TEACHERS' DISCOURSE PRACTICES IN MULTILINGUAL MATHEMATICS CLASSROOMS IN NIGERIAN SECONDARY SCHOOLS

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ABSTRACT

This study focused specifically on the Discourse practices of Mathematics teachers in multilingual classrooms of secondary schools in Nigeria. The Secondary School Mathematics classrooms were observed using the lens of Gee's Discourse analysis theory and method and were to enable me to closely examine and understand the challenges of teachers in multilingual classrooms. The Discourse practice main categories (language and non-language practices) enabled me to identify and understand what mathematical Discourse practices existed in the multilingual classrooms. The main research question was: What Discourse practices were used by teachers as plainly evinced in their language (verbal and non-verbal) in northern Nigeria multilingual Mathematics classrooms? To answer this research question, I used these sub-questions

i. How do teachers use language (verbal and non-verbal) to enact practices as reflected in their Discourses in the teaching and learning of Mathematics in multilingual classrooms in northern Nigeria?
ii. Why do teachers use language (verbal and non-verbal) in their Discourse practices in multilingual Mathematics classrooms of northern Nigeria?

The study adopted a qualitative research design. As is the case with most qualitative methods, the sample in this study was small and purposive. The sample consisted of four purposively selected multilingual Mathematics teachers in two Secondary Schools. Data gathering techniques for this study included video observations, written field notes and face-to-face reflective interviews in the Schools and classrooms. The language of description in this study refers to all the categories and sub-categories developed before, during and after my pilot of this study. These categories and sub-categories were developed from Gee's Discourse analysis theory, reviewed relevant literature and the data gathered from the multilingual classrooms of Mathematics teachers. The empirical results of the analysis as presented in Chapters Six to Eight centered on the dominant Discourse practices such as mathematical explaining, mathematical reiterating, mathematical questioning, mathematical symbolising, mathematical re-voicing, mathematical gesturing and mathematical proceduralising. The empirical results of this study also showed that there was a projection of the high status of the identity of the Mathematics teachers. I also observed that Mathematics teacher allowed students to code-switch in their classroom interaction to help them verbalise their thinking as the majority of them were not proficient in the LoLT. The observations in the Mathematics classroom also suggested that teachers used the whole-class participation norm in form of teacher-led discussions and choral responses. In the light of the emergent issues in this study I, therefore, recommend workshops and in-service training for Mathematics teachers. This kind of training will enrich the teachers' knowledge, help them to make enlightened decisions and use contextually appropriate methods of teaching students in multilingual classrooms.

Keywords

Discourse practice; Secondary School teacher; Multilingual Mathematics classroom; Language practice; Non-language practice; Dominant Discourse practices; Norms of practice; Textual Discourse practice analysis

DECLARATION

I declare that this thesis is my own unaided work. It is being submitted for the degree of Doctor of Philosophy at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other University.

Alexander Michael

Sign this 31st day of July in the year (2019)

DEDICATION

This research work is dedicated to my mother Wushiwaa and late father Michael Malaazee. Also to my beloved wife; Mercy, our children Lucia and Jason,

You are special to me!!!

PUBLICATIONS AND PRESENTATIONS EMANATING FROM THIS RESEARCH

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LIST OF ACRONYMS/ABBREVIATIONS

NPoC	National Population Commission
FME	Federal Ministry of Education
LoLT	Language of Learning and Teaching
IRE	Initiation, Response, Evaluation
SS2	Senior Secondary Two
NCTM	National Council of Teachers of Mathematics
SSCE	Senior Secondary Certificate Examinations
COAG	Council of Australian Governments
WAEC	West African Examination Council

CHAPTER ONE: Background and Rationale of the Study

1.1 Introduction

This study explored secondary school teachers' Discourse practices in multilingual Mathematics classrooms in Nigeria. The motivation for this focus was driven by the challenges teachers grapple with while teaching Mathematics in a language which students are also learning to understand (Adler, 2001; Essien, 2013; Moschkovich, 2007a, 2009; Phakeng, 2013). As Phakeng (2013) observed, challenges of language and Mathematics teaching and learning are not limited to one country, but are worldwide. In order to understand these challenges in the Nigerian context, I engage with two key broad interrelated issues that had direct bearing on this study: education and the nature of multilingualism.

In terms of education, Nigeria is divided into two main regions: the more educated and developed region is in the south, while the northern region has a low education standard and attainment (Fabunmi, 2003, 2005). Poor educational standards in the northern region of Nigeria affect mostly the school-going age group, at both Primary and Secondary Schools levels (National Population Commission(NPoC, 2013)). Despite the persistent efforts over many years by the government of Nigeria to ensure that all citizens have equal educational opportunities, northern Nigeria continues to be educationally backward compared to the southern region of the country (Fabunmi, 2003, 2005; NPoC, 2013). A key subject like Mathematics, which is taught at all educational levels, suffers most in terms of teaching and learning (Fabunmi, 2003, 2005; NPoC, 2013). The primary objective of every Mathematics teacher is to have students learn the subject. The teaching and learning of Mathematics is a vital component of education, but like any other subject, involves the use of language.

In the Nigerian context, Akinnaso (1993) reported that Nigeria is divided linguistically into three categories: 1) about 400 native languages with little or no common vocabulary; 2) three foreign languages - Arabic, English, and French; and 3) a "neutral" language (Pidgin English). English is the lingua franca of Nigeria

(Federal Ministry of Education(FME, 2012)). None of the home languages in Nigeria (Hausa, Igbo and Yoruba) has been accepted as a unifying medium of instruction in schools (FME, 2012). The nation's language policy (FME, 2012) documents, and the 1999 amended constitution of Nigeria allow for the use of Hausa, Igbo and Yoruba languages with English at some official public functions. Accordingly, these three languages have been accorded national language status and are learned in the nation's schools, in addition to English (Akinnaso, 1993; FME, 2012). The home language in any region is the Language of Learning and Teaching (LoLT) in the first three years of Nigerian Primary schools, and during this period, the English language is also offered as a subject. In the fourth year, English replaces the home languages as the LoLT. Students are also offered the choice of one home language and one foreign language (FME, 2012) which they study until their final year in Secondary School. A home language according to FME (2012) is the language of teachers and students, in which they might be fluent or not, but speak more often than any other language within their immediate localities. For example, Hausa and Mumuye are the home languages in most localities of Jalingo metropolis in Taraba state.

It is therefore clear that Nigeria is a multilingual country, and the population of the nation is multilingual. Multilingualism in the educational context is the "presence of two or more languages" in the conduct of classroom activities (Barwell, 2009, p. 2). A multilingual person is an individual who can write or speak two or more languages (Adler, 2001). Merging Barwell's and Adler's definitions, a multilingual classroom in this study will mean a Mathematics classroom where the teacher and/or students can write or speak two or more languages, irrespective of whether or not these languages are used in teaching and learning in a multilingual classroom. As observed by Barwell (2004) Mathematics teachers vary their talk in teaching in multilingual classrooms in order to explain different concepts, thus accomplishing different social actions in their classroom Discourse. An examination of current Mathematics education research (Adler, 2001; Essien, 2013; Moschkovich, 2007a; Setati, 2002; Setati & Barwell, 2006) revealed that issues of teachers' practices in the multilingual classrooms fall under a Discourse of school Mathematics.

According to Gerofsky (1999)"…Discourse analysis can provide useful and sometimes surprising new perspective on understanding teaching and learning" (p.36). Gerofsky's study suggests possibilities for an illuminating insight on my research regarding teachers Discourse practices while teaching Mathematics in multilingual classes. Gee (2005, p. 102) noted that "the goal of Discourse analysis is to render even Discourses with which we are familiar 'strange', so that even if we ourselves are members of these, we can see consciously (maybe for the first time) how much effort goes into making them work and, indeed, seem normal, even 'right' to their members". A Discourse approach can help view matters related to teachers' practices from different perspectives as I will fully explain in greater detail in Chapter Three of this research work as my theoretical underpin. Through close examination of teachers' varied use of languages (Barwell, 2004), within the local contexts (schools/classrooms) it might be possible for me to uncover and describe these Discourse practices. This study specifically focused on examining these Discourse practices that occur in a multilingual Mathematics classroom.

The National Council of Teachers of Mathematics (NCTM, 2000) opined that Discourse helped teachers to adjust their teaching to aid the understanding of complex concepts. As noted by Wachira, Pourdavood, and Skitzki (2013) some forms of Discourse not only fosters the development of shared and better insight in to teaching and learning but also helps to deepen the examination of the Mathematical actions and interactions of teachers/students. It is therefore logical to argue that better insight into the teaching and learning of Mathematics occurs if there is a clear identification and understanding of those Discourses in the classrooms, as well as why and how they are used. Examples of Discourse practices in multilingual Mathematics classrooms might include Mathematical Proceduralising, Mathematical code switching, and Mathematical re-voicing (Moschkovich, 2002; Setati, 2005a). It is vital that this study identifies, describes, analyses and explains Mathematics teachers' Discourse practices in a multilingual classroom. This study investigates Discourse practices of Mathematics teachers in Secondary Schools in northern Nigeria. According to Gee (2005) the term Discourse with 'D' upper case, is not just sequential writings or talks but,

> different ways of using language, other symbolic expressions, and objects of thinking, feeling, believing, valuing and acting that can be used to identify oneself as a member of a socially meaningful group or 'social network,' or to signal (that one is playing) a socially meaningful role (p. 13)

Gee (2005) referred to discourse with lower case "d" as language-in-use (such as conversation or stories) and is a subset of Discourse with 'D" upper case. Discourse practices in this study refer to dialectically cognitive and socio-cultural activities in a multilingual Mathematics classroom which are constituted by actions, meanings for talks, focus of attention, goals and non-language symbols (Moschkovich, 2007a) For example, code-switching is a common practice in multilingual classrooms which involves the use of two or more languages, ways of thinking and acting.

While studies (Adler, 2001; Essien, 2013; Moschkovich, 2007b; Setati & Barwell, 2006) from other multilingual settings have contributed to the understanding of how Discourse practices in multilingual classrooms are used for the effective teaching and learning of Mathematics, not all the findings are applicable to the Nigerian context because of its peculiar sociolinguistic character. There are specific differences between the contexts discussed in the studies mentioned, and the context in Nigeria. In South Africa, for example, where most classrooms are multilingual, most of the languages (eleven) are official (Adler, 2001; Essien, 2013; Setati, 2002), in Nigeria however this is not the case. In Nigeria, only one official language (English) is used in the Secondary Schools. There are few noticeable populations of first language English speakers in South Africa, depending on location, while in Nigeria the populations of first language English speakers are not noticeable. In the United Kingdom and the United States of America, most students will generally learn and speak English in Mathematics classrooms. This is so, because English is one of the main languages of the students in schools and the multilingual classrooms are mostly due to immigrants (Barwell, 2012; Moschkovich, 2002, 2003, 2007a, 2007b). In Nigeria, the languages spoken in the same locality are, in the main, not mutually intelligible as mentioned earlier. Hence, speakers of different home languages may or may not understand one other. Although English is the LoLT in schools and classrooms, most Nigerian languages have a dominant presence as indicated.

