne o itumelela geometry? Lb. Ee. M. Did it help you to have Setswana written down or do you think it was unnecessary? Both languages di a go thusa? Lb. Sharp. Di a thusa M. How? Di go thusa jang. Lb. Ga ke sa tthaloganye ka English ke lebelela Setswana. M. O. K. when something is in English, you go to Setswana. So its like fifty-fifty. There were new words in Geometry ka Setswana, bo dikuthlomabapi le dikuthlo-tsaemelano for corresponding angles. Lb. Mm M. This Setswana terminology di ne di go thusa ga o ntse o bala di go thusa gore o understand Geometry better? Lb. Ee. M. Ga di go tlietse more difficulties? Lb. No.	L.: I liked it. It was not difficult. T. So it was not difficult. Mr. P used much more Setswana or English? L.: Both. T.: Both. How do you feel about it? Does it help you, to use both languages? L.: Yes. T.: Do you speak English or Sepedi better than ...? Researcher: No, not Sepedi but Setswana. T.: Setswana or English, which one is better? L.: Setswana T.: Setswana is better than English. These Geometry notes also had the Setswana explanation. How do you feel about it? Was it difficult? L.: I understand the Geometry notes. T.: So you to understand it.. L.: Yes. T.: Did you enjoy Geometry? L.: Yes. T.: Did it help you to have Setswana written down or do you think it was unnecessary? Did it help you to have both languages? L.: Sharp – it helped me. T.: How? L.: If I do not understand the English term – I refer to the Setswana word list. T.: OK. When something is problematic in English, you refer to Setswana. So it is like fifty-fifty. There were new words for the geometry in Setswana such as “dikhutlomabapi” for adjacent angles, and “dikhutlho-tsaemelano” for corresponding angles. L.: Mm. T.: Did this Setswana terminology help you to understand geometry better? L.: Yes. T.: Or did it make it more difficult? L.: No.
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M. You said that you like Setswana explanations. Lb. Yes. M. Would you like it if the tests were in Setswana and English? Lb. English. M. O rata ditest in English because Mr. P. is using English. Lb. Yes. M. If this test di le mo English without Setswana nê, from question A-Z, do you think that you will be in a position to answer all the questions? Lb. Yes. M. As you indicated that Mr. P. uses English. Lb. Yes. M. Ga le kwala di test, do you have the list of words tse di tsenang mo English le Setswana? Lb. No. M. During the test le filwe a list of words? Were you expected go di gopola ka tlhogo? Lb. Yes. M. A o dirisa list ya mafoko ? A ya go thusa? Lb. Yes. M. I want you to understand very well, se ke tlo go se bua. Lb. Yes. M. So, don't you think go ka ba easy ga o user Setswana more than English, because in Setswana you can explain yourself very well nee? Do you think it's best ga o user Setswana more than English? Lb. Ee. 6. SAM Profile: Boy. Mother tongue: Setswana. Setswana 83 English 71 Mathematics 47 M. Ao, ngwana! Just like this. So I am going to use both Setswana and English nee, so that you can understand. Do you live with your parents?	T.: You said that you like Setswana explanations. L.: Yes. T.: Would you like it if the tests were in Setswana and English? L.: English. T.: So you would prefer the tests to be in English because Mr. P. is uses English. L.: Yes. T.: If the test on this work is in English only, without the Setswana, from question A-Z, do you think that will you be in a position to answer all the questions? L.: Yes. T.: As you indicated that Mr. P. uses English. L.: Yes. T.: Did you use a list of words that is in English and Setswana during your test? L.: No. T.: You were not given a list of words during the test. Were you expected to memorize the terms? L.: Yes. T.: Do you use a list of words? Does it help you? L.: Yes. T.: I want you to understand very well, something that I am going to tell you. L.: Yes. T.: So, do you think that you will like Setswana explanations with all your Mathematics because you express yourself better in Setswana than in English? L.: Yes. 6. SAM Profile: Boy. Mother tongue: Setswana. Setswana 83 English 71 Mathematics 47 T.: Yes, learner! Just like this. So I am going to use both Setswana and English, so that you can understand. Do you live with your parents?
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Lr. Yes. M. Do you have brothers and sisters? Lr. Yes. M. How many brothers? Lr. One. M. Sisters. Lr. One. M. What language do you speak at home? Lr. Setswana. M. What other languages do you speak? Kwa ntle ga Setswana. Lr. Xhosa. M. O dirile Xhosa le Setswana leng? Lr. Ke dirile Setswana ke le ngwana SeXhosa, ke se ithutile. M. Ok. Why do you speak Xhosa now? Lr. Ke gore re na le direlatives tse di buang seXhosa. M. So, whether the relatives are there or not do you still continue to speak Xhosa? Lr. No. Ga ba le teng fela. M. What happens during their absence? Lr. Re bua Setswana. M. Ok. So go monate nee. You enjoy the relatives, because now you speak their language. So, do you understand Setswana better than English or English better? Do you like Mathematics? Lr. Yes. M. Is it difficult? Lr. Sometimes. M. So you did this Geometry with Mr. P. Lr. Yes. M. I want you to tell me something about this Geometry. Lr. Ke gore e re ruta ka diangle. M. OK. E lebile diangles. Lr. Ee. E re bontsha measurement ya diangle. M. The measurements ya diangle, and what else? Was there anything	L.: Yes. T.: Do you have brothers and sisters? L.: Yes. T.: How many brothers? L.: One. T.: Sisters. L.: One. T.: What language do you speak at home? L.: Setswana. T.: What other languages do you speak - besides Setswana? L.: Xhosa. T.: When did you learn isiXhosa and Setswana? L.: I've done Setswana from my childhood and learned isiXhosa on my own. T.: OK. Why do you speak Xhosa now? L.: My relatives speak Xhosa. T.: So, whether your relatives are there or not do you still continue to speak Xhosa? L.: No, when my relatives are at home. T.: What happens during their absence? L.: We speak Setswana. T.: OK. It sounds very interesting. You enjoy the relatives, because now you speak their language. So, do you understand Setswana better than English or English better? Do you like Mathematics? L.: Yes. T.: Is it difficult? L.: Sometimes. T.: So you did this Geometry with Mr. P. L.: Yes. T.: I want you to tell me something about this Geometry. L.: It is all about angles. T.: OK. Geometry is based on angles. L.: Yes, plus the measurements of the angles. T.: The measurements of the angles, and what else? Was it difficult for
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difficult for you maybe? Lr. Yes. M. Like what? Lr. Like bodikhutlomabapi ke tsona tse e ka reng di a ntsietsa. M. The problem is the Setswana terms or English terms? Lr. Tswana. M. Setswana terms? Lr. Yes. M. O rata go kwala Maths ka Setswana or English. Lr. Ka English. Ke gore diterms ke di tlwaetse ka English thata. M. So, you mean gore, diterms tse ka Setswana di difficult, but ka English they are better. Lr. Yes M. O ka rata go kwala question paper, in Setswana? Lr. Yes. M. Gape wa re Setswana terms di matsapa? Lr. Ke gore di mpha bothata. M. O ka rata listi ya mafoko ka English o be o kwala tests ka Setswana? Lr. Yes. Ke kgona go tlhaloganya ka pele. M. Ka speed? Lr. Yes. M. O tla tsaya nako go tlhaloganya list ya mafoko a Setswana. Lr. Yes. M. It sounds very interesting. Mr P. used much of the Setswana than English or English than Setswana. Lr. English go na le Setswana. M. Yes. R.esearcher: But did he speak English more than Setswana in Geometry or was it the same? Lr. It is not the same. M. Is not the same? Lr. Yes. M. Ko Geometry o user English?	you? L.: Yes. T.: Like what? L.: Adjacent angles are problematic. T.: The problem is the Setswana terms or English terms? L.: Setswana. T.: Setswana terms? L.: Yes. T.: Would you like to write Mathematics in Setswana or English? L.: In English because I'm used to English terms. T.: So, do you mean that English terms are much better than Setswana terms. L.:Yes, they are much better in English. T.: Would you like to write your question paper in Setswana? L.: Yes. T.: Simultaneously, you feel that Setswana terms are problematic. L.: Yes, Setswana terms give me problems. T.: Would you like to have the list of words in English and write your tests in Setswana? L.: Yes, and I would understand better. T.: Better? L.: Yes. T.: So it is a matter of time to before you understand this list of Setswana words. L.: Yes. T.: It sounds very interesting. Mr P. used much more Setswana than English or English than Setswana. L.: He used much more English than Setswana. T.:Yes. R.:But did he speak English more than Setswana in Geometry or was it the same? L.: It is not the same. T.: Is not the same? L.: Yes. T.: He used English in Geometry?
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Lr. Ke gore English thata go na le Setswana. M. Jaaka algebra, o user eng? Like maybe the other program not the same as this one? Lr. O ntse a dirisa English. R. In this Geometry program, did he used more English or not? Lr. He used more English than Setswana. M. So, you said this terminology is more difficult in Setswana than English, because Mr P. uses more English than Setswana Lr. O na le go dirisa Setswana. M. These Geometry notes also had the Setswana explanatiosn. How do you feel about it? Lr. Ke feela betere ka gore o kgona gore ga go kwadilwe ka English le Setswana o kgona go tshwarelela ka pele. M. So, it helps you to understand better, because if you want to say something you don't know you will go to Setswana. Dinotes tsa Setswana di a go thusa? Lr. Yes. M. So it helps you to understand Geometry better? Lr. Yes. M. A dinotes tsa Setswana terms le English terms for glossary, o ka di rata? O ne o tla nna better to understand Geometry? Lr. Ee. M. So, it seems you don't like the Setswana terms, David? Lr. Mo Mmetsheng. M. Mo Mmetsheng. Especially when it comes to Maths? Lr. Ee. M. Diproblematic? Lr. Yes. M. Do you think they are necessary? Lr. Yes, tsona di a thusa mole le mole. M. Oh. They help so that you can understand, but still you feel you can	L.: The teacher used much more English than Setswana. T.: What other languages do the teacher use for algebra and other programmes? L.: He uses English. R.: In this Geometry programme - did he use more English or not? L.: He used much more English than Setswana. T.: So, you said this terminology is more difficult in Setswana than English, because Mr P. used more English than Setswana. L.: Sometimes he used Setswana. T.: This Geometry notes also had the Setswana explanations. How do you feel about it? L.: I feel much good because the usage of both English and Setswana make it better to understand. T.: So, it helps you to understand better, because if you come across any problem in other language you refer to Setswana. Did it help to have the Setswana notes? L.: Yes. T.: So it helped you to understand Geometry better? L.: Yes. T.: Would you like to have the notes and glossary in both Setswana and English? Would it help you to understand geometry better? L.: Yes. T.: So, it seems you don't like the Setswana terms, David? L.: In Mathematics. T.: Especially when it comes to Mathematics? L.: Yes. T.: Is it problematic? L.: Yes. T.: Would you say that the terms are necessary? L.: Yes, they helped here and there. T.: Oh. They helped so that you can understand, but still you feel you can
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<i>still do without them.</i> <i>Lr. Yes.</i> <i>M. Geometry e na le explanations tsa Setswana. Did they help you?</i> <i>Lr. No.</i> <i>M. O rata English?</i> <i>Lr. Yes.</i> <i>M. So, according to you the Setswana terms are wasting your time?</i> <i>Lr. Yes.</i> <i>R. Go tla nna better for you to use the English notes?</i> <i>Lr. Yes, and English only.</i> <i>R. English only?</i> <i>Lr. Yes.</i> <i>M. So even in the test - would you like to write in English?</i> <i>Lr. Yes.</i> <i>M. Not English and Setswana?</i> <i>Lr. No, English.</i> <i>R. OK. There was a list with the test. Did Mr. P. give you the list when you write the test with the Setswana terminology?</i> <i>Lr. Yes. He gave us but I did not use it.</i> <i>R. You did not use it?</i> <i>Lr. Yes.</i> <i>M. Because you prefer English?</i> <i>Lr. Yes.</i> <i>R. OK. Thanks.</i>	<i>still do without them.</i> <i>L.: Yes.</i> <i>T.: This Geometry notes also had the Setswana explanations. Did they help you to understand?</i> <i>L.: No.</i> <i>T.: Do you prefer English terms?</i> <i>L.: Yes.</i> <i>T.: So, according to you the Setswana terms are wasting your time?</i> <i>L.: Yes.</i> <i>R: Do you feel that it will help you if you use the English notes?</i> <i>L.: Yes, and English only.</i> <i>R.: English!</i> <i>L.: Yes.</i> <i>T.: So even in the test – would you like to write it in English?</i> <i>L.: Yes.</i> <i>T.: Not English and Setswana?</i> <i>L.: No, English.</i> <i>R.: OK. There was a list with the test. Did Mr. P. give you the list when you write the test with the Setswana terminology?</i> <i>L.: Yes. He gave us but I did not use it.</i> <i>R.: You did not use it?</i> <i>L.: Yes.</i> <i>T.: Because you prefer English?</i> <i>L.: Yes.</i> <i>R.: OK. Thanks.</i>
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ANNEXURE 10: GLOSSARY