The socio-linguistic and educational uniqueness of Nigeria provided me with the opportunity for insights into the teaching and learning which contributed to my understanding of Discourse practices of Mathematics teachers in multilingual contexts. Given the context discussed above, it was crucial that teachers' Discourse practices in multilingual Mathematics classrooms be explored in the Nigerian context which yields insights into the teaching and learning of Mathematics in classrooms that constitute students from diverse language backgrounds. The study was conducted in Second year Senior Secondary school (SS2) multilingual classrooms. It is at this level that the issues of multilingualism are most prevalent due to the fact that most parents in rural areas transfer their children to urban metropolitan townships in northern Nigeria. One of the apparent reasons for parents doing this is that these urban schools are better resourced and students are immersed in the English language. Again, not much research has been conducted at these levels of classes in northern Nigeria. Furthermore, the classes were relatively small in terms of the student population; beside the fact that, the students were not to write any external examinations. It was also the preparatory period before students wrote their Senior Secondary Certificate Examinations (SSCE).

1.2 Problem statement

Recent research conducted on the Nigerian Secondary School Mathematics results by Ogundele, Olanipekun, and Aina (2014); Oluwole (2008) and the West African Examination Council (WAEC) Chief Examiners reports in May/June, 2006 to 2014 (WAEC, 2011, 2012, 2014) indicated that students had performed poorly over the years. One of the main factors of this poor performance, according to Ogundele et al. (2014) and Oluwole (2008), was the problem of teaching Mathematics to students who were learning to understand the LoLT in multilingual classroom. Additionally, WAEC Chief Examiners' reports on trigonometry, a key topic in Mathematics, which has a multitude of application in the life of every person showed negative students' performance. It worth noting that trigonometry as a topic covers about 20% of the Nigerian mathematics syllabus of junior and senior levels of Secondary education (FME, 2012; WAEC, 2011, 2012, 2014). Studies conducted by notable researchers (Clarkson, 2005, 2007; Cross, 2002; Cummins, 2000; Howie, 2003) had led to the conclusion that in many contexts, multilingual students tended to underachieve in Mathematics.

The national language policy in Nigeria (FME, 2012) stipulates that a student's home languages should be used as the LoLT in the first three years of Primary School (as earlier discussed in Chapter One, Section 1.1), but does not indicate how this is to be done. Previous studies conducted in Nigeria have revealed that Mathematics teachers face many language problems when teaching the subject in multilingual classrooms (Kolawole, 2005; Kolawole & Oginni, 2010; Odetula & Salman, 2014; Ogundele et al., 2014; Okunrinmeta, 2014; Oluwole, 2008; Udosen, 2013). One of the main problems identified in these studies is the challenge of teachers having students who were not proficient in the LoLT which impedes understanding. In most classrooms in urban and semi-urban settlements of Nigeria, it is common to have more than 15 different home language speakers in one classroom. Thus most teachers struggle with the challenge of teaching students who are not proficient in the LoLT. However, this study explored teachers' Discourse practices in multilingual contexts in which the LoLT was not one of the home languages of teachers and students. This challenge of teachers in teaching students who are not proficient in the LoLT was further confirmed by studies (Ogundele et al., 2014; Oluwole, 2008; WAEC, 2011, 2012, 2014) conducted over the years by researchers and external examination bodies in Nigeria as elaborated below.

In the context of Nigeria, there was limited literature on the detailed descriptions and analysis of the language challenges in multilingual Mathematics classrooms (Jegede, 2011). Of the one hundred and twenty three articles published in ABACUS, the leading journal in Mathematics education of Nigeria and the journals of the Mathematics education panel, published by the science teachers association of Nigeria from 2005 to 2014, only **three** articles focused on the language problem in multilingual Mathematics classrooms. These three articles (Akinoso, 2014; Kolawole & Oginni, 2010; Odetula & Salman, 2014) focused on the southern part of Nigeria and none focused on the north. The lack of previous studies of the language challenges that existed in multilingual Mathematics classrooms in the northern

Nigerian context suggest that it was crucial to conduct a study of the practices that were possibly used by teachers in multilingual Mathematics classrooms. Studies conducted in Nigeria and other contexts on this subject matter are discussed below.

Akinoso (2014) and Ogundele et al. (2014) looked at the causes and remedies of students' poor performance in Nigerian Mathematics students. They stated that students who passed both English and home languages performed better in Mathematics. Similarly, Oluwole's (2008) study on students' achievement in a home language/English versus students' achievement in English only in south Western Nigeria found that home language/English had a positive influence on Mathematics students' performance. Salman, Mohammed, Ogunlade, and Ayinla (2012) opined that students' misunderstanding of the English language caused mass failures in Senior Schools Certificate Mathematics examinations (SSCE), as perceived by Secondary School teachers and students in Nigeria. A lesson from the studies of Akinoso (2014), Ogundele et al. (2014), and Oluwole (2008) would be, for the performances of students who learn Mathematics in a language that is not their own to improve, it may be important that the teachers allow the use of both LoLT and home languages. Similarly, Halai (2007, p. 5) contends that Mathematics teachers in a multilingual classroom confront "challenges, because they are working with students who are learning to communicate Mathematics in a language that is not their home language". Since teaching in a multilingual classroom is complex and understanding this complexity is not straight forward, teachers' engagement of students with their practices are imperative in a multilingual Mathematics classroom (Essien, 2013). Thus, the main purpose of this study was to understand teachers' Discourse practices used in multilingual Mathematics classrooms in northern Nigeria secondary schools.

As argued by these authors (Moschkovich, 2002; Setati, 2005a; Setati, Molefe, & Langa, 2008), teachers in Mathematics classrooms needed to have an understanding of multilingualism as a resource for teaching and learning, even though there were great challenges. Halai (2007) stated that; this required teachers and students to interact using mathematical activities which allowed them to use their home languages. One method of dealing with these challenges as discussed included an exploration of how teachers' Discourse practices were used in the context of teaching Mathematics where students were multilingual and still learning in the LoLT. What Discourse practices were used by teachers in their language/non-language symbols in northern Nigerian multilingual Mathematics classrooms? My study explored these questions from the notion of Discourse as expounded by Gee (2005).

1.3 Research questions

The main research question was: What Discourse practices were used by teachers as plainly evinced in their language (verbal and non-verbal) in northern Nigeria multilingual Mathematics classrooms? To answer this research question, I used these sub-questions.

1. How do teachers use language (verbal and non-verbal) to enact practices as reflected in their Discourses in the teaching and learning of Mathematics in multilingual classrooms in northern Nigeria?
2. Why do teachers use language (verbal and non-verbal) in their Discourse practices in multilingual Mathematics classrooms of northern Nigeria?

Together, these research questions enabled me to see the pattern of actions and interactions of teachers' use of language and non-language symbols in their Discourse practices in northern Nigerian multilingual classrooms. The questions also enabled me understand why and how teachers used activities and identities during the teaching and learning of Mathematics in a multilingual classroom. This study understood, identified, described, and explained teachers' Discourse practices in a multilingual Mathematics classroom.

1.4 Research design

This study is located within the interpretivist paradigm. In explaining interpretivism Carson, Gilmore, Perry, and Gronhaug (2001) argued that knowledge is acquired through social construction rather than objectively determined. In line with the interpretivist paradigm, this study adopts a qualitative research design. As with most qualitative methods, the sample in this study was small and purposive (Cohen, Monion, & Morrison, 2011). The sample consisted of four purposively selected multilingual Mathematics teachers in two Secondary Schools (two from school A and two from school B). Data gathering techniques for this study included video observations, written field notes and face-to-face reflective interviews in schools and classrooms. The data gathering process covered a period of one year six months (from September 2016 to February 2018). The data collection was in two phases. The first phase focused on classrooms observations. A total of 12 lessons were observed. In the second phase of data collection, I worked with the same four Mathematics teachers who had participated in the first phase. This phase focused specifically on a semi-structured in-depth reflective interview with each teacher.

In order to carry out an analysis of the text and Discourse practices two steps were involved; it was important first and foremost to identify these Discourse practices in the text (verbal and non-verbal) obtained from the teachers' videoed lessons observations and interviews which were further investigated. Secondly, it was essential to look at how and why language was used in the multilingual classrooms together with other "ways of thinking or feeling, ways of manipulating objects or tools, ways of using non-language symbols etc.", by teachers to carry out particular Discourse practices, to achieve the purpose of analysis in this study(Gee, 2005, p. 9) The language of description in this study is clarified in Chapters Four and Five and refers to all the categories and sub-categories developed before, during and after my pilot study. These categories and sub-categories were developed from Gee's Discourse analysis theory, reviewed relevant literature and the data gathered from the multilingual classrooms of Mathematics teachers. The empirical results of the analysis as presented in Chapters Six to Eight in this study centered on the dominant Discourse practices such as Mathematical explaining, Mathematical reiterating, Mathematical questioning, Mathematical symbolising, Mathematical re-voicing, Mathematical Gesturing and Mathematical proceduralising. The term dominant Discourse practice (DP) as used in this study refers to the DP that has influence (in directing the flow of the Discourses) across data obtained from teacher's Mathematics classroom. It, therefore, means that the dominant DP in one teacher's class might not necessarily be dominant in another teacher's class.

1.5 Operational definitions

LANGUAGE: Is the communication in speech (verbal) and sound by teachers and students in a particular context (Mathematics classes). This definition is the understanding of the term language as it is used in this study.

NON-LANGUAGE: In this study non-language is the way of communication using non-verbal cues by teachers and students in Mathematics classes.

HOME LANGUAGE: The usual language of teachers/students, one they speak more often than any other language (FME, 2012). It is the language of teachers and students, in which they might be fluent or not, but speak more often than any other language within their immediate localities. For example, Hausa and Mumuye are the home languages in most localities of Jalingo metropolis in Taraba State, Nigeria.

LANGUAGE OF INSTRUCTION (LANGUAGE OF LEARNING AND TEACHING -LoLT): The official language used in learning and teaching, which is not the home language of teachers/students. In Nigeria English language is the LoLT.

A MULTILINGUAL PERSON is a person who can write or speak two or more languages (Adler, 2001).

A MULTILINGUAL CLASSROOM: In their studies, Setati and Barwell (2006) defined a multilingual classroom as a place where the teachers, students, and others draw from one or more than one language as they go about their work. They further explained that, the presence of these languages does not mean that language diversity is an **asset** in that classroom. In this study, a multilingual classroom would mean a situation where teachers used a range of languages in teaching Mathematics.

MULTILINGUALISM: The majority of Nigerians are multilingual instead of bilingual; the term multilingualism will be use throughout this study.

Multilingualism as defined by Barwell (2009) is the presence of two or more languages in conduct of classroom activities.

DISCURSIVE: This term in my study, refers to the patterned ways of teachers speaking or writing in a Mathematics classroom.

PRACTICE: Practice in this study is the use of spoken, or written language (verbal and non-verbal) by one or shared by two or more people to "make clear to others what it is [they] take to be doing" (Gee, 2005, p. 11). It is the regular way of doing and communicating Mathematics which can either be used by a teacher and/or students in the multilingual Mathematics classrooms. Examples of these practices include; Mathematical defining, Mathematical code-switching, Mathematical explaining, and Mathematical re-voicing.

ENGAGE: Refers to the ability of teachers to attract and sustain students' attention and interest in multilingual classrooms.

DISCOURSE: According to Gee (2005) the term Discourse with 'D' upper case, is not just sequential writings or talks but, "different ways of using language, other symbolic expressions, and objects of thinking, feeling, believing, valuing and acting that can be used to identify oneself as a member of a socially meaningful group or 'social network,' or to signal (that one is playing) a socially meaningful role" (p.13). Gee's definition is the understanding of the term Discourse as it is used in this study.

DISCOURSE PRACTICES: are regular ways of using language, other symbolic expressions, and objects of thinking, feeling, believing, valuing and acting in the mathematic classrooms either by a teacher or shared by teacher and students in enacting their activities.

1.6 Conclusion

This chapter has given a global overview of what this research sets out to explore. In doing so, it has dealt with the research questions, the purpose of the study, the problem statement and has discussed the study in the context of northern Nigeria.

1.7 Outline of the thesis

In **Chapter Two**, I present a discussion of the relevant literature on teachers' Discourse practices, language as a resource, and the role of language and teachers in multilingual Mathematics classrooms. Specifically, this Chapter is concerned with the identified Discourse practices and how languages with other semiotic devices are negotiated by teachers/students using Mathematical activities in the multilingual classrooms. I deal with the review of relevant literature concerning the challenges of teachers in multilingual classrooms where teaching and learning of Mathematics is in a language other than students' home language. I have also engaged with kinds of literature on common Discourse practices of teachers in the context of multilingual Mathematics classrooms.

Chapter Three locates the study within the Discourse analysis theory and method of Gee (2005) as a lens to understanding teachers' Discourse practices in multilingual Mathematics classrooms. This chapter discusses the theory of Gee's Discourse analysis which underpins the data analysis in my study. The justification for the suitability of the theoretical perspective for the study is presented. The chapter also discusses the relevant literature complementary to Gee's Discourse analysis theory.

The research design, research contexts and methods of data collection used in the study are described in **Chapter Four** where I descuss the population, sample, research instruments validity and reliability.

Chapter Five outlines how the language of description was developed from Gee's Discourse analysis theory and methods, collected data and the literature. The Chapter also addresses the processes involved in the development of the two categories (language and non-language) to enable entry into multilingual Mathematics classrooms and analyses of the collected data for this study.

Chapter Six provides empirical results for the analysis of the observed lessons in School B. I present empirical results of identified dominant Discourse practices for two teachers from school B and how the Mathematics teachers used their dominant Discourse practices during teaching and learning as visibly evinced in the multilingual classrooms.

Chapter Seven provides empirical results from the lesson observations of School A. The Chapter presents the analysis of dominant DP of the remaining two teachers from school A.

Chapter Eight describes the Mathematics teachers concerning multilingual classrooms. This Chapter focuses on the reflective interviews of the teachers in their schools. These in-depth interviews were aimed at validating what the teachers did in their classrooms while teaching plus their reasons why they did what they did in the way they did.

Finally, **Chapter Nine** synthesizes the implications of the dominant DP in the teaching and learning of Mathematics in the Page 3 of 4 multilingual classrooms and proposes some recommendations. In this chapter I also discuss the theoretical/methodological contributions of this study and the limitations of the framework.

CHAPTER TWO: Situating the Study in the Literature

2.1 Introduction

In Chapter One, I explained the context of this study - Teachers' Discourse practices in multilingual Mathematics classrooms. As my study sets to explore teachers' Discourse practices, in this chapter, I present a discussion of the relevant literature on teachers' Discourse practices, language as a resource, as well as the role of language and teachers in multilingual Mathematics classrooms. This chapter is specifically concerned with the identified Discourse practices and how languages, with other semiotic devices, are negotiated by teachers using Mathematical activities in multilingual classrooms.

2.2 The role of language in the teaching of Mathematics

The role of language in the teaching and learning of Mathematics has been a matter of interest over many years (Essien, 2010; Howie, 2003; Moschkovich, 2009; Salami, 2008; Setati, 2002; Setati, Adler, Reed, & Bapoo, 2002; Zabrodskaja, 2007). The roles played by language in Mathematics teaching are diverse. They cover a wide range of areas in Mathematics education, such as reading of Mathematical figures, symbols, numbers, and the pedagogical description of concepts in the classrooms by teachers. Pimm (1987) discussed a wide range of issues covering the role of language in the Mathematics classroom, some of which are language of communication in the classroom, and making sense of Mathematical word problems. Moschkovich (2002) and Setati et al. (2008) argued that in addition to algorithmic competence, learning Mathematics also involves learning to communicate Mathematically. This involves teachers' Discourse practices which play an important role in how students learn to communicate mathematically. More relevant to this study is how language was used by teachers in the teaching and learning of Mathematics enabling an in-depth analysis for the exploration of their Discourse practices in classrooms.

Language is one of the vital factors in students' understanding and the way they make sense of mathematical concepts used by the teacher (Cuevas, 1984). Stathopoulou and Kalabasis (2007) indicated that a student's lack of understanding of language can result in their hating Mathematics. Similarly, Meaney (2005) argued that when Mathematics teachers did not speak fluently, this affected students' understanding of mathematical ideas and concepts. These observations show that language influences the perception of humans (Edmonds-Wathen, Trinick, & Durand-Guerrier, 2016). Enyedy et al. (2008) argued that language shaped the concepts and processes which organise most of the everyday situations in the Mathematics classroom. Thus, the way and manner in which students communicate knowledge of mathematical concepts is partly determined by the language use of the teacher. According to Ní Ríordáin (2009), both teachers and students use highly specialised mathematical language such as hypotenuse, differentiation and integration. Students need competence in using the Mathematical vocabulary to explain their knowledge or understanding to others. Clearly, language plays an important role in developing understanding within the Mathematics classroom.

Focusing on Nigeria, Okunrinmeta (2014) showed that students preferred to learn in English with their home languages instead of only English, as they could express themselves better; "becoming aware of differences between languages can help teachers and students avoid confusion as well as enrich the learning environment"(Edmonds-Wathen et al., 2016, p. 25). Similarly in a study, Ryve (2004) suggested that communication in the home language of students to complement the LoLT is essential to the teaching of Mathematics, since good communication in a Mathematics classroom plays a key role. However, good communication can equally take place in a Mathematics classroom by using one language. It is logical to draw the conclusion that Ryve's study was suggesting the use of home languages to support students who are struggling to understand the LoLT. This argument above is in agreement with the national numeracy review report (2008), as commissioned by the Council of Australian Governments (COAG), which showed that home languages contribute significantly to Mathematics teaching. However, issues of language challenges in Mathematics classrooms occur where students learn in a language which is not their home language. The next section discusses studies conducted in multilingual Mathematics classroom contexts.

As noted by Phakeng (2013), the issues of Mathematics teaching and learning in multilingual contexts are much more complex than a mono/bilingual context.

2.3 Teaching and learning of Mathematics in multilingual classrooms

Linguistic diversity has given rise to multilingualism globally. As a result, students use several languages in schools and where they live. Multilingualism presents a complex situation for teachers in Mathematics classrooms (Clarkson, 2009; Temple & Doerr, 2012). The study conducted by Ogundele et al. (2014), for example, discussed the case of students in Nigeria and argued that students often sat in silence in a multilingual Mathematics classroom, and that they did not have the opportunity to communicate using their language or the specialised language of Mathematics. In addition, their interactions in the classrooms with the teacher involved low-level responses to questions and answers which did not allow for the students' home language development (Akinoso, 2014). The question that should be of concern to researchers and teachers is thus: should the several languages used by students outside their classrooms be overlooked? I share the view of researchers (Clarkson, 2009; Temple & Doerr, 2012) who argued that Mathematics teachers need to create meaningful activities for students to practise and learn Mathematics in the languages they understand within the Mathematics classrooms. This should include meaningful Discourse practices which would allow the use of students' home languages.

In a study Adler (2001) working with Mathematics teachers in South Africa, talked about three areas of complexity which caused tension in teaching Mathematics classrooms. She called these dilemmas. One of the dilemmas which Adler discussed was the dilemma of mediation. The "dilemma of mediation involves the tension between validating diverse learner meanings and at the same time intervening so as to work with the learners to develop their mathematical communicative competence" (Adler, 2001, p. 3). This challenge is further worsened by the "dilemma of transparency where the tension is between implicit and explicit practices" with respect to use of language in teaching of Mathematics in multilingual classrooms (Adler, 2001, p. 4). As noted by Adler these dilemmas are a challenge for all teachers. She added that these dilemmas were not specific to multilingual classrooms, but that the dilemmas were more complex in multilingual classrooms where informal spoken Mathematics was not in the LoLT. Adler (2001) pointed to the complexity by describing dilemmas as contextual and personal. She also explored the dilemma of code-switching. According to her, teachers in the multilingual classrooms faced a continual dilemma of whether to switch or not switch languages in their day-to-day teaching: if the teachers stuck to English, students often did not understand. Yet if they switched between English and Tswana, they had to be "careful" as students would be denied access to English (p.3). Adler concluded that there would be teaching and learning benefits if teachers of multilingual classrooms had additional training in one or more of the students' home languages. Essien (2011) pointed out that the language practice of teachers in monolingual classrooms did not need to be the same as those in the multilingual classroom. Essien's argument about the need for teachers to be trained further in learners' home languages to deal with the complexity of teaching effectively in the multilingual Mathematics classrooms agreed with Adler (2001) study, which found out that in multilingual classrooms teachers need additional training in the home language of the students besides the LoLT.

In essence, students can only harness the resources of home languages if teachers give them the opportunities to use them in communication in the classrooms. It is noteworthy that Moschkovich's (2002) argument from a socio-cultural perspective did not concentrate on what bilingual students could not do: "instead [it] focuses on describing the resources bilingual students use to communicate mathematically" (Moschkovich, 2007b, p. 90). Furthermore, Kersaint, Thompson, and Petkova (2014) argued that students' cultural and linguistic background must be respected in the Mathematics classroom. Ogundele et al. (2014) also opined that the use of a home language in teaching Mathematics in multilingual classrooms served as a valuable resource. Thus, Mathematics teachers must endeavour to give opportunities for learning the subject to all students in multilingual classrooms. The section that follows discusses teachers' role in the multilingual Mathematics classrooms.

2.4 The role of teachers in multilingual Mathematics classrooms

Focusing on the teachers' role in classroom interaction, Strom, Kemeny, Lehrer, and Forman (2001) reported that teachers used several languages to guide students' mathematical argumentation in a multilingual classroom. Others, such as Barwell (2005), contended that teachers needed to differentiate between the precise, subject language of Mathematics and students' informal talk for effective teaching and learning in a multilingual classroom. In a study on the role of the teacher in the development of students' use of language in Mathematics classrooms, Mercer and Sams (2006) found out that a teachers' guidance and practical direction on how language was used appropriately in Mathematics classroom yielded significant results in problem solving. In a study, Planas and Morera (2011) argued for a multi-dimensional view on how everyday situations in a multilingual classroom should be organised in order to answer questions on teachers' practices. Thus, from the arguments above it is clear that Mathematics teachers need to engage students in their Discourse practices using language for effective teaching and learning in the multilingual classrooms.

As reported by Ní Ríordáin (2009), teachers of Mathematics should be aware of the importance of language and incorporate aspects of it into the teaching of the subject. Many teachers have found themselves teaching students in a language which is not their home language (Setati, 2002) and they have to carefully explore other means of making students understand their teaching. Teachers need to help students in their proper use of language to share and negotiate their ideas in multilingual classroom. Planas' and Civil's (2013) study on language-as-resource argued that the complexity of using home languages by students to learn Mathematics "may be addressed through classroom practices in which the students' home languages successfully become a vehicle in the construction of Mathematics knowledge" (p.2). In a similar study on using language as a transparent resource in the teaching and learning of Mathematics in a Grade 11 multilingual classroom in South Africa, Setati et al. (2008) found that the use of multiple languages was beneficial for students. The role of teachers in productive Discourse practices in a Mathematics classroom is central (Setati & Barwell, 2006). From the foregoing, it is clear that exploring, negotiating, and creating an environment for knowledge sharing, meaning making and the effective engagement of students by teachers are very important using language in their Discourse practices.