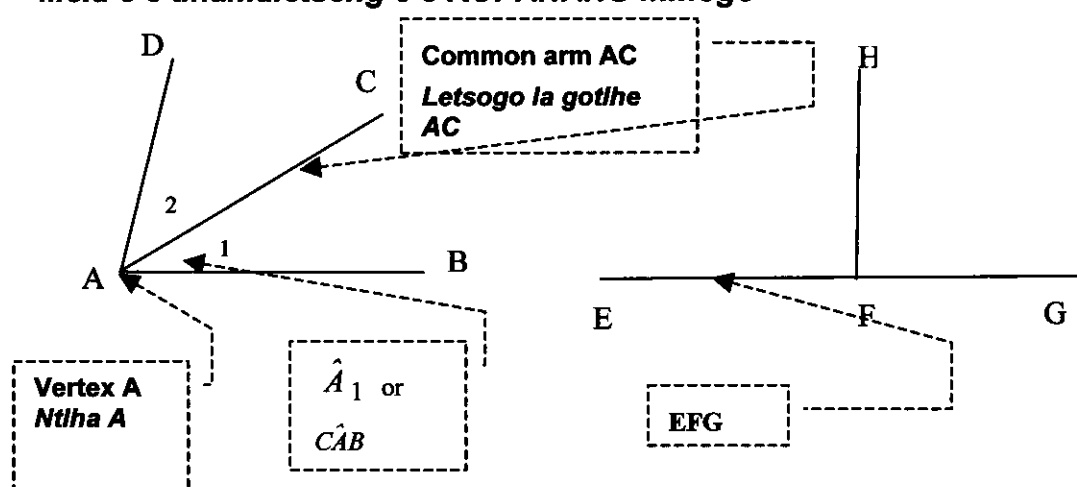
LIST OF WORDS

Straight lines	<i>Mela e e tlhamaletseng</i>
Common arm	<i>Letsogo-gotlhe</i>
Vertex	<i>Ntlha</i>
Angle	<i>Khutlo</i>
Adjacent angles	<i>Dikhutlomabapi</i>
Worksheet	<i>letlharebodirelo</i>
Intersect	<i>kopanang</i>
Vertically opposite angles	<i>Dikhutlotsepamo-tebagano</i>
Transversal	<i>Molakgabaganyo</i>
Horizontal line	<i>Mola o o rapameng</i>
Alternate angles	<i>Dikhutlo-thefosano</i>
Corresponding angles	<i>Dikhutlo-tsamaelano</i>
Co-interior angles	<i>Dikhutlogare mmogo</i>
Theorems	<i>Diteoreme</i>
Parallel lines	<i>Mela e e bapileng</i>
R.T.P. required to proof <i>E</i>	<i>Tlhoka go bontshiwa</i>
Statement	<i>Polelo</i>
Reason	<i>Lebaka</i>
Proof that	<i>Bontsha gore</i>
Summary	<i>Tshobokanyo</i>

ANNEXURE 11: NOTES GIVEN TO THE LEARNERS IN THE INTERVENTION PROGRAM

MELA E E TLHAMALETSENG LE DIKHUTLO TSE DI BOPIWANG KE FA MELA E E TLHAMALETSENG E KOPANA.
STRAIGHT LINES AND THE ANGLES FORMED WHEN STRAIGHT LINES MEET OR INTERSECT

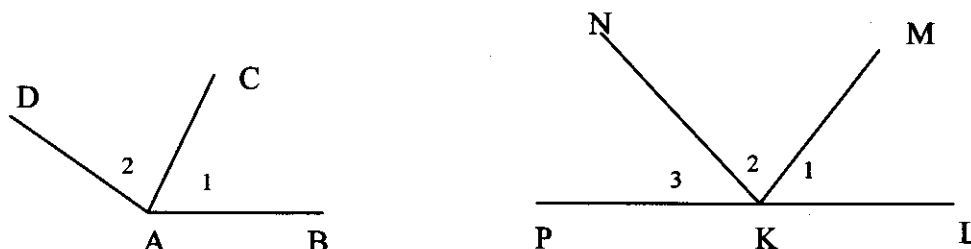
1. **Straight lines that MEET each other**
Mela e e tlhamaletseng e e KOPANANG mmogo



- **Vertex:** The point where the lines meet is called a **vertex (plural vertices)**. *Ntlha:* Lefelo le mela e kopanang mo go lona le bidiwa *ntlha (dintlha bontsi)*.
- **Angle $\hat{A}_1$ and $\hat{A}_2$.** (The little "hat" on the A means angle)
Khutlo $\hat{A}_1$ le $\hat{A}_2$. ("Kapinyana" e e mo godimo ga A e kaya khutlo)
- **Common arm AC** is the line (arm) of the two angles that they share
Letsogo-gotlhe AC ke mola (letsogo) wa dikhutlo tse pedi tse di o aroganang

1.1 Adjacent angles \Dikhutlomabapi

What is adjacent angles? \Dikhutlomabapi ke eng?



Adjacent angles have \Dikhutlomabapi di na le:

- one **vertex** \ntlha e le nngwe;
- one or more **common arm(s)** \letsogo-gotlhe le le lengwe kgotsa a le mmalwa;
- the angles are on **different sides of the common arm**.
dikhutlo di mo dintlheng tse di farologaneng tsa letsogo gotlhe.

EXERCISE 1 \ TIRO 1

1. $\hat{A}_1$ and adjacent angles, $\hat{K}_1$ and and are adjacent angles\ $\hat{A}_1$ le
dikhutlo mabapi, $\hat{K}_1$ le le..... Ke dikhutlomabapi

2. Is it possible that more than two angles can be adjacent? Explain.
A go a kgonega gore dikhutlo tse di fetang bobedi di ka nna mabapi? Tlhalosa.

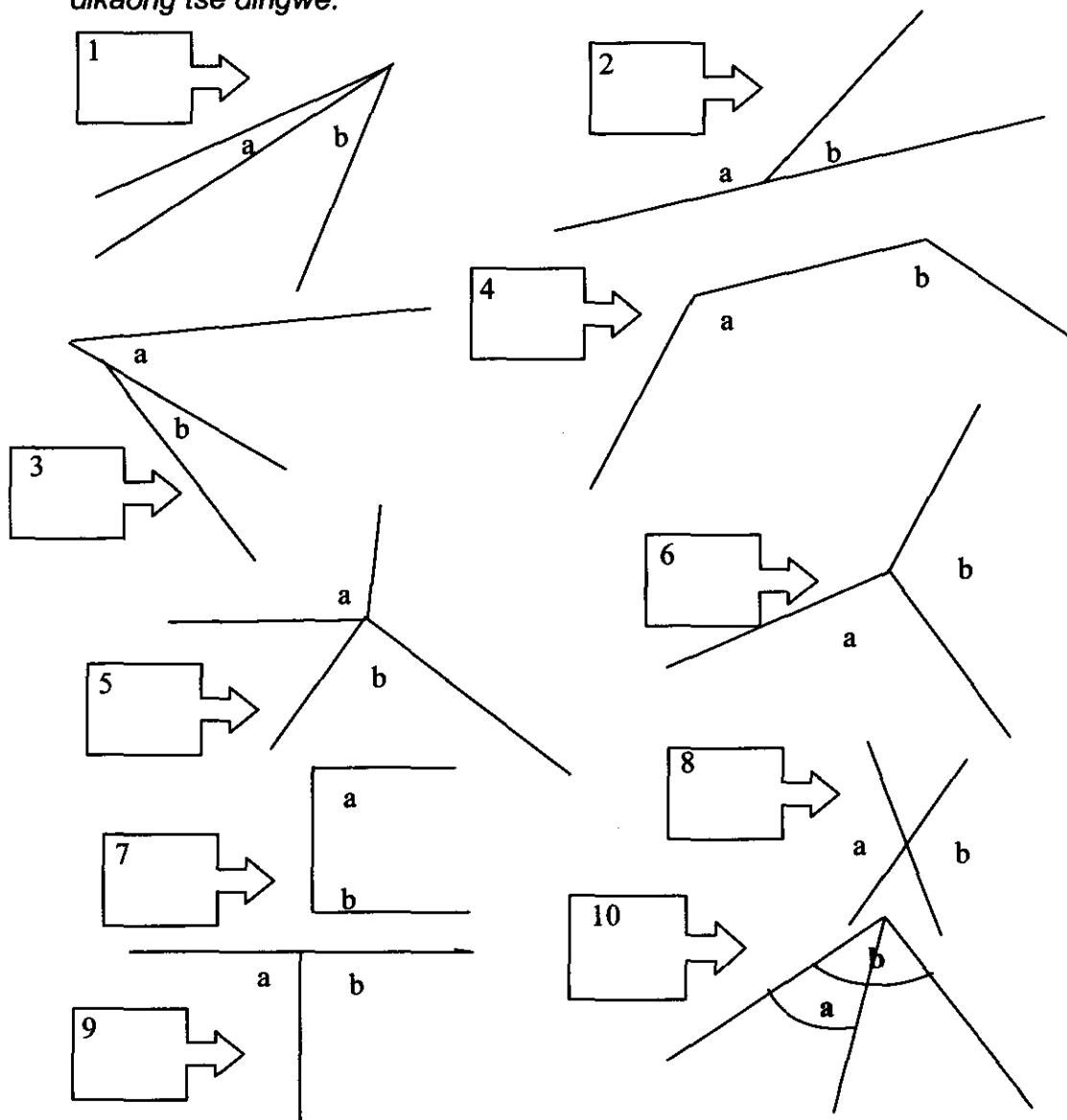
3. Do worksheet 1\ *Dira letlharebodirelo la 1*