2.5 The use of different Discourse Practices in a multilingual Mathematics classroom

Numerous studies (Setati, 2002; Setati & Adler, 2000; Setati & Barwell, 2006) have looked at Discourse practices in the multilingual classrooms to understand how teachers stimulated students' participation in teaching and learning of Mathematics. Studies (Essien, 2011; Setati et al., 2008) have also revealed how much teachers struggle in their roles as facilitators within the multilingual classrooms while engaging students in their practices. Further investigation of Discourse practices particularly in the northern Nigeria context as foregrounded in Chapter One in this thesis can yield insights into how teachers engage students in teaching and learning Mathematics in the multilingual classrooms. The reviews of Discourse practices in this study are neither comprehensive nor exhaustive and should not be treated as such. I now discuss Discourse practices in a multilingual context and consider the review of some common practices which occur in a multilingual Mathematics classroom such as code-switching, and re-voicing.

Enumerated in Moschkovich's (2007a) study are some common Discourse practices in multilingual classrooms such as IRE (Initiation-Response-Evaluation) which is a format of interactions in Mathematics classrooms and whole class discussion. Pimm (1987) explained that in most classrooms teachers always placed emphasis on a quiet, controlled, conducive environment for meaningful teaching and learning of Mathematics. He further argued that the usual situation in a Mathematics classroom was that of a teacher initiated questions and the students' response were then evaluated. More relevant to this study is how these sources indicated teachers' heavy reliance on the IRE pattern of interaction. Multilingual classrooms should be organised in such a way that teachers would help students to act in different ways using language and non-language symbols in their different Discourse practices.

Apart from the IRE Discourse practices in multilingual Mathematics classrooms, Setati (2005a) did her work in South Africa and observed that this IRE Discourse practices worked together with the procedural Discourse practices. A procedural Discourse practice is where the emphasis in teaching Mathematics is aimed at establishing the steps which should be taken to calculate certain mathematical problems with no development of the concepts. This kind of Discourse practice would lead students to accept procedures. Even though solving Mathematics requires knowledge of algorithms, this must be backed-up with a good deal of conceptual understanding so that students would know why and how the steps are undertaken in calculating problems. When teachers place more emphasis on following procedures, then the students would have to memorise the directions. Setati (1998) argued that switching between the students' home language and the LoLT enhanced the quality of mathematical interaction in the multilingual classroom. Thus the home language of students should be used to clarify concepts and enhance the conceptual understanding of the Mathematics.

In addition to these Discourses, there are also regulatory and contextual Discourse practices. A regulatory Discourse practice is mostly used by teachers and refers to teachers' action and interactions, they focus on regulating the behaviour of students (Setati, 2005a). Teachers do use this Discourse practice to attract students' attention, to ask them to listen during lessons in the class. Contextual Discourses are Discourse practices which involved Mathematical problems on the context. An example: when teachers are teaching word problems then the actions and interactions are about the contexts, and not the Mathematics. This practice is recognised during teachers' actions and interaction while solving the mathematical problem, although the contexts under discussion might be familiar, but the ways in which they would be discussed in the classrooms is not the same as in ordinary everyday interaction. Most often teachers may pretend to the students that s/he did not know the context, so that together they could solve the problem. Several works in South Africa, UK and the USA (Adler, 2001; Barwell, 2009; Essien, 2013; Moschkovich, 2002, 2004, 2007a; Setati & Barwell, 2006) have analysed specific Discourse practices involved in classroom interactions of teachers and students. The next sections discuss some of these practices, specifically code-switching, translating and re-voicing.

2.5.1 Code-switching

Code-switching, according to Iqbal (2011), is from a combination of two words 'code' and 'switching'. Code, in this study, refers to any kind of system which two or more people employ for communication. On the other hand, switching means movement from one system to another. In recent years, code-switching has attracted a great deal of research attention, especially in the multilingual Mathematics classroom (Adler, 2001; Essien, 2010; Setati, 2002; Zabrodskaja, 2007). In a study in Malaysia, Then and Ting (2011) found out that code-switching helped students to understand terms and concepts in Mathematics which ordinarily they would not have understood if the teacher had used only the LoLT. Similarly, Musau (2003) stated that in Kenya, code-switching was a resource in meeting students' needs in the multilingual Mathematics classroom, because it supported students and helped them to understand difficult problems. Setati (2005b) also argued that code-switching usage in multilingual Mathematics classrooms could be for the purpose of classroom management. Worthy of note is the study of Schafer and Chikiwa (2014) which pointed out that for code-switching to be effective, teaching materials in home languages should be provided to aid the consistent and systematic usage of code-switching in the multilingual Mathematics classrooms. In another study Baker (1993) observed that teachers emphasise points to clarify some concepts using code-switching. Similarly Adler (2001), Howie (2003), Schafer (2010) and Setati (2005a) indicated that the use of code-switching in multilingual Mathematics classrooms showed there was a significant improvement in student understanding of mathematical concepts when it was used.

However Halai (2011) problematised the use of code-switching and cautioned that it should be used prudently. She added that the situation in which code-switching is used and how it is employed, determines its usefulness. Furthermore, Halai suggested that teachers and students needed to be proficient in the use of the language of instruction to avoid potential confusion in code-switching. Setati and Adler (2000) discussed the language practices of teachers in some primary schools in South Africa on code-switching. Although in their suggestions, they have proposed that code-switching is a resource to harness students' home language, also they noted that the practice of code-switching had challenges which could not be ignored. The authors noted that it was important to understand the role of different kinds of Discourses. For example, Setati and Adler suggested that, those teachers should start with informal talk in the students' first language, leading through to more formal mathematical talk, and finally in English. Moschkovich (2007a) reported on how a person code-switched and said that depended on what was understood to be appropriate in a given social setting. From the foregoing, it is logical to conclude that as important as code-switching is, it should be used prudently. Another practice in the multilingual Mathematics classroom which is similar but not quite the same as code-switching is translating.

2.5.2 Translating

Translation simply means words or sentences which have changed from one language to a different language. Bose and Choudhury (2010, p. 97) defined translation as words "substituted by words from a second language, without disturbing the original meaning of the sentence, which is in the primary language". Halai and Karuku (2013) noted that the distinction between code-switching and translation is to characterise translation as a situation where the meaning of what was said or written in an entire communicative episode in the source language was rendered entirely in the target language. Code-switching is concerned with supporting students to understand difficult problems in the multilingual Mathematics classrooms. It is possible for teachers and students to translate during code-switching, but not all the time. In most instances, teachers do translate to ensure that students have a better understanding of what they are teaching.

Translation can be particularly important in solving word problems in Mathematics, which require more than just cognitive skills, as reported in Chitera (2011) and Halai (2009). These authors as above further argued that an important challenge with translation was to ensure that it did not lead to mistranslation of the intended mathematical meaning. As Chitera (2011) remarked, "the challenging process of translation will be to ensure that mathematical terms remain the same in meaning from the original source" (p.44).

2.5.3 Re-voicing

Re-voicing, as reported by Enyedy et al. (2008) is a practice which promotes a deeper conceptual understanding of Mathematics by engaging students in classroom debate and fostering mathematical argumentation. Re-voicing is a special form of reported speech, as argued by Enyedy et al. (2008). Re-voicing is used by teachers and students to encourage academic debate by showing how students' knowledge of understanding relates to the ideas of others in a common mathematical interaction in multilingual classrooms (Morais & Neves, 2001). It helps students to know when they or their classmates have acted as a competent member in the multilingual Mathematics classroom (Enyedy et al., 2008; Yamakawa, Forman, & Ansell, 2005). Re-voicing can be considered to include explicit verbal and other moves by teachers and students. The practice of re-voicing essentially tries to repeat some or all of what has been said in a preceding tone as the basis for a shift in the interaction. Planas and Morera (2011, p. 1357) reported that this repetition could be identified in two ways; "linguistically exact copy, or as a reformulation". Krussel, Edwards, and Springer (2004) and Moschkovich (2007b) noted that teachers' use of re-voicing was an essential part of what the teacher did during the process of instruction. It is practically impossible to focus on Discourse practices without looking at norms of practice, the reason is that the norms are interlinked and intertwined with the Discourse practices in the Mathematics class. Gee (2005) referred to the norms as Discourse models. He further posited that the Discourse models (norms) are the "simplified, often unconscious and taken-for-granted, theories about how the world works that we use to get on efficiently with our daily lives" (Gee, 2005, p. 71). The next sub-head discusses norms of practice as characterised from the relevant literature.

2.5.4 Norms of practice

Norms of practice as explained by McClain and Cobb (2001) refer to the patterns and ground rules which contribute to stability of learning in the Mathematics classroom during Discourses. To reiterate, Discourse practices are regular ways of using language, other symbolic expressions, and objects of thinking, feeling, believing, valuing and acting in the Mathematic classrooms either by a teacher or shared by teachers and students in enacting activities and identities, while the norms of practice are concerned with the dynamics of the process of Discourses in the classrooms. McClain and Cobb (2001) categorised norms of practice in Mathematics into two, namely; social norms and socio-mathematical norms. In the following paragraph, I engaged fully with these categories.

2.5.5 Social and socio-mathematical norms

In a research in which Kang and Kim (2016) investigated the beliefs of teachers regarding their students learning in Mathematics of grade four learners, a variety of social norms emerged. The study results indicated that the mathematical belief of grade four teachers was reflected in the decision making for Mathematics instruction, and that these greatly influenced the purpose, contents and methods of the Mathematics class which contributed to creating socio-mathematical norms. Yackel (2000, p. 11) made a distinction between social norms and socio-mathematical norms: "the understanding that students are expected to explain their solutions and ways of thinking is a social norm, whereas the understanding of what counts as an acceptable mathematical explanation is a socio-mathematical norm". Kang and Kim (2016) identified five socio-mathematical norms as listed below:

1. Acceptable explanations norms: An understanding of what counts as mathematically acceptable explanations.
2. Mathematical Difference norms: An understanding of what counts as Mathematical Difference
3. Mathematical Effectiveness norms: An understanding of what counts as Mathematical Effectiveness
4. Mathematical Insight norms: An understanding of what counts as Mathematical Insight
5. Other norms: Cases in which a new or unfamiliar socio-mathematical norm, which did not appear in the theoretical review would be disclosed and observed

In another study (Tatsis & Koleza, 2008, pp. 96-97) which investigated social and socio-mathematical norms in a collaborative problem-solving of pre-service Mathematics teachers' classroom, the result shows identification of several social and socio-mathematical norms as listed below. The first three (1-3) were social norms while the rest (4-9) are classified under socio-mathematical norms.