4. **After** you have done **worksheet 1**, draw your own figure to show THREE adjacent angles/*Morago ga go dira letlharebodirelo la 1, thala sethalo sa gago go bontsha dikhutlo mabapi di le THARO*

**FIGURE WITH THREE ADJACENT ANGLES
 SETHALO KA DIKHUTLO MABAPI DI LE THARO**

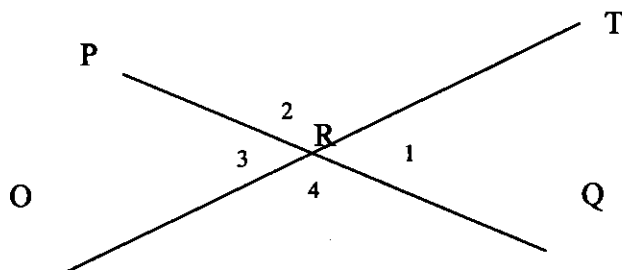
Worksheet 11 Letlha e potlako

- For each figure decide if **a** and **b** are adjacent angles. Write yes or no in the box beside each figure. *Mo sethalong sengwe le sengwe sweetsa gore a a le b ke dikhutlo mabapi. Kwala Ee kgotsa Nnyaya mo lebokosong go bapa le sethalo sengwe le sengwe.*
- For each figure that you have said **YES**, mark the **common vertex**, the **common arm**, and mark the angles with **✓** to show that it is on **different sides of the common arm**. (See no 1 for an example). *Mo sethalong sengwe le sengwe se o rileng Ee, tshwaya ntlha ya gotlhe, ya letsogogotlhe, mme o tshwaye dikhutlo ka ✓ go supa gore e mo lethakoreng le le farologaneng la letsogogotlhe. (Leba palo 1 jaaka sekao).*
- Discuss in your groups why you said NO for the other examples. *Buisanang mo ditlhopheng tsa lona gore ke eng o rile Nnyaya mo dikaong tse dingwe.*



2. Straight lines that intersect Mela e e tlhamaletseng e e kopanang:

These lines do not only meet, but they also **intersect with** (cut) each other. Mela e ga e kopane fela, mme e **putlagana gape le** (segana) e mengwe.



1. R is the **point of intersection**, with angles $\hat{R}_1, \hat{R}_2, \hat{R}_3, \hat{R}_4$

R ke lefelo la kopanelo, ka dikhutlo $\hat{R}_1, \hat{R}_2, \hat{R}_3, \hat{R}_4$

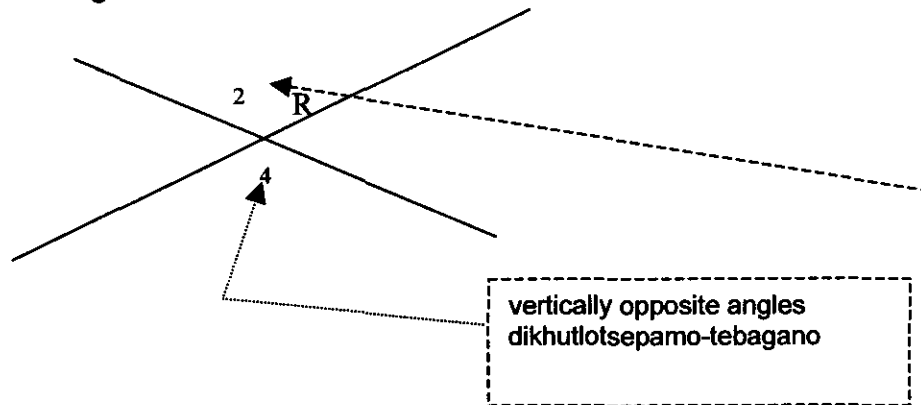
TIRO 2

1. Can you see any adjacent angles? \A o kgona go bona dikhutlo mabapi dingwe?
.....
2. Write down as many **pairs (two)** adjacent angles that you can see. \Kwala **dipara (bobedi)** tsa dikhutlo mabapi tse o ka di bonang ka bontsi jo o ka bo kgonang.
.....
3. Can you see **three** angles that are adjacent? Write as **many groups of three** adjacent angles as you can see. \A o ka bona dikhutlo di le **tharo** tse di mabapi? Kwala **dithopha di le dintsi** tsa dikhutlo mabapi tse tharo tse o ka di bonang.
.....

2.1 Vertically opposite angles \Dikhutlotsepamo-tebagano

Vertically opposite angles are formed at the **intersection** of two straight lines.

Dikhutlotsepamo-tebagano di bopiwa mo makopanelong a mela e mebedi e e tlhamaletseng.



EXERCISE 3 \TIRO 3

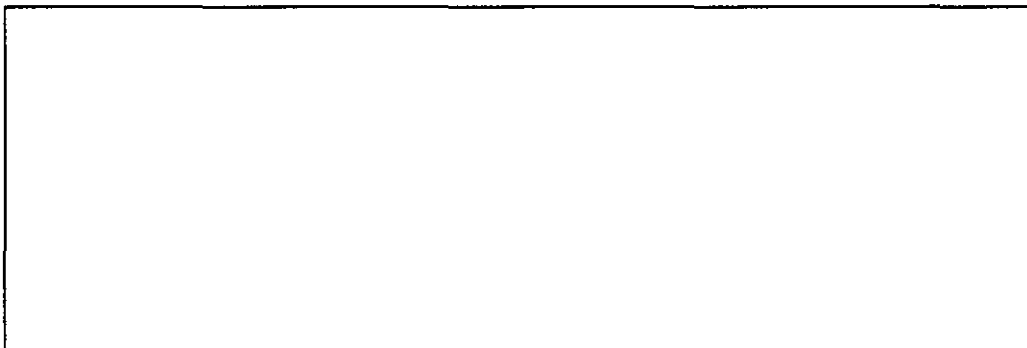
1. Write down the numbers of a pair of **vertically opposite** angles that you see in the figure above. \Kwala dipalo tsa para ya **dikhutlotsepamo-tebagano** tse o di bonang mo sethalong se se fa godimo.

.....

2. Write numbers for **another pair** of vertically opposite angles on the figure. \Kwala dipalo go para e nngwe gape ya dikhutlotsepamo-tebagano mo sethalong.

.....

3. Try to draw a figure with **three** angles that are vertically opposite. \Leka go thala sethalo se se nang le dikhutlo di le **tharo** tse di tsepameng di lebagane.



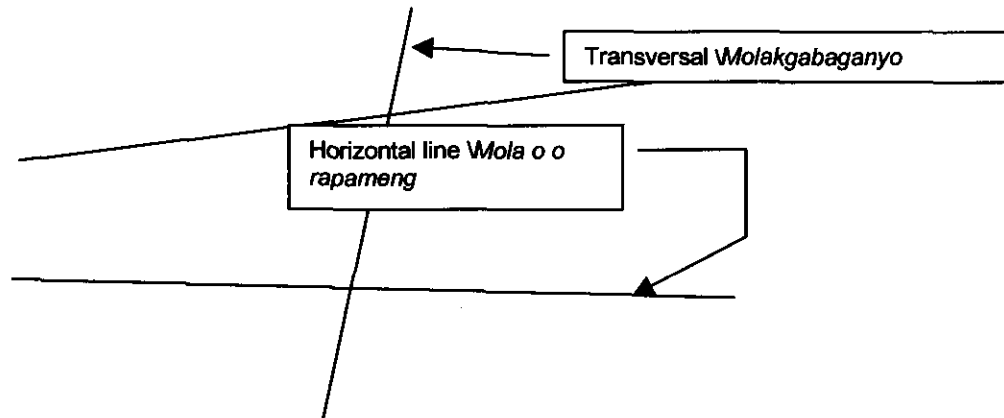
4. Is it possible? If you say YES write the numbers of the vertically opposite angles. If you say NO try to explain why not. \A go a kgonega? Fa o re EE kwala dipalo tsa dikhutlotsepamo-tebagano. Fa o re NNYAYA leka go tlhalosa gore ke eng go sa kgonege.

.....

2.2 Two horizontal lines with a transversal Mela e mebedi e e rapameng e na le molakgabaganyo

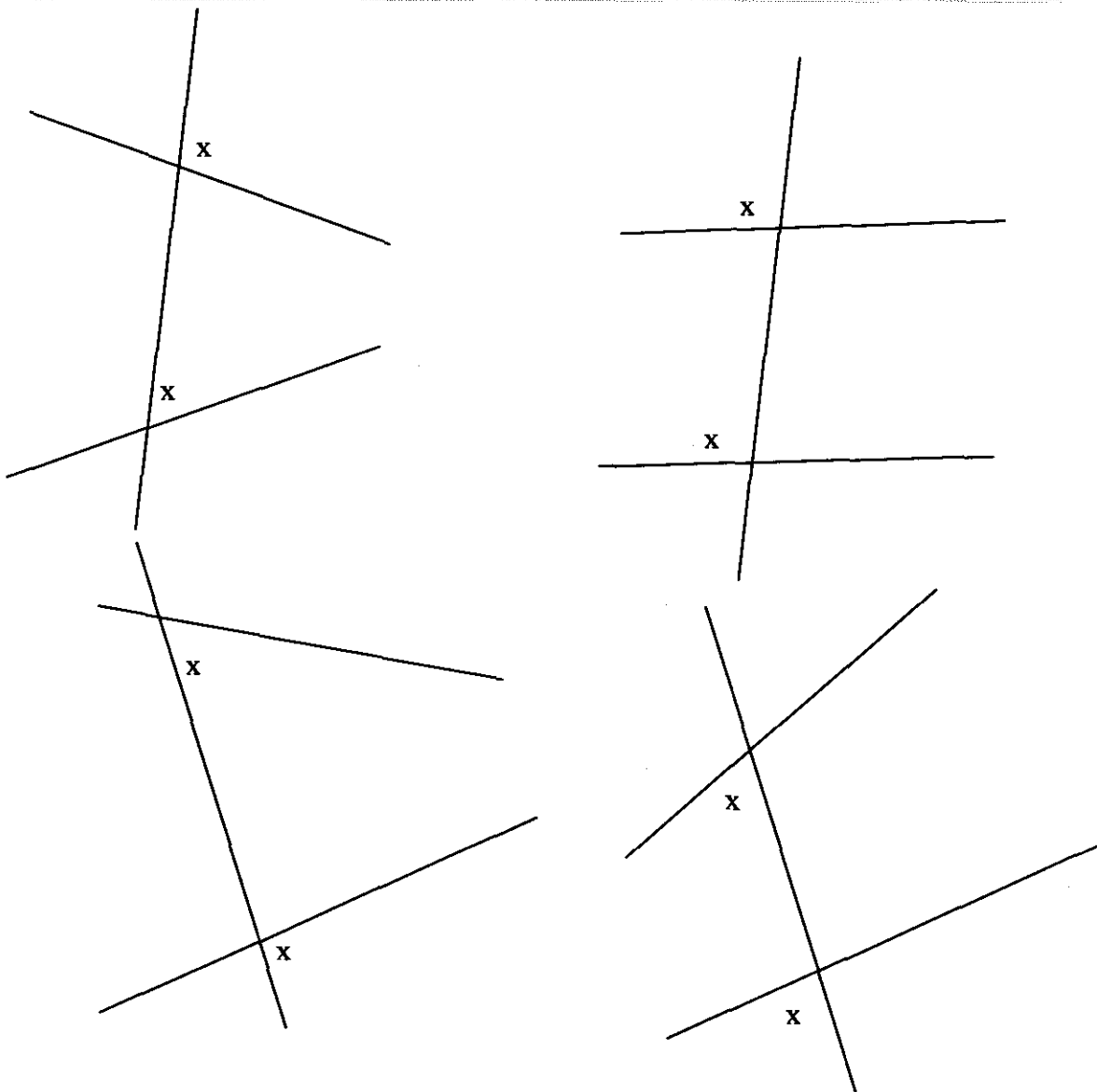
Transversal: A vertical line that cut two or more horizontal lines.\

Molakgabaganyo: Mola o o tsepameng o o kgabaganyang mela e mebedi kgotsa e le mmalwa e e rapameng.



WORKSHEET 2 \LETLHAREBODIRELO 2

1. Find the shortest sentence that will describe the pairs of angles in the figures below – the short description must apply to all four figures. \Batla polelo e khutshwakhutshwane e e tla tlhalosang dipara tsa dikhutlo mo dithalong tse di fa tlase – tlhaloso e khutshwane eo e tshwanetwa ke go dira mo dithalong tsothe tse nne.



Description

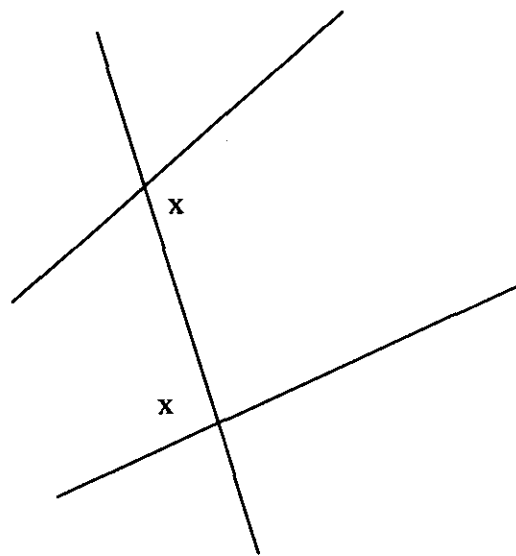
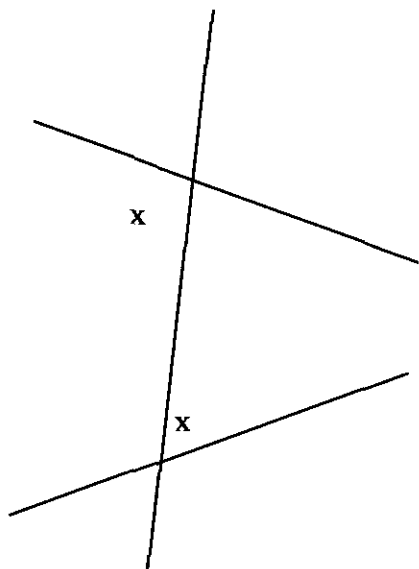
\Tlhaloso.....

.....

The mathematical name is \Leina la Mmetse ke:

.....

2. Find an appropriate **common description** for the pair of angles in the two figures below. *\Batla tlhaloso e e tshwanang e e maleba ya para ya dikhutlo mo dithalong tse pedi tse di fa tlase*

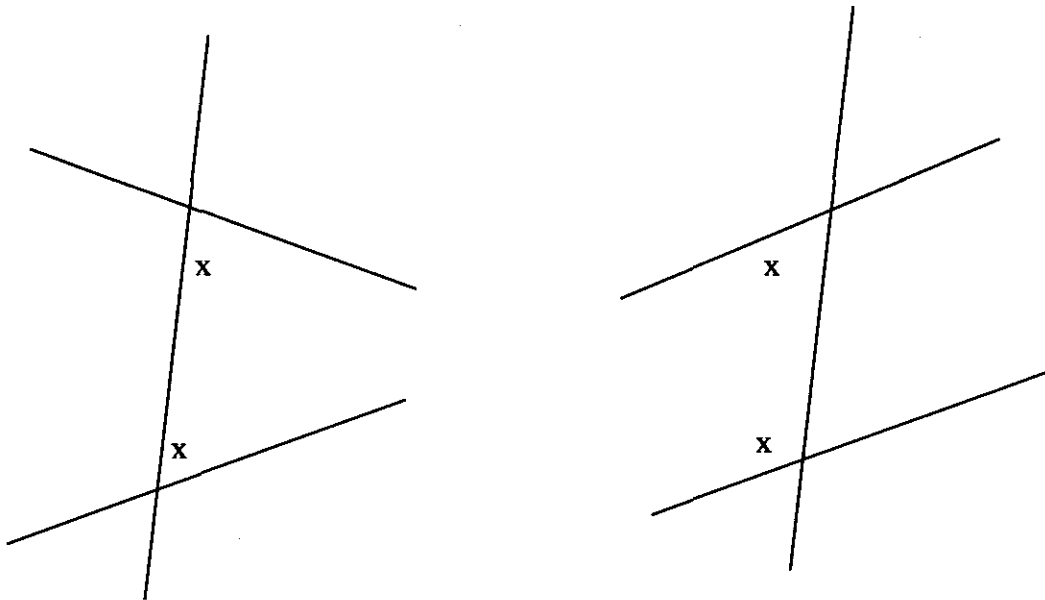


Description\Tlhaloso:.....

The mathematical name is \Leina la Mmetse ke:

.....

3. Find an appropriate common description for the pair of angles in the two figures below. / Batla tlhaloso e e tshwanang ya para ya dikhutlo mo dithalong tse pedi tse di fa tlase



Description\Tlhaloso:.....

.....

The mathematical name is \Leina la Mmetse ke:

.....

WORKSHEET 3 \LETLHARE-BODIRELO 3

1. Use figure 1 and determine \Dirisa sethalo sa 1 mme o batle:

- (a) One transversal \Molakgabaganyo o le mongwe.....
- (b) Two pairs of alternate angles \Dipara di le pedi tsa dikhutlo-thefosano.....
-
- (c) Two pairs of corresponding angles \Dipara di le pedi tsa dikhutlo-tsamaelano....
-
- (d) One pair of adjacent angles \Para e le nngwe ya dikhutlomabapi.....
- (e) One pair of vertically opposite angles \Para e le nngwe ya dikhutlotsepamo-
tebagano.....

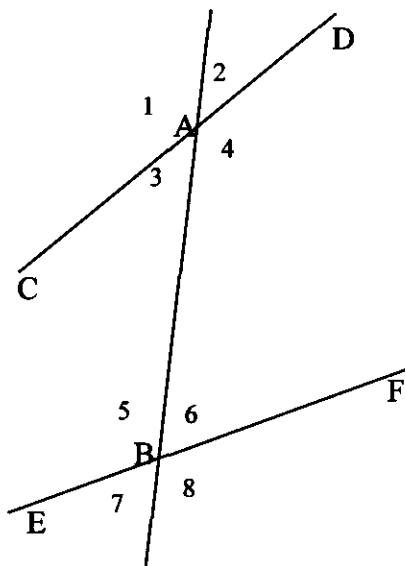


Fig. 1 \Sethalo 1

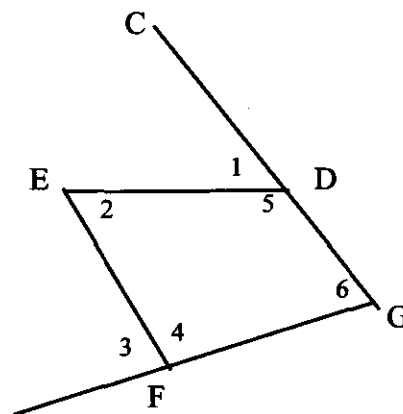


Fig. 2 \Sethalo 2

2. Use figure 2 and determine \Dirisa sethalo sa 2 mme o battle

- (a) Two pairs of corresponding angles \Dipara di le pedi tsa dikhutlo-tsamaelano
-
- (b) Two pairs of alternate angles \Dipara di le pedi tsa dikhutlo-thefosano
-
- (c) Two pairs of co-interior angles \Dipara di le pedi dikhutlogare mmogo
-