1. Collaborative norm: the participants are expected to reach a mutual agreement on the solution process and its features, i.e. the concepts and procedures. This is expressed through the first person plural of the verbs and the questions about the partner's opinion before implementing a method.
2. Justification norm: one has to justify his/her opinion, especially when s/he expresses disagreement with his/her partner. This is expressed through words such as 'because', or 'that's why'.
3. Avoidance of threat norm: one is expected not to impose a threat towards his/her partner, i.e. not insult him/her.
4. Non-ambiguity norm: mathematical expressions are expected to be clear and unambiguous. This is expressed through prompts for rephrasing.
5. Third person comprehension norm: mathematical expressions are expected to be explicit enough so that they can be understood by a third person who reads them. This norm is related to the non-ambiguity norm and is expressed through prompts for rephrasing, enhanced with references to the third person.
6. Mathematical justification norm: mathematical methods need some sort of justification before their implementation; there needs to be a rationale to support their use. This is mainly expressed through questions beginning with 'why', e.g. 'why should we use that method?'
7. Mathematical differentiation norm: mathematical areas such as algebra and geometry are distinct, non-overlapping areas. There is also a differentiation between mathematical and a 'practical' solution to a problem. In the triangle problem it takes the form of differentiating between the 'geometrical' solution (i.e. draw 14 lines segments) and the 'algebraic' one (i.e. find a formula that produces the number of the sections).
8. Validation norm: mathematical methods need to be validated before and/or after they are implemented. This norm is related to the justification norm according to the following scheme: introduction of a method-justification or method validation of a method. A method might be validated by its difficulty, its time duration or even its result. In some cases the method might be validated by its 'identity', i.e. whether it is a 'pure mathematical' or a 'practical' method. The validation norm is expressed through queries for

information on the above, or through relevant quotes, such as; ‘forget about it, it’ll take us ages to make that.

9. Relevance norm: the outcome of a method is expected to be relevant to the problem’s conditions. In other words the result has to make sense. This is related to the validation norm, since an irrelevant result might probably lead to the withdrawal of a method.

In my study, the knowledge of theses norms of practice in the Mathematics classrooms, as listed above together with a careful attention to details in the video recorded classroom observations, interviews and field notes enabled me to identify and describe precisely the characteristics of the norms of practice that were privilege by teachers and students

2.6 Conclusions

Delineating from the literature reviewed above, it is evident that, teachers’ Discourse practices in most Nigerian multilingual mathematics classrooms have not yet been properly explored. However, there is a need to identify and explore these teachers’ Discourse practices in order to understand how and why mathematics teachers at times use home languages to help students in the multilingual classrooms. In a context where home language is one of the LoLT, the teachers are supposed to be trained and focus on the practices appropriate to the multilingual nature of the context.

As mentioned in Chapter One, these authors (Moschkovich, 2002; Setati, 2005a; Setati, Molefe, & Langa, 2008), reported that teachers in Mathematics classrooms needed to have an understanding of multilingualism as a resource for teaching and learning, even though there were great challenges. Halai (2007) stated that; this required teachers and students to interact using mathematical activities which allowed them to use their home languages. One method of dealing with these challenges as discussed included an exploration of how teachers’ Discourse practices were used in the context of teaching Mathematics where students were multilingual and still learning in the LoLT. What Discourse practices were used by teachers in their language/non-language symbols in northern Nigerian multilingual Mathematics classrooms? My study explored these questions from the notion of Discourse as expounded by (Gee, 2005).

CHAPTER THREE: Theoretical Perspective

3.1 Introduction

As noted in the previous Chapter, this study seeks to explore, identify, and understand what Discourses exist in the multilingual Mathematics classrooms, as well as why and how they are used by teachers. Hence the need to look for a theory which would help me understand teachers' Discourse practices. Discourse practices in this research refers to regular ways of using language, other symbolic expressions, and objects of thinking, feeling, believing, valuing and acting in the Mathematics classrooms either by a teacher or shared by teacher and students in their activities (Gee, 2005). Thus the selected theory should enable the analysis of not only the verbal talks, but also non-language symbols and other objects of thinking used by teachers and students within the Mathematics classrooms. The theoretical perspective should be able to help me categorise different topics or themes emerging from the data. From the foregoing that I needed to explore teachers' talk and actions and to identify the Discourse practices that are used by the teachers and consequently understand why and how they used them in teaching of Mathematics, for me this implied an approach from a Discourse perspective. Gee's Discourse analysis: Theory and method (Gee, 2005) was used to analyse teachers' Discourse practices within the Mathematics classroom. While Gee's Discourse analysis perspective is not specifically developed in the context of Discourse practices in Mathematics classes, nor is it a theory of teaching, it does give insight on why and how identities and activities (practices) are enacted during Discourses as it is in the context of this research. Before engaging with the why and how the theory provides insight for teaching, it is necessary to elaborate on Gee's Discourse analysis theory first.

The Discourse analysis theory (Gee, 2005, p. 6), "seeks to balance talk about the mind, talk about social interaction and activities, and talk about society and institutions". By activities Gee (1999) simply means practices. Practice in this study is defined as the use of spoken, or written language and/or non-language symbols by one or shared by two or more people to "make clear to others what it is [they] take to be doing" (Gee, 2005, p. 11). Gee gave examples of these practices such as; "meetings, water cooler gossip sessions and corridor politics" (Gee, 1999, p. 1). In this study the word practice would be used instead of activity as used interchangeably by Gee, as it is appropriate to the research focus. Gee's perspective looks at language-in-use together with non-language symbols, objects of thinking, and feelings (for example gestural and facial expressions i.e. body language). Figure 3.1 below is a flow chart for overview of Discourse analysis theory and method. Gee made a distinction between Discourse (with upper case D) and discourse (with lower case d) as indicated on the diagram below. The discourse (with lower case d) otherwise called; language-in-use, refers to how language is used "on site" (in the context) to enact practices and identities (Gee, 2005, p. 1). Practices and identities are rarely ever enacted through language alone. When discourse (language-in-use) is combined integrally with non-language symbols to enact specific identities and practices then, Discourse (with upper case D) is involved as explained in Chapter One (Section 1.1) in this research. Gee (1999) contended that the key to understanding Discourse is recognition. Recognition work as shown on Figure 3.1 below is the way people engage in certain work to make visible to others (and to themselves), who they are and what they are doing. Gee argued that if you put language, action, interaction, values, beliefs, symbols, objects, tools and places together in such a way that others recognise (know who or what) a particular identity when engaged in a particular practice, then you are in a Discourse. If it is not recognisable then you are not in the Discourse (Gee, 2005). Identity as defined by Gee (2005) is different roles or positions played (acted) by a person in a peer or social group, such as religious groups, clubs, cultures, schools and/or classrooms to be recognised by others. Gee (2005) observed that identity and practice are not discrete and separable but, rather, interlinked. The reason is while people are recognised with an identity, partly because of the practices those people engage in, and these practices are also partly recognised for what that identity portrays. In any situation people 'pull off' or try to 'pull off' (recognise) certain identities (Gee, 2005). People do this using language and practice. They speak, act and dress in certain ways to portray certain identities. Their talking, acting and writing are all embedded in what Gee referred to as Discourse (with upper case D).

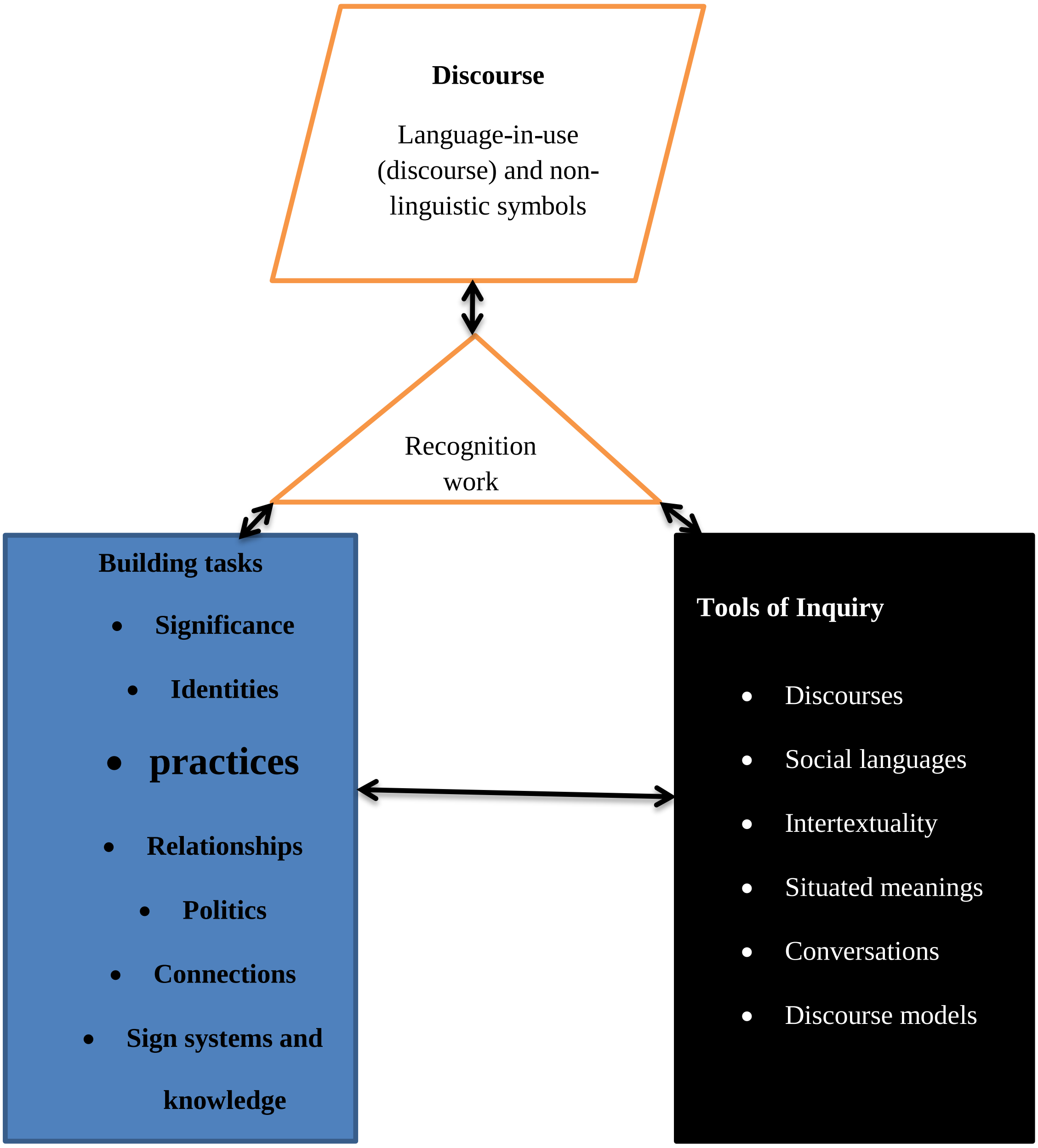


Figure 3.1: An overview flow chart for Gee’s Discourse Analysis: Theory and Method

In the Gee's (2005) work, he provided both theory and method for studying “language-in-use … to enact specific activities (practices)” (p.1). Gee (2005) reported that, whenever we speak or write, we always and simultaneously construct or build seven things or seven areas of reality which Gee called the seven building tasks of language. The building tasks as represented above with a long blue rectangle on the left hand side of the flow chart includes: Significance, Identities, Practices, Relationships, Politics, Connections, and Sign systems and knowledge. These building tasks according to Gee (2005) are used when we speak or write. He argued that, we design what we have to say to fit that situation in which we are communicating. He added that, how we speak or write creates that very situation. In another instance, we always actively use spoken and written language to create or build the world of practices, identities and institutions around us. Gee argued that we continually and actively build and rebuild our worlds not just through language, but through language used in tandem with actions, interactions, non-language symbols systems, objects, tools, technologies, and distinctive ways of thinking, valuing, feeling and believing (Gee, 1999, 2005). When we do that, according to Gee (2005) we are involved in a Discourse.