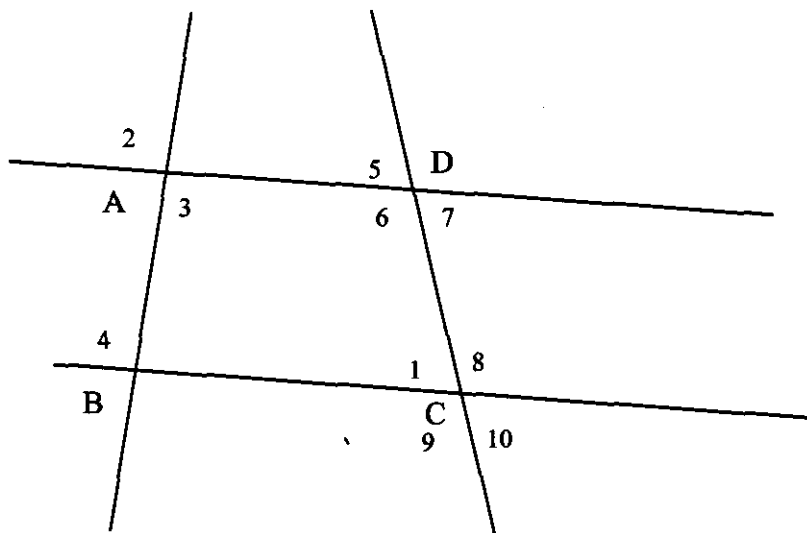


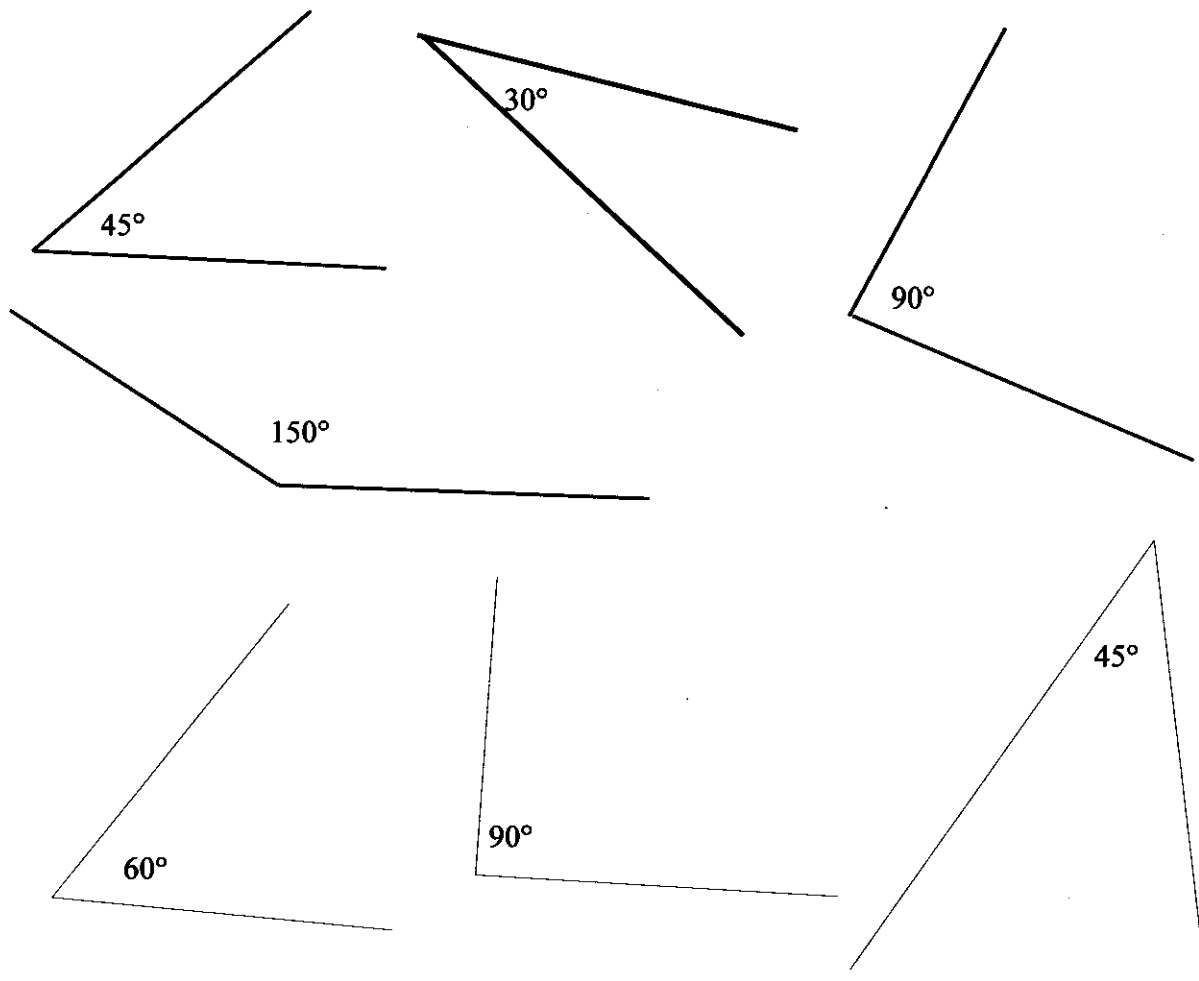
Fig 3\Sethalo 3

- 3.1 (a) $\hat{A}_2$ and $\hat{B}_4$ are $\hat{A}_2$ le $\hat{B}_4$ ke angles\dikhutlo
- (b) $\hat{A}_3$ and $\hat{D}_5$ are $\hat{A}_3$ le $\hat{D}_5$ ke.....angles \dikhutlo
- (c) $\hat{C}_1$ and $\hat{C}_8$ are $\hat{C}_1$ le $\hat{C}_8$ ke..... angles \dikhutlo
- (d) $\hat{D}_5$ and $\hat{D}_7$ are $\hat{D}_5$ le $\hat{D}_7$ ke.....angles \dikhutlo
- 3.2 Decide whether the following statements are true or false and explain why \Sweetsa gore a dipolelo tse di latelang ke nnete kgotsa nnyaya mme o tlhalose goreng o re jalo:
- (a) $\hat{A}_3$ and $\hat{D}_6$ are co-interior angles $\hat{A}_3$ le $\hat{D}_6$ ke dikhutlogare mmogo
-
- (b) $\hat{C}_9$ and $\hat{D}_6$ are vertically opposite angles $\hat{C}_9$ le $\hat{D}_6$ ke dikhutlotsepamo-tebagano.
-
- (c) $\hat{D}_5$ and $\hat{C}_9$ are corresponding angles $\hat{D}_5$ le $\hat{C}_9$ ke dikhutlotsamaelano
-
-(d) $\hat{D}_6$ and C_{10} are alternating angles $\hat{D}_6$ le C_{10} ke dikhutlothefosano
-

3. Theorems \Diteoreme

3.1 Adjacent angles on a straight line \Dikhutlomabapi mo moleng o o tlhamaletseng

WORKSHEET 4\LETLHAREBODIRELO 4



- Cut out the angles \Segolola dikhutlo.
- Fit them together and find as many as possible combinations of angles that will form a straight line. Write down the different combinations \Di lekanye mmogo mme o batle dikopanyo ka bontsi jo bo ka kgonegang jwa dikhutlo tse di tla bopang mola o o tlhamaletseng. Kwala dikopanyo tse di farologaneng

.....

- What do you find? \O bona eng?

.....

- THEOREM\TEOREME:** The sum of the adjacent angles on a straight line is \ Palogotlhe ya dikhutlo mabapi mo moleng o o tlhamaletseng ke

.....

3.2 Vertically opposite angles \Dikhutlotsepamo-tebagano

WORKSHEET 5\LETLHAREBODIRELO 5

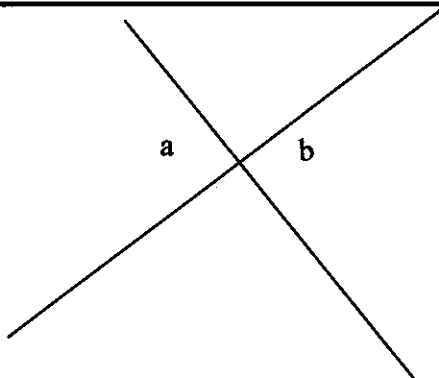


fig 1\sethalo 1

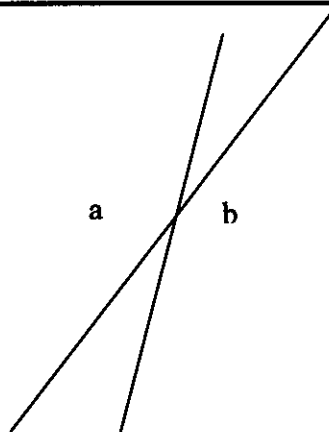


fig 2\sethalo 2

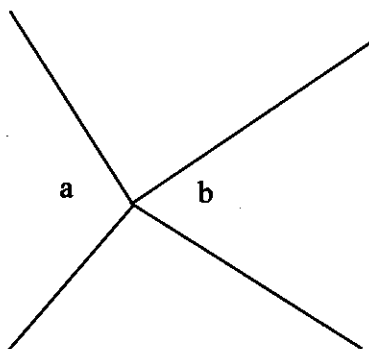


fig 3\sethalo 3

(a) Cut out angle a and b for each figure and fit it on each other. Write down your findings\Segolola sekhutlo a le b mo sethalong sengwe le sengwe mme o bo o se lekanya mo go se sengwe. Kwala dikarabo tsa gago:

(b) Complete\Feleletsa:

In figure 1 a and b \Mo sethalong sa 1 a le b

.....

In figure 2 a and b \Mo sethalong sa 2 a le b

.....

In figure 3 a and b \Mo sethalong sa 3 a le b

.....

Complete\Feleletsa:

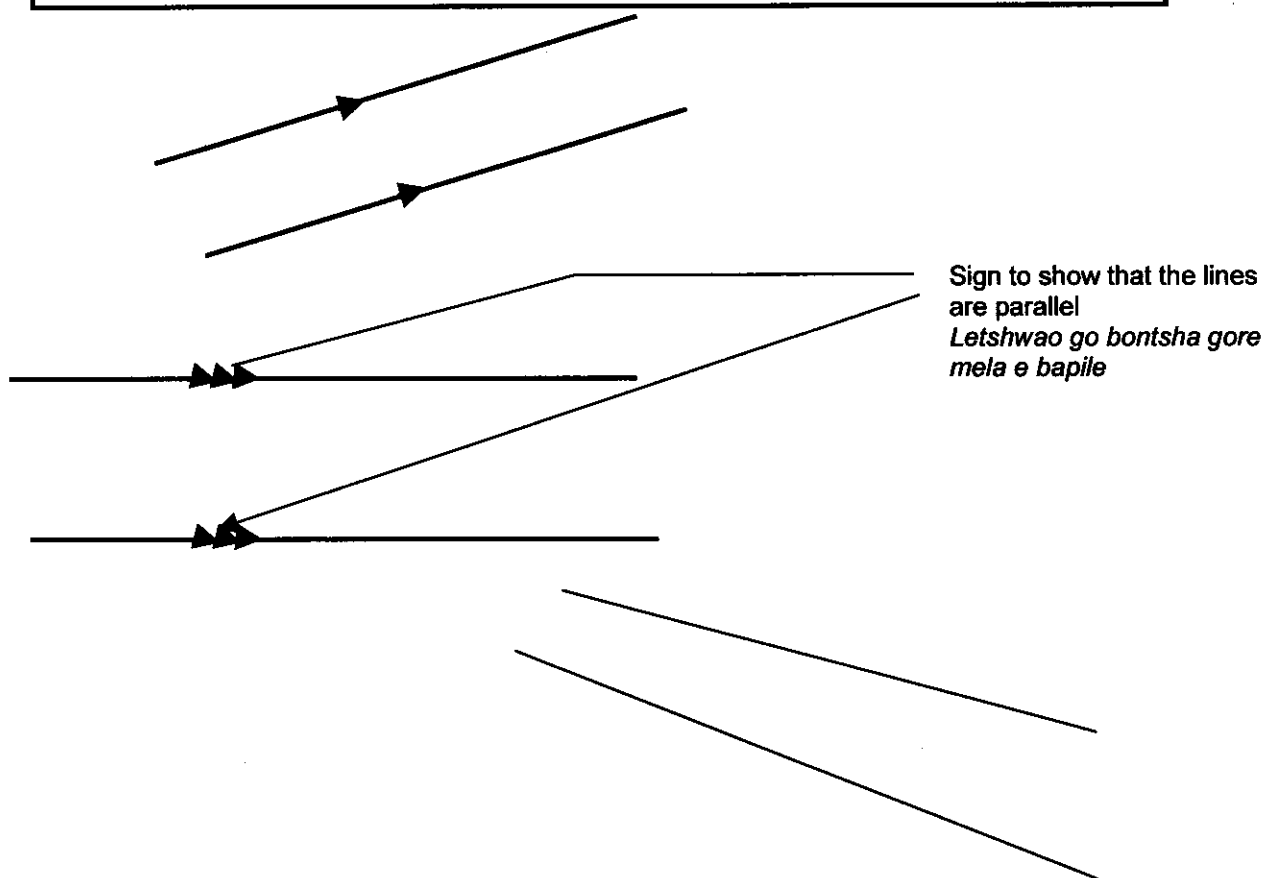
THEOREM: If two straight lines intersect the vertically opposite angles
\TEOREME:

Fa mela e mebedi e e tlhamaletseng e kopana dikhutlotsepamo-tebagano di

.....

3.3 Parallel lines /Mela e e bapileng

WORKSHEET 6/LETLHAREBODIRELO 6



Measure the width of each pair of parallel lines at different places.
Lekanya bophara ba para nngwe le nngwe e e bapileng mo mafelong a a farologaneng.

What do you find \O bona eng

.....

Measure the width of the pair of lines that **are not** parallel at different places.
Lekanya bophara ba para ya mela e e sa bapang mo mafelong a a farologaneng.

What do you find \O bona eng.....

Try to write your own definition of parallel lines\Leka go kwala tlhaloso ya gago ya mela e e bapileng

.....

3.3 Corresponding, alternate and co-interior angles

Dikhutlotsamaelano, dikhutlothefosano le dikhutlogare mmogo

WORKSHEET 7\LETLHAREBODIRELO 7

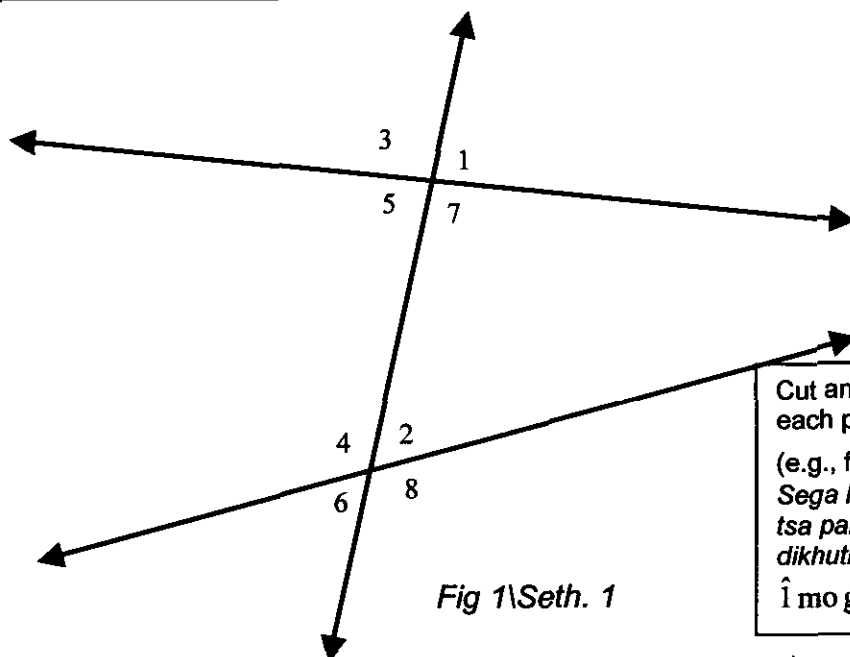


Fig 1\Seth. 1

Cut and Fit together the angles of each pair of corresponding angles. (e.g., fit $\hat{1}$ on $\hat{2}$, etc.)
Sega le go lekanya mmogo dikhutlo tsa para nngwe le nngwe ya dikhutlotsamaelano. (sk., lekanya $\hat{1}$ mo go $\hat{2}$, jj.)

- Repeat the process for fig. 2.

Boeletsa tirego go sethalo. 2.

- Repeat with alternate angles

Boeletsa ka dikhutlothefosano

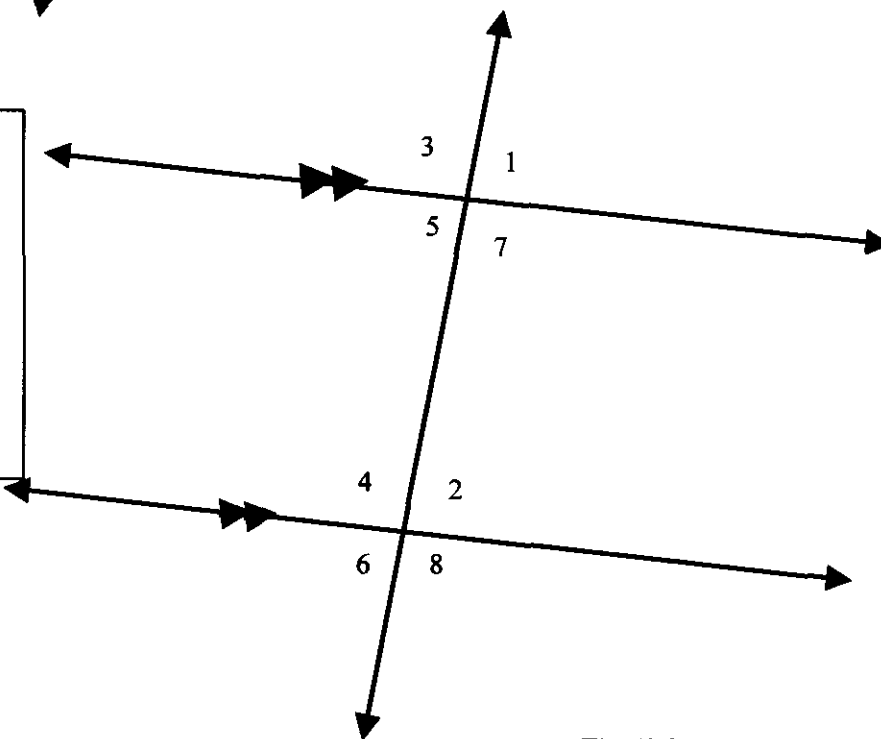


Fig.2\Seth. 2

Conclusions\Dikonotelelo:

If the lines are parallel \Fa mela e bapile.

.....
If the lines are not parallel \Fa mela e sa bapa
.....

WORKSHEET 8\LETLHAREBODIRELO 8

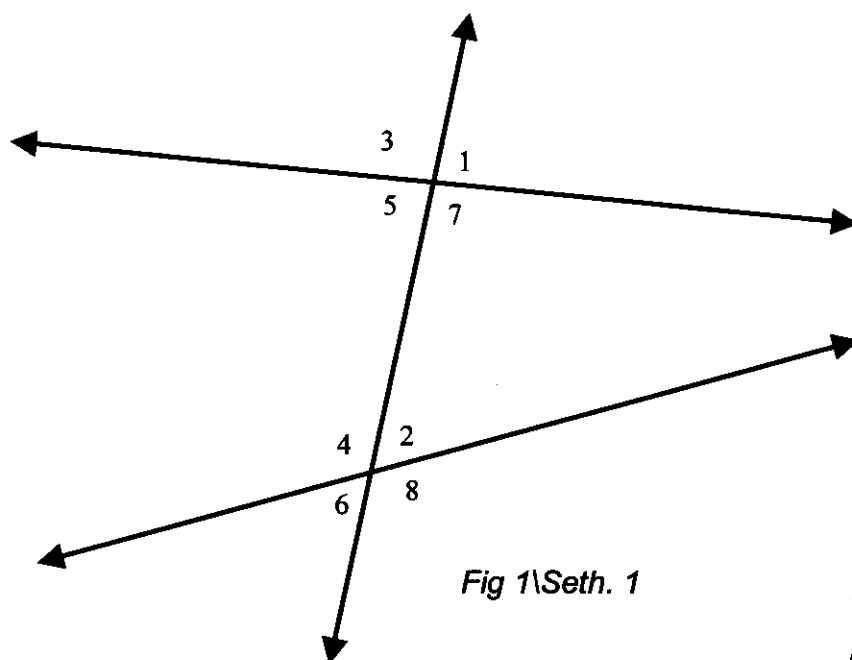


Fig 1\Seth. 1

Cut and Fit together the angles of each pair of ALTERNATE interior angles.

(e.g., fit $\hat{5}$ on $\hat{2}$, etc.)

Sega le go lekanya mmogo dikhutlo tsa para nngwe le nngwe ya THEFOSANO dikhutlogare. (ka sekai, tsenya $\hat{5}$ mo go $\hat{2}$, jj.)

Repeat the process for fig. 2.
Boeletsa tirego go Sethalo. 2.

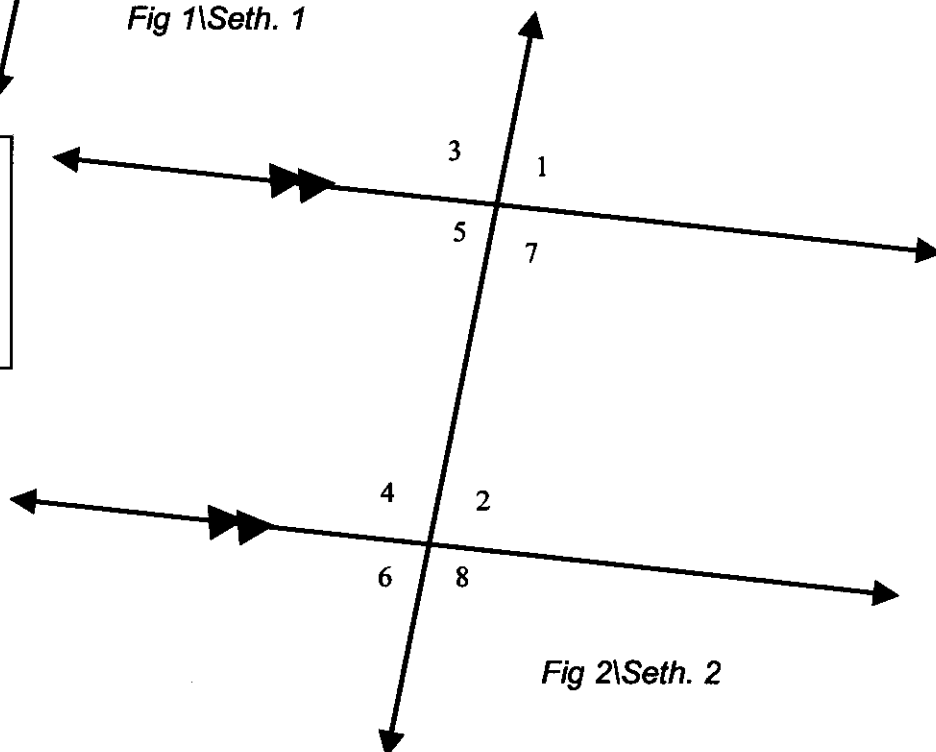


Fig 2\Seth. 2

Conclusions\Dikonotelelo:

If the lines are parallel \Fa mela e bapile.....