Gee (2005) also provided six tools of inquiry as represented on the right hand side of the above flow chart (long black rectangle); namely: Discourses, social languages, intertextuality, Conversations, situated meanings, and Discourse models. The tools of inquiry according to Gee are primarily relevant to how people build identities and practices and recognise identities and practices others are building around them. The tools of inquiry are not rigid definitions, rather they are meant to be thinking devices which guide the inquiry in regard to language-in-use and specific issues and questions (Gee, 2005). Tools of inquiry as defined by Gee (2005) are "ways of looking at language-in-use that will help us study how building tasks are carried out and with what consequence" (p.19). In addition, Gee (2005) provided the methods of data analysis using these tools of inquiry. The tools of inquiry help to ask questions about seven building tasks we create when using language and understand why and how language is used the way it is used. Gee's tools of inquiry and the building tasks can be adapted and be applied flexibly to specific problems and contexts of study. Discourse analysis perspective by Gee has been extensively used in multilingual Mathematics classroom research (Dlamini, 2009; Moschkovich, 2003, 2004, 2007a; Setati, 2002, 2005b; Tobias, 2009). Before engaging fully with Gee's tools of inquiry and the building tasks, I would first elucidate on recognition work, because of its paramount importance to the understanding and identification of the Discourse practices of teachers in this study.

3.2 The Recognition work

The notion of recognition as explained by Gee (2005) is the way people engage in certain work to make visible to others (and to themselves), who they are and what they are doing. Gee argued that people engage in such work either consciously or unconsciously, when they try to recognise others (and themselves), for who they are and what they are doing within actions and interactions (Gee, 2005). In an illustration of who a real Indian is, Gee gave a vivid description of the role a real Indian must perform to be recognised. He argued that this involved "correctly responding to and correctly engaging in the sparring, which Indians call 'razzing', and each participant further establishes cultural competency in the eyes of the other" (Gee, 2005, p. 26). The idea of recognition and being recognised according to Gee is consequential. It involves a great deal of more than just language. He argued that, it involved "acting-interacting-thinking-valuing-talking-(sometimes-writing-reading) in the appropriate way with the appropriate pros at the appropriate times in the appropriate places" (Gee, 2005, p. 26). Such ways of using language, of thinking, valuing, acting, and interacting, in the right places and at the right times with the right objects (associations which can be used to identify oneself as a member of a socially meaningful group or social network) is what Gee (2005) refers to as Discourse (with upper case D).

Recognition work and Discourses according to Gee go hand in hand. He argued that recognition work creates Discourse, and in turn this Discourse renders recognition work possible and meaningful. Gee (2005) stated that recognition work determines what the context (in this instance Mathematics classroom) demands and enables the correct reading of the mathematical text of the classrooms. For example, the word function has several contextual meanings. In English language class, the word function could mean the purpose of something. In the Discourse of a Mathematics class, a function is a quantity whose value depends on the varying values of others. Function could also mean something else in another context. Hence teacher/students who define function in the Mathematics class as a variable possess the recognition work in the context of Mathematics. Therefore, recognition work in a classroom context means that teachers and students understand where they are plus what is required of them to do under the work of recognition while engaging in their Discourse practices. Certain questions needed to be asked about the Gee's building tasks using tools of inquiry in order to identify teachers' Discourse practices. The tools of inquiry as mentioned earlier are: Discourses, social languages, situated meanings, intertextuality, Conversations, and Discourse models. First I provide a discussion on these mentioned tools of inquiry; thereafter I give description of the building tasks. I now engage with Gee's tools of inquiry.

3.3.1 Discourses

Discourse (with upper case D) is the use of language plus non-language symbols to enact practice (Gee, 2005). As earlier discussed, these non-language symbols includes; thinking and acting, using symbols, objects, feelings and expressions such as gesture, graphs, and tables to enact practices at the right time and in the right place so as to be recognised. Gee, (2005) argued that:

> Whos and whats are not really discrete and separable. You are who you are partly through what you are doing and what you are doing is partly recognised for what it is by who is doing it. So it is better, in fact, to say that utterances communicate an integrated, though often multiple or "heteroglossic" who-doing what (p. 23).

This suggests that Discourse in the Mathematics classroom is more than identities, but also the practices which are associated with the identities. In simple terms Discourse as earlier defined in Chapter One (Section 1.1) of this study are:

> different ways of using language, other symbolic expressions, and objects of thinking, feeling, believing, valuing and acting that can be used to identify oneself as a member of a socially meaningful group or 'social network,' or to signal (that one is playing) a socially meaningful role (Gee, 2005, p. 13)

An example: the language used in multilingual Mathematics classrooms, the way of writing, the manner of talking, the content, objects, the actions used, are some of the characteristics of teachers' Discourse practices. Practice, the key focus in this study as defined earlier in previous chapters, is the use of spoken, or written language and/or non-language symbols by one or shared by two or more people to "make clear to others what it is [they] take to be doing”,(Gee, 2005, p. 11). Gee argued that the concept of practice connotes doing. He use the word “what” (Gee, 2005, p. 1) in referring to practice. I think example would be useful here: let consider the concepts of code-switching. As a term, code-switching is a practice in the multilingual Mathematics classrooms as a result of it been used (action or doing) as enacted by teachers and students in their Discourse practices. In her study Moschkovich (2002) emphasised “there is no one practice in the Discourse of Mathematics classrooms” (p. 199). She pointed out that there were a range of practices in the Mathematics classroom. Therefore as earlier discussed in Chapter Two (section 2.5), Discourse practices in this study are neither comprehensive nor exhaustive and should not be treated as such. Other examples of practices in this study may include; Mathematical explaining, Mathematical re-voicing, and exemplifying mathematically.

In Mathematics classrooms such as in the context of this study, Discourse practices were enacted by teachers and students in their procedural tasks, and regulating norm (Moschkovich, 2002; Setati, 2005a). These Discourses as listed above have been thoroughly dealt with in Chapter Two and the analysis Chapters (Six to Eight) of this research. I now turn to elaborate on situated meanings as Gee’s Discourse analysis, tools of inquiry and its application to this study.

3.3.2 Situated meanings

Situated meanings are meanings of text (verbal and/or non-verbal) based on their actual contexts of use (Gee, 2005). Gee observed that situated meanings do not reside in peoples’ minds, but are distributed in the practices and settings of cultural groups, books, and media. The human mind according to (Gee, 2005) recognises or assembles patterns of Discourse on the spot, adapts and builds upon these Discourses, which gives rise to meanings. In his study Pimm (1987) cited an example which gave insight on situated meaning. Pimm observes that the term ‘PRODUCT’ is an item sold in a store, whereas in Discourse of a Mathematics class, ‘PRODUCT’ is a result of multiplication. Any of the two different meanings of the word ‘PRODUCT’ may be used in the Mathematics classrooms. It implies, for example that teachers/students meanings of text (verbal and/or non-verbal) in their mathematical tasks should be understood base on the classroom situation.

My reason for focusing on situated meaning was to understand teachers' meaning of text (verbal and/or non-verbal) in the multilingual Mathematics classrooms during their Discourse practices. This is because I explored the ways of using language, other symbolic expressions, and objects of thinking, feeling, believing, valuing and acting in the multilingual Mathematics classrooms either by a teacher, or shared by teachers and students in enacting their identities and practices. In a given mathematical tasks, teachers might recognise the meanings of text, in their Discourses based on the classroom situation. In attempting to understand teachers' meaning of text (verbal and/or non-verbal) in their practices, it is necessary to understand how these meanings are communicated using social languages. What follows is a discussion of social language as a tool of inquiry.

3.3.3 Social languages

According to Gee (2005) we speak and write not in a language such as English alone, but in specific social languages. By Social languages, Gee referred to several different languages used to express different significant identities and enact different Discourse practices (Gee, 1999, 2005). Social languages include the language of a mathematician, formal and informal languages within varieties of language. Teachers use informal languages in everyday life, but at school and Mathematics classrooms in particular they use formal mathematical language. I argued that it is important for teachers to take into consideration where to use formal and informal languages, because students in Mathematics classrooms can talk differently about the same thing using varieties of social languages. In informal language for example, it is common to hear people use English alphabet 'O' instead of the number zero (0). Teachers need to guide students in knowing and using formal Mathematics language appropriately. The ways of speaking, reading, and writings using Mathematics register are mostly applied within the context of the subject. For example teachers often talk and write using the social language of a mathematician in their classrooms, thus assuming the identity of a mathematician and carrying out Discourse practices such as Mathematical proceduralising, and giving mathematical proof of problems or formulae, as observed (in Section 2.2 of this study) by Ní

Ríordáin (2009). Teachers and students use highly specialised mathematical language such as hypotenuse, differentiation and integration.

One verbal or written text can be in one social language or it might mix with more than one social language (Gee, 2005). The social language might require one or multiple languages. When a mixture of social languages is used, it might portray the person using that mixture of the languages as enacting multiple identities within a talk, or as enacting a single identity with multiple social languages.

Social languages have a unique grammar. This is the grammar which makes decoding texts easier. This grammar, which Gee called Grammar2, is not the normal or the usual grammar studied in schools (which he called Grammar1). It is "the rule by which grammatical units like nouns and verbs, phrases and clauses, are used to create patterns that signal who-doing-what within a Discourse" (Gee, 2005, p. 4). In simple terms, Grammar2 is the pattern in our speech which makes a specific social language and an identity recognisable. Mathematics Grammar2 consists of symbols and mathematical terms which have distinctive meanings. These situated meanings can be used with symbols by Mathematics teachers in certain practices in the classrooms.

3.3.4 Intertextuality

Intertextuality according to Gee (2005) refers to the process of either mixing or borrowing written or spoken words from one variety of language (one social language) to accomplish a switching to another kind of language. For example words such as density, centimeter, kilometer, volume and length used by Mathematics teachers could also be used by Physics teachers. Thus, these words as above could either be limited to Mathematics and/or Physics language, but the process of their usage by teachers in either mixing or borrowing from any of the mentioned subjects is what Gee calls intertextuality. It is necessary for me to point out that intertextuality as a tool of inquiry of Gee's Discourse analysis theory is an important aspect of Discourse which needed to be examined as well.

3.3.5 Conversations

Conversations with a ‘C’ upper case, is a tool of inquiry (Gee, 2005). This refers to debates, motifs or themes familiar to a society. Gee (2005) noted that Conversations means “several number of interactional practices taking place among specific people at a specific time and context” (p.22). These Conversations, according to Gee are circulated in a multitude of text and media which are products of historical dispute among different Discourses. For example, in a context where English language is the LoLT, Mathematics teachers might only use English language while teaching, because it is the familiar Conversation, yet English language is a product of historical dispute among different Discourses before the 16th century.

3.3.6 Discourse models

Discourse models, as described by (Gee, 2005, p. 83) are “simplified, often unconscious first thoughts or taken-for-granted assumptions about what is typical or normal”. The thoughts do not reside in people’s heads but are embedded in words in the practices and in the culture in which people live. These thoughts may be learnt through experiences and written materials from or among people. Gee (1999) contended that Discourse models varied significantly based on social group and other socio-cultural contexts. He argued that Discourse models operate within multiple Discourses. A typical example of a discourse models in a Mathematics classroom would be students answering questions to which the teacher knows the answer is a typical Discourse model (Moschkovich, 2007b). It is typical Discourse because when students do not correctly answer the questions, the teacher might correct those students. In that instance, the Mathematics teacher is operating within a normal or typical Discourse model. It is important to point out here that the term Discourse models as conceptualised by Gee could be referred to as the norms of practice. I, therefore, used the term norms of practice in this study instead of Discourse models because norms of practice is widely used in the Mathematics education literature and it is a familiar term and well accepted by Mathematics educators and researchers.

These sections above have elaborated the tools of inquiries used as thinking devices about the seven building tasks. From the description above, it is clear that these tools do not work in isolation from each other; rather, each reinforces the working of the other. It therefore means that the Discourse analysis questions must be asked concerning the seven building tasks based on the understanding of how the tools of inquiry are used, to allow for the analysis of how language and non-language symbols are enacting specific identities and practices. As mentioned before, the tools of inquiry help to ask questions about the seven areas of reality, what Gee (2005) called the seven building tasks. It is therefore important to give the description of the seven Building tasks, and the Discourse analysis questions in the paragraphs that follow. First I will discuss significance as a building task.

3.4.1 Significance

Significance means to value things or issues in certain ways in a Discourse, so as to make them important or not (Gee, 1999). We use language and non-language symbols to make things significant (Gee, 2005). Certain words or phrases in our talks mark the important or lack of importance of what we are saying. I therefore argued that teachers in classrooms can make mathematical concepts significant or not in their Discourse practices. They do that by talking and acting in a certain way in the classrooms, in order to make mathematical concepts significant or not to students using the social languages of Mathematics with situational meanings of text or symbols in their Discourse practices. In this study Mathematics teachers used social languages to emphasise and make significant particular Discourse practices. The Discourse analysis questions are: How and what significance is given to particular Discourse practices by teachers? In other words, what values are being ascribed by teachers to their discussions in the Mathematics class? How are Discourse practices made significant or insignificant through the use of language, emphasis and gesture by teachers? The next construct of Gee's theory, which is applied in this study, is practice.

3.4.2 Practice

Practice is the use of spoken, written and/or non-language symbols by one or shared by two or more people to "make clear to others what it is [they] take to be doing" (Gee, 2005, p. 11). Passive voice or backgrounding (in Gee's term) could indicate a possible lack of action or practice. Gee (2005) contended that, "we continually and actively build and rebuild our worlds, not just through language, but through language used in tandem with actions, interactions, non-language symbol systems, objects, tools, technologies and distinctive ways of thinking, valuing, feeling, and believing" (p.10). For example in a classroom situation teachers are recognised by students through the practise of their teaching, in their actions, interactions and the use of symbols or objects (mathematical instruments). This construct (practice) would be explored in the classrooms to identify and understand why and how teachers enacted practices. Thus the Discourse analysis questions are: What practices do teachers put forward in their Discourses and how are languages and non-language symbols used to show what they are involved in?

3.4.3 Identities

Identity as earlier defined (section 3.1) above is different roles or positions played (acted) by a person in a peer or social group, such as religious groups, clubs, cultures, schools and/or classrooms to be recognised by others. Students can recognised Mathematics teachers as they assume an identity in the classrooms. Gee (2005, p. 22) use the word "who" in referring to an identity. As an example: Mathematics teachers can project themselves as language teachers in their Discourse practices by correcting students' wrong use of language. In this instance, students recognise the language teacher as the identity enacted. In another context, the same Mathematics teachers might assume different identities. Gee (2005, p. 23) reported that language alone is not enough to be recognised as "a particular who". He argued that [it] requires acting, thinking, interacting with other people and with various objects (mathematical instruments, pictures and diagrams) in an appropriate location and at appropriate times. This study identified, characterised and explained Discourse practices used by teachers in instances of enacting their identities in the data. Here, the Discourse analysis questions are: What identities (roles, positions) are the teachers enacting and describing? How are languages and non-language symbols used to make the identity of the teachers identifiable?

3.4.4 Relationships

According to Gee (2005) we use language to build and sustain relationships with other people, groups and institutions with whom we are communicating. Gee argued that we relate to other people, social groups, cultures or institutions in terms of different identities we assume that they have. In turn the identities we construct for ourselves are often defined, in part, by how we see and construe our relationships with others. The relationships which teachers have with students would show the identities that they are seeking to enact in their Discourses (Gee, 2005). For example: teachers can enact practices which would portray an identity as a mathematician which might be in a relationship with other mathematician during lessons. During lessons that relationship might be used by teachers in words and/or phrases which would draw students to learn Mathematics. Again the Discourse analysis questions are: What relationships do the students see as existing in the situation that the teachers are describing? How does it manifest in teachers' Discourse practices? How are the teachers' Discourse practices put forward in the classrooms and negotiated in their relationships?

3.4.5 Politics

The notion of politics (the distribution of social goods) as used in Gee (2005) means anything that a group of people consider to be valuable, and can be a source of power, status or worth. Thus, the knowledge of Mathematics is social goods in the classrooms. Teachers are engaged in the distribution of these social goods in the Mathematics classrooms in their Discourse practices. During teachers' interactions with students, these social goods are visible and recognisable in what they privilege or not in their Discourse practices which this study explored. The Discourse analysis questions are: What social goods were perceived by the teachers and students? How do social goods expressed in the Discourse practices affect the teachers or the students?

3.4.6 Connections

Gee (2005) argued that we use language and non-language symbols to render certain things connected or disconnected. He noted that sometimes the connections made are explicit, while at other times they are implicit (Gee, 2005). Teachers can make connections or not between mathematical terms and concepts (or vice versa) during their Discourse Practices in the classrooms. Gee (2005, p. 13) pointed out that people "use language to connect and make things relevant or irrelevant to other things". For instance, in the classrooms, Mathematics teachers make connections or disconnections between two content areas such as set theory and geometry in the use of circles and rectangles while teaching the students. In Addition, in solving problems on inequality, Mathematics teachers could make connections or disconnections between students understanding of inequality in their ordinary everyday language and the mathematical language in their Discourse practices. Students would then understand the concept more clearly. Here, the Discourse analysis questions are: In what ways are teachers connecting or disconnecting mathematical terms or concepts in their Discourse practices? What sorts of connections are made to previous or future interactions with people, ideas, text, and symbols outside the present action and interaction in the Mathematics classroom?

3.4.7 Sign systems and Knowledge

Sign systems and Knowledge could include different language (English and Hausa), different varieties of social language (formal, informal, mathematical language), and other non-language symbols (gesture, graphs, pictures, and equations). Sign systems and Knowledge represent different ideas, knowledge, and beliefs (Gee, 2005). Sign system and Knowledge according to Gee (2005) can be used by people (in these case Mathematics teachers) differently in several ways in order to understand their world. Teachers in their Discourse practices can communicate using sign systems and certain forms of knowledge (ways of knowing the world) thereby portraying it as relevant or not in the multilingual Mathematics classrooms. Teachers would use several languages including gestures, symbolic, and graphical sign systems to make relevant some mathematical concepts to other concepts in their teaching. Thus the Discourse analysis questions are: What Sign system or ways of knowledge do the teachers refer to? What verbal and non-verbal symbols are used by teachers which indicated their Discourse practices?

3.5 Complementing Gee's Theory

As I have earlier indicated, I have emphasised with certainty that regardless of the significance recognition to the language and non-language categories of Discourse practices, Gee's theory, is limited. Gee's theory is a sociocultural and sociolinguistic theory, hence the difficulty for me using Gee's theory as both theoretical and analytical framework was to develop an analytical framework which would capture all the categories and sub-categories of Discourse practices in multilingual Mathematics classrooms of my study. Therefore, Gee’s Discourse analysis perspective was limited in terms of providing all the necessary tools for gaining an entry into the multilingual Mathematics classrooms.

In adopting and applying Gee (2005) Discourse analysis theory and methods in the present study, I turned to previous research work that had successfully used this method in the multilingual Mathematics classrooms. The work of Moschkovich (2002) was one. Moschkovich used 3 perspectives on bilingual learners in the United States of America (USA) to consider how a situated and sociocultural perspective can inform work in the Mathematics classroom. One of her focus was on participation in Mathematical Discourse practices. The implications in her study are somewhat different to what my study is investigating because she approached her work from the learners (students) perspective, but there is one significant similarity which had a bearing on what my study is investigating: the notion of Gee’s Discourse analysis for identification of Discourse practices in the context of multilingual Mathematics classrooms. Among other findings in her study, Moschkovich discovered that bilingual students used some resources such as gestures, objects, everyday experiences, their first language, code switching and Mathematical representations in learning Mathematics. These findings provide insight on some analytical tools for clarifying how teaching and learning take place in the multilingual Mathematics classrooms in my study. Moschkovich (2002) further noted from Gee’s Discourse perspectives, that the teaching and learning of Mathematics in the multilingual classroom is “…, developing classroom socio-mathematical norms and using multiple material, linguistic, and social resources” (p.197). For her, Mathematical Discourse practices are linked with socio-mathematical norms in the multilingual Mathematics classrooms.

Moschkovich (2002, p. 198) argued that Discourses in Mathematics classrooms (as explained above) involve “ways of talking acting, interacting, thinking, believing, reading, and writing”. Her definition of Discourse is not my understanding of

Discourse in this research. But her definition seemed to be linked to Discourses and by this I mean Discourse practices in the Mathematics classrooms involve different ways of combining and integrating verbal and non-verbal symbols by teachers/students to enact Mathematical tasks that are recognisable and identifiable as a member of the class or the school (Moschkovich, 2002, 2003).

The aforegoing presupposed that the Discourse practices in the multilingual Mathematics classrooms could be identified and as well discussed in detail. Nevertheless, one of Moschkovich's primary concerns as above was the focus on developing classroom socio-mathematical norms and the use of multiple materials, linguistic, and social resources. I saw this as pertinent to my study and as such seemed to me that Discourse practices are recognised during classrooms lessons as the teachers engage students in interaction (Gee, 2005). These practices become visible through the actions and interactions of the teachers and students with books and other Mathematical instruments (Setati, 1998, 2005). In this research, Discourse practice were identified and understood during lessons that Mathematics teachers demonstrated when using language and non-language symbols in their classes. I now consider the Guiding Questions of Discourse Practices in this study.

3.6 Guiding questions of the Discourse Practices

As earlier indicated in Chapter One, this study was guided by one main research question and two sub-questions. After giving the description of Gee (2005) Discourse analysis and method theory which underpins this study, I now briefly explain below the guiding research questions.

Main question: What Discourse practices were used by teachers as plainly evinced in their language (verbal and non-verbal) in northern Nigeria multilingual Mathematics classrooms? This study identified and explained teachers' Discourse practices enacted during their interaction with students in the classrooms. I identified and explained the kinds of Discourse practices of teachers from the collected data of the video recorded classrooms observations, interviews and the field notes.

Sub-question:1. How do teachers use language (verbal and non-verbal) to enact practices as reflected in their Discourses in the teaching and learning of Mathematics in multilingual classrooms in northern Nigeria?

There are many different Discourse practices such as the once mentioned earlier in this research which teachers engaged students in their Mathematics classrooms. Teachers used verbal and non-verbal symbols in order to ensure that certain concepts and ideas are clear in the classrooms. I identified and explained the kinds of Discourse practices of teachers from the collected data.

Sub-question: 2. why do teachers use language (verbal and non-verbal) in their Discourse practices in multilingual Mathematics classrooms of northern Nigeria?

Most teachers' Discourse practices occur within Mathematics classrooms and in a particular lesson. This study, examines the dominant Discourse practices of teachers in the multilingual mathematics classes and how they use or not verbal and non-verbal symbols in teaching and learning (Gee, 2005, p. 12). This was done, by analysing the data of the video recorded, classroom observations, in-depth reflective interviews and field notes.

3.6.1 Questions for the analytic process

Tools of inquiry, building tasks, complementary research work to Gee's theory and the guiding questions for this study are fully discussed above. I now turn to certain questions about the seven building tasks. In this study, the 26 questions of Gee were reformulated and adapted. The questions are presented in Table 3.1 below.