.....
If the lines are not parallel \Fa mela e sa bapa

.....

Cut out the pairs of co-interior angles of each diagram and fit each pair on the line. \Segolola dipara tsa dikhutlogare mmogo tsa sethalo sengwe le sengwe o be o lekanya para nngwe le nngwe mo moleng.

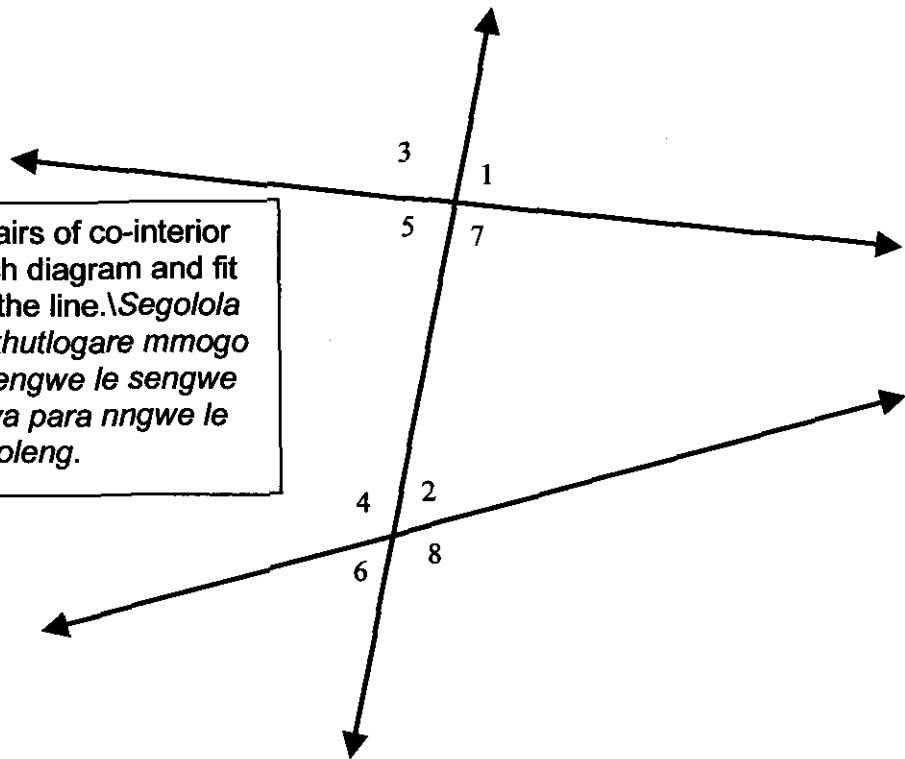


Fig. 3\ Seth. 3

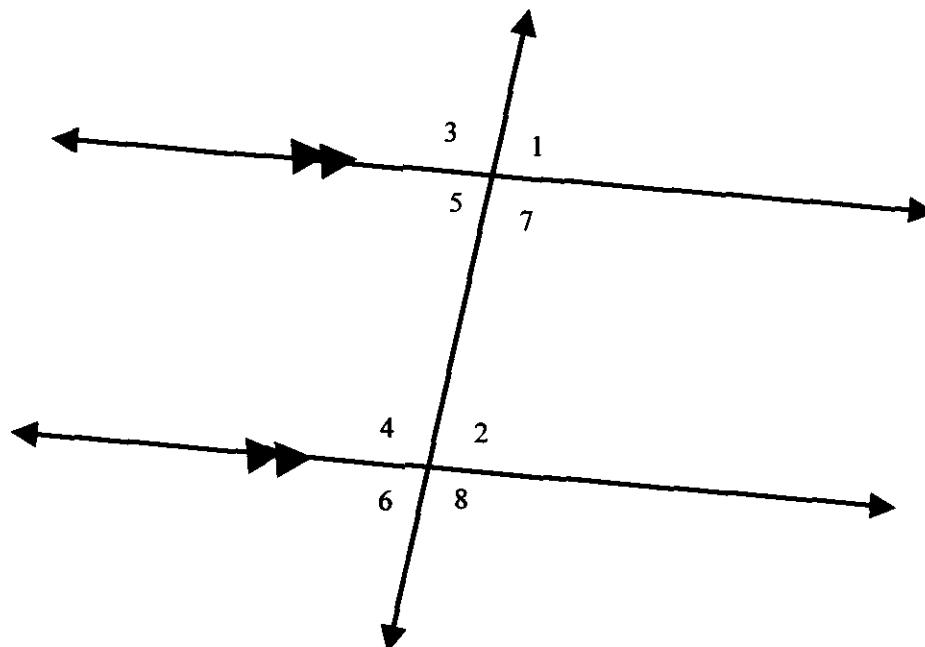


Fig. 4\ Seth. 4



Conclusion\ Dikonotelelo: If the lines are parallel\ Fa mela e bapile

If the lines are not parallel \ Fa mela e sa bapa

WORKSHEET 9\LETLHAREBODIRELO 9

1. Calculate all the unknown, numbered angles and write it on the diagram. Discuss the reasons for each step in your group *Balelela tsotlhe tse di sa itseweng, e le dikhutlo tse di nang le dipalo o be o di kwala mo sethalong. Buisanang ka mabaka a kgato nngwe le nngwe mo setlhopheng sa lona.*

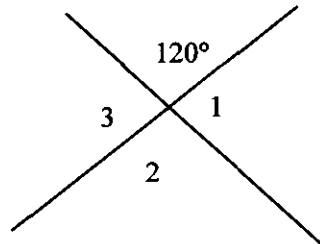


Fig.1\Set. 1

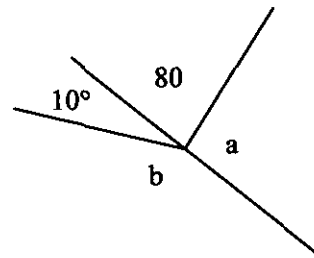


Fig. 2\Set. 2

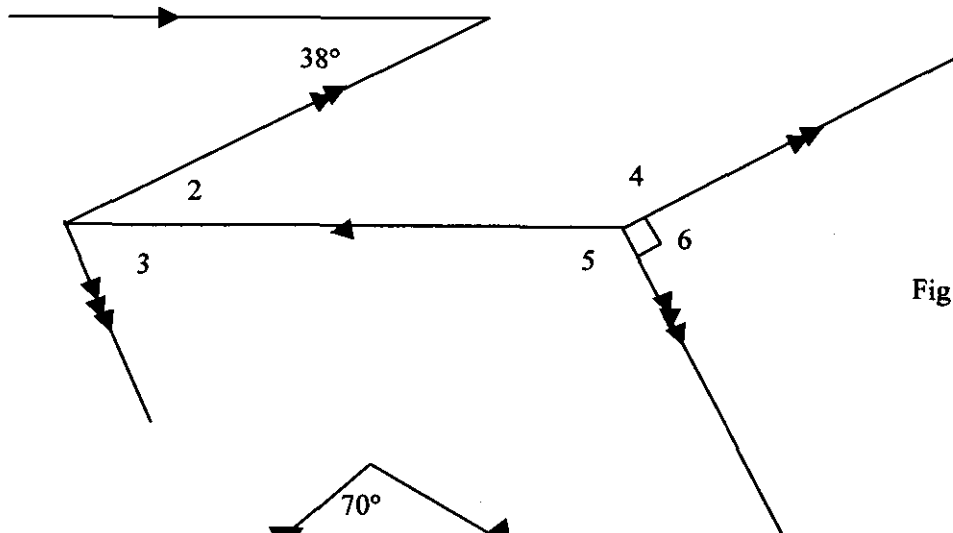


Fig 3\Set. 3

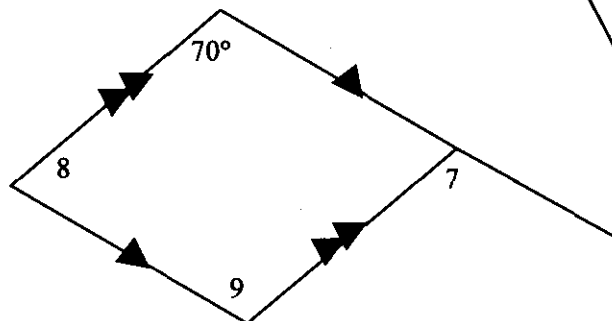


Fig 4\Set. 4

3. Determine whether the following pairs of lines are parallel or not /
Batla gore a dipara tse di latelang tsa mela di bapile kgotsa nnyaya:

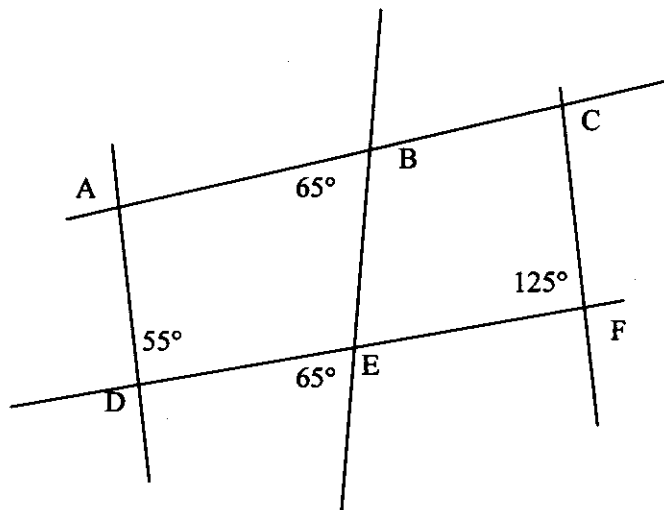


Fig.5\Seth.5

Mark each of the following statements as true or false

Tshwaya nngwe le nngwe ya dipolelo tse di latelang ka Ee kgotsa Nnyaya

- (a) $AB \parallel DE$
(b) $AD \parallel BE$
(c) $BE \parallel CF$

4. Mathematics shorthand \Mokwalokhutshwe(shorthand) wa mmetse

To write the reasons when we do riders (Geometry problems) we use signs to make it shorter \Go kwala mabaka fa re dira dipalotlaleletso (dipalo tsa jometeri) re dirisa matshwao go e khutshwafatsa

- 4.1 The sum of adjacent angles on a straight line is 180° : sum adj. < on str. line = 180°
Palogotlhe ya dikhutlomabapi mo moleng ke 180° : pal.mabp.<mo mol. Tlham. = 180°
- 4.2 Vertically opposite angles are equal: vert. opp. < =
Dikhutlo-tsepamo tebagano di a lekana: tspm. tebg. < =
- 4.3 Corresponding angles are equal if the lines are parallel.: corr. <'s equal, $AB \parallel CD$
Dikhutlotsamaelano di a lekana fa mela e bapile.: tsaml. <'s lekana, $AB \parallel CD$
- 4.4 Alt angles are equal if the lines are parallel.: alt. <'s equal, $AB \parallel CD$
Dikhutlo thefosano di a lekana fa mela e bapile.: thfs. <'s lekana, $AB \parallel CD$
- 4.5 The sum of co-interior angles are equal to 180° if the lines are parallel.: sum of co-int. <'s = 180° , $AB \parallel CD$
Palogotlhe ya dikhutlagare mmogo e lekana le 180° fa mela e bapile.: palo ya tsaml-gar. <'s = 180° , $AB \parallel CD$

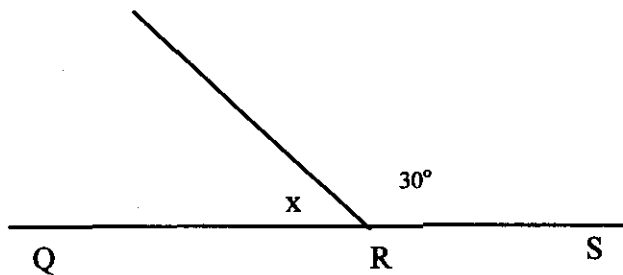
This is only examples. You may create your own shorthand sentences.

\Tse ke dikao fela. O ka itlhamela dipoleo tsa gago tsa mokwalokhutshwane.

WORKSHEET 10\LETLHAREBODIRELO 10

1.

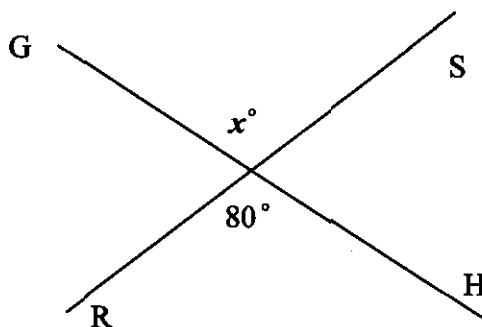
Find x \Batla x



<i>E tlhoka go bontshiwa</i> (R.T.P. required to proof)	STATEMENT \POLELO	REASON \LEBAKA
$x=?$		

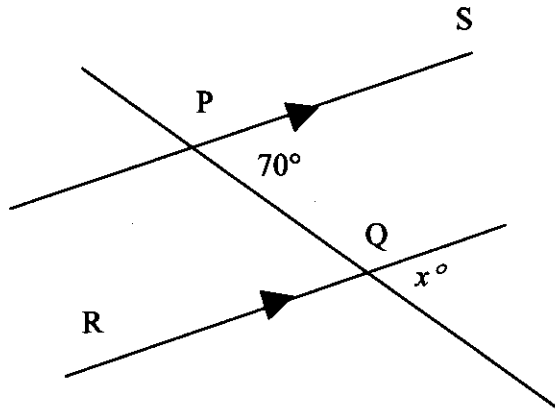
2.

Find x \Batla x



<i>E tlhoka go bontshiwa</i> (R.T.P)	STATEMENT \POLELO	REASON \LEBAKA
$x = ?$		

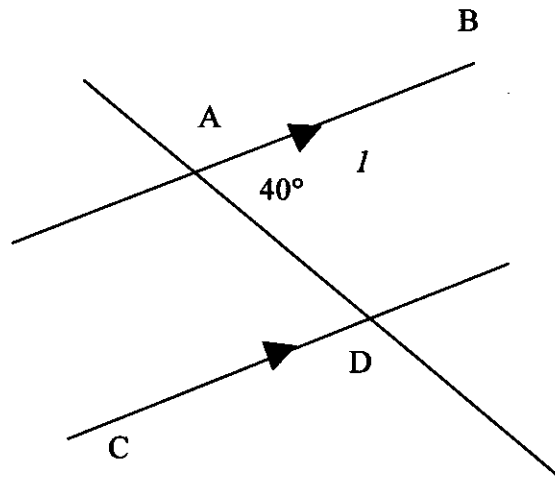
3.



Find x \Batla x

<i>E tlhoka go bontshiwa</i> (R.T.P)	STATEMENT \POLELO	REASON \LEBAKA

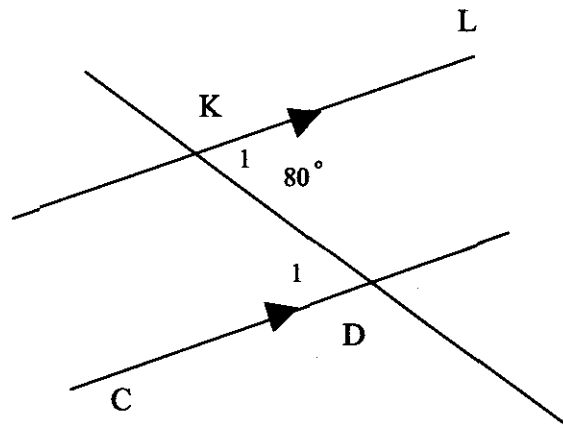
4.



Find $\hat{D}_1$ \Batla $\hat{D}_1$

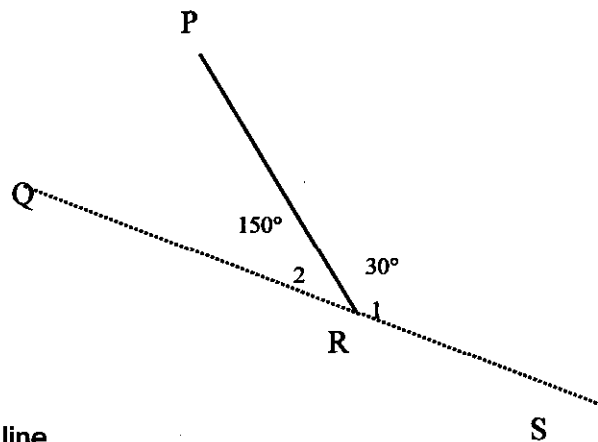
<i>E tlhoka go bontshiwa</i> (R.T.P)	STATEMENT \POLELO	REASON \LEBAKA

5.



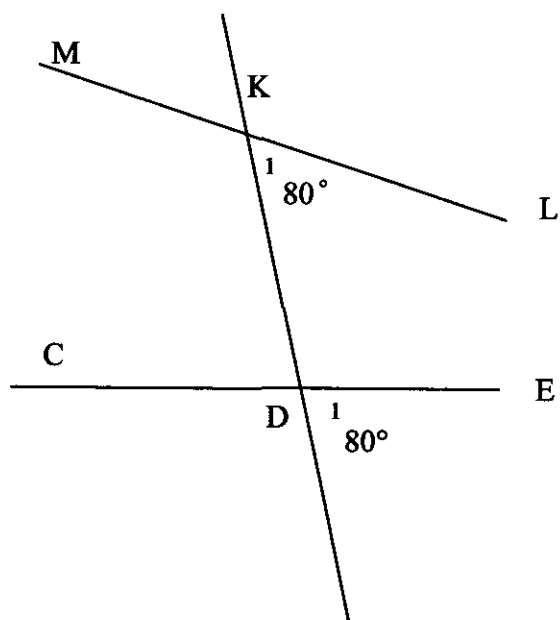
Find $\hat{D}_1$ Batla $\hat{D}_1$

E tlhoka go bontshiwa (R.T.P)	STATEMENT \POLELO	REASON \LEBAKA



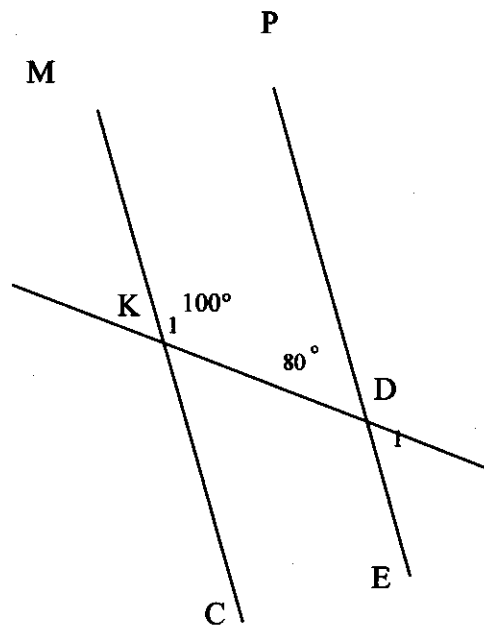
Prove that QRS is a straight line
Bontsha gore QRS ke mola o o tlhamaletseng

E tlhoka go bontshiwa (R.T.P)	STATEMENT \POLELO	REASON \LEBAKA



Prove that $ML \parallel CE$
Bontsha gore $ML \parallel CE$

<i>E tlhoka go bontshiwa (R.T.P)</i>	STATEMENT VPOLELO	REASON VLEBAKA



Prove that $MC \parallel PE$
Bontsha gore $MC \parallel PE$

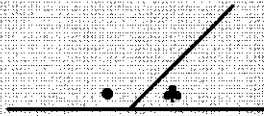
<i>E tlhoka go bontshiwa (R.T.P)</i>	STATEMENT / POLELO	REASON / LEBAKA

SUMMARY \TSHOBOKANYO

GROUP 1 \SETLHOPHA SA 1 Straight lines Mela e e tlhamaletseng

1. The sum of adjacent angles on a straight line is 180°

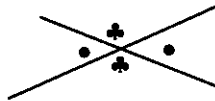
Palogotlhe ya dikhutlomabapi mo moleng o o tlhamaletseng ke 180° .



$$\bullet + \clubsuit = 180^\circ$$

2. If two straight lines intersect, the vertically opposite angles are equal

Fa mela e mebedi e e tlhamaletseng e kopana, dikhutlotsepamo-tebagano di a lekana.



$$\clubsuit = \clubsuit$$

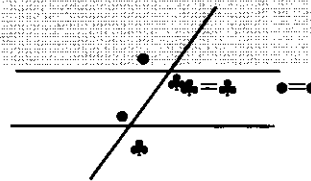
$$\bullet = \bullet$$

2. If two parallel lines are cut by a transversal

Fa mela e mebedi e e bapileng e kgaoganngwa ka molakgabaganyo:

- a) corresponding angles are equal

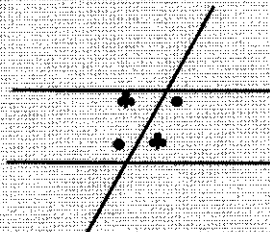
dikhutlothefosano di a lekana



- b) interior alternate angles are equal

dikhutlothefosano tse di mo gare di a lekana

$$\clubsuit = \clubsuit \quad \bullet = \bullet$$



- c) the sum of the co-interior angles are 180°

palogotlhe ya dikhutlogare mmogo ke 180°

$$\bullet + \clubsuit = 180^\circ$$