Table 3.1:

Analysis Questions about the seven building tasks

Research Questions	Specific analysis Questions
1. What Discourse practices were used by teachers as plainly evinced in their language (verbal and non-verbal) in northern Nigeria multilingual Mathematics classrooms? 2. How do teachers use language (verbal and non-verbal) to enact practices as reflected in their Discourses in the teaching and learning of Mathematics in multilingual class-rooms in northern Nigeria? 3. Why do teachers use language (verbal and non-verbal) in their Discourse practices in multilingual Mathematics classrooms of northern Nigeria?	1. What Discourse practices are used by teacher/students in their verbal and non-verbal talks in the multilingual Mathematics classroom? 2. How are the social goods (example status and power) relevant/irrelevant in the verbal and non-verbal teaching of students in the multilingual Mathematics classroom during Discourses? 3. What sorts of relevant social relationships do teachers/students display in their Discourse practices using verbal and non-verbal skills in the multilingual Mathematics classroom? 4. What sorts of connections looking backward or forward are made within and through work during Discourses in the multilingual Mathematics classroom? 5. What languages (Mumuye and Hausa) are relevant in the verbal and non-verbal actions of the teacher and students in the multilingual Mathematics classrooms during Discourses? 6. How do teachers make relevant (or irrelevant) in their verbal and non-verbal work, the DP in the multilingual Mathematics classroom and in what ways? 7. How do teachers make the social goods relevant (or irrelevant) in their verbal and non-verbal work during the enactment of the DP in the multilingual Mathematics classroom? 8. How are social relationships stabilised or transformed by teachers/students in their verbal and non-verbal work during Discourses in the multilingual Mathematics classrooms?

9.	How do teachers make relevant (or irrelevant), the social languages in their verbal and non-verbal lessons to enact Discourse practices in the multilingual Mathematics classroom and in what ways?
10.	Why do teachers use language (verbal and non-verbal) to make relevant and irrelevant their Discourse practices in the multilingual Mathematics classroom?
11.	Why do teachers use language (verbal and non-verbal) to play their part (roles, positions) in multilingual Mathematics classroom?
12.	Why do teachers/students use verbal or written texts to set up certain relationships to the Discourses in the multilingual Mathematics classrooms?
13.	Why do teachers use language (verbal and non-verbal) to connect social goods to Discourses operative in the multilingual Mathematics classroom?
14.	Why do teachers use language (verbal and non-verbal) to make relevant (irrelevant), the social languages to Discourse practices and in what ways in the multilingual Mathematics classrooms?
15.	Why do teachers use language (verbal and non-verbal) in their sign systems and symbols during Discourse practices in the multilingual Mathematics classroom?

CHAPTER FOUR: Research Methodology

4.1 Introduction

As noted in Chapter One, the purpose of this research was to identify and explore teachers' Discourse practices in the multilingual Mathematics classrooms. This Chapter describes the research paradigm, the design of the study and how data was collected to achieve the purpose of the research. I used the research methodology by Cohen et al. (2011) as a guide to this study. The population, sample, research context, the research instruments, validity, and reliability are discussed. The chapter concludes with a discussion on the ethical issues.

4.2 The paradigm and research design

The essential function of a research paradigm is to support and facilitate the generation of knowledge. There are found several branches of research paradigms, in education and in social science, each possessing its own assumptions about knowledge (Cohen et al., 2011). Cohen et al. contend that research paradigms of interests in education include: 1) the prediction and control of educational processes through knowledge (the scientific paradigm such as positivism). A positivist approach is an observer of reality. Positivism deals with prediction, objectivity, replicability and the discovery of scientific generalisations; 2) the desire to change education for effective achievement (the critical theoretic paradigm); and 3) the desire to understand educational phenomena, including the individual sense making (the qualitative paradigm, such as interpretivism).

This study is located within the interpretivist paradigm. In explaining interpretivism Carson et al. (2001) argued that knowledge is acquired through social construction, rather than objectively determined. Carson et al. (2001) further noted that an interpretivist paradigm normally stays away from rigid frameworks as in positivist research. Instead, flexible structural research frameworks which are receptive to capturing human interactional meanings are adapted. Therefore, the researcher remains open to new ideas and knowledge during the conduct of the research. An interpretivist researcher is concerned with understanding meanings, motives, reasons and other subjective experiences which are contextual in nature and time bound

(Neuman, 2000). The main reason for locating my study within the interpretivist paradigm is because of my interest to understand teachers' Discourse practices and make sense or meanings from these practices. So, within this paradigm, I entered the field with an open mind. With the help of the research participants, I was able to describe and interpret teachers' Discourse practices during their engagement with students in multilingual Mathematics classrooms.

In line with the interpretivist paradigm, this study adopts a qualitative research design. According to Brantlinger, Jimenez, Klingner, Pugach, and Richardson (2005), qualitative research is "a systematic approach to understanding qualities or the essential nature of a phenomenon within a particular context" (p. 195). Brantlinger et al. (2005) further posited that qualitative research broadly adapts inductive approaches to produce insightful results into understanding phenomena which are difficult to be measured quantitatively. Generally, qualitative research produces findings not arrived at using statistical methods. This study was set to give detailed descriptions of Discourse practices. Therefore qualitative research enabled my study to generate in-depth insight into teachers' Discourse practices in multilingual Mathematics classrooms. An important feature of qualitative research is the concern to capture detailed descriptions of research participants' engagement. Geertz (1973) used the term 'thick description' to refer to the detailed descriptions of participants' actions in a specific research context. Therefore, with the qualitative method, I gained insight and detailed understanding of teachers' Discourse practices in multilingual Mathematics classrooms. I now discuss the population of the study, sample and how the data was collected and analysed.

4.3 Population, sample and research context

The population of the study was multilingual Mathematics teachers in Secondary Schools located in a northern Nigeria state metropolis. As an administrative centre of the state, in which most government ministries, agencies, boards, and parastatals are located, the metropolis has many diverse language groups who engage in civil and private work, agriculture and business. As a result of migration to this city, multilingualism in the Mathematics classroom is more obvious here compared to other areas of the state which is why this location was chosen.

As is the case with most qualitative methods, the sample in this study was small and purposive (Cohen et al., 2011). The sample consisted of four purposively selected multilingual Mathematics teachers in two Secondary Schools (two from School A and two from School B). These Schools were chosen on the recommendation of the Ministry of Education because of their multilingual nature. Students come from diverse language backgrounds all over Nigeria. The schools offer both Junior and Senior Secondary classes (JSS 1-3 and SS1-3), which is equivalent to grades 7-12 in South African intermediate and High school/classes. The four participants were current teachers, teaching in Second-year Senior Secondary (SS2) multilingual Mathematics classrooms. As earlier indicated in Chapter One, my choice of SS2 classrooms was based on the reasons that at this level, issues of multilingualism are most apparent due to the fact that most parents in rural areas transfer their children to urban metropolitan townships in northern Nigeria. One of the apparent reasons for parents doing this is that these urban schools are better resourced and students are immersed in English. Again, not much research work has been conducted at these levels of (SS 2) classes in northern Nigeria. Furthermore, the classes are relatively small in terms of the student population; besides the fact that, the students do not write any external examinations. This is also the preparatory period before students write their Senior Secondary Certificate Examinations (SSCE). And also to obtain data of sufficient richness to allow for a productive analysis for my research from the experienced Mathematics teachers who were assigned to teach these multilingual classrooms.

The purposive selection of the Mathematics teachers was to enable me to choose those who met the criteria for selection and were willing to participate. These criteria are further explained in the next paragraph. Table 4.1 below is a summary of biographical data from the teachers in the sample and reflects the multilingual nature of the schools/classes. Two languages (one core and one elective) are taught in each of the two schools. Students speak three or more languages in addition to the languages taught. All the teachers are multilingual and each of them could speak at least four languages. The teachers also indicated that in addition to the languages they spoke well, they could also understand many of the home languages of students. All the teachers are holders of a Bachelor's degree in Mathematics or Mathematics education, all have at least 15 years classroom teaching experience and all are currently in the teaching profession.

Table 4.1:

Teachers' Biographical Profiles in Schools and Classes

Teacher	Gender	Educational Qualification	Years of Teaching Experience	Years of Teaching SS2	Spoken languages
E	Female	B. Sc (Ed), Maths (Hons), M. Sc (Ed) Maths	24years	18years	Jukum, Hausa, Pidgin English
G	Male	B. Sc (Ed) Maths (Hons)	17years	9years	Jenjo, Hausa, Arabic, Pidgin English
S	Male	B. Sc (Ed) Maths (Hons)	15years	6years	Igbera, Hausa, Arabic, Pidgin English
M	Male	B. Tech Maths (Hons)	18years	7years	Kutebe, Hausa, Pidgin English

The criteria for selecting the four Mathematics teachers as indicated in Table 4.1 above was based on their location, teaching experience, use of Mathematics syllabus, and accessibility. To achieve these criteria I conducted a pre-interview data collection phase during my pilot study, with each of the selected principals of the two schools and their teachers in the study area. I confirmed that these records were correct with the Ministry of Education before the data collection. It is important to elaborate further on the above-mentioned criterion:

a) **Location:** Teachers who were currently serving in the study area. I ascertained their status from the principals of each school.
b) **Teaching experience:** Teachers who had a minimum of a university Bachelor's degree in Mathematics and/or Mathematics education and had at least four years of teaching experience. The teachers also had knowledge about the presence of languages within their schools and classrooms. This awareness was important because teachers not only gave the students the opportunity to use the different languages present in the classrooms in the development and communication of their mathematical knowledge and thinking during lessons but also used the shared home languages with the students in their teaching. This criterion was also important because it excluded the possibility that the teachers' Discourse practices could be due to lack of teaching experience or recognised qualifications. Experience and qualifications do not necessarily equal good practices. I consulted the Ministry of Education and their principals for recommendations.
c) **Mathematics syllabus:** Teachers taught the same Mathematics contents (trigonometry). This enabled me to see similarities and differences in both the contexts and Discourse practices of the teachers in the multilingual classrooms.
d) **Accessibility:** The teachers who allowed me to access their schools/classrooms were cooperative, willing, plus interested in participating which assisted in the successful conduct of my study.

The satisfactory criteria provided an opportunity for working with teachers who were available, qualified, interested and ready to embark on the study. Thus it enabled me to obtain data of sufficient richness.

4.4 Data Collection

Data gathering techniques for this study included video observations, written field notes and face-to-face reflective interviews in schools and classrooms. My choice of using these methods was to get rich data for my research, and also triangulate between the three methods to enhance internal reliability. As stated before the teachers' Discourse practices are revealed during the teaching and learning Mathematics in multilingual classrooms. Discourses are about how verbal and non-verbal language which are used to enact specific practices (Gee, 2005). To gain access to teachers' Discourse practices it was important to observe them in their teaching. That is, in their classroom discussion and interaction with students and talk to teachers about their practices.

The data gathering process covered a period of one year and six months (see Appendix C). The data collection was in two phases. The first phase focused on classrooms observations. Classrooms observations allowed me to gather at firsthand the teachers' Discourse practices in multilingual Mathematics classrooms (i.e. what they do in their teaching) (Adler, 2001). It enabled me to gather information about the interactions which took place (verbal and non-verbal) between teachers and students in the classrooms. I focused on teachers' Discourse practices during lessons and video observed each of the participants three times in different lesson presentations on trigonometry in their various school classrooms. My reason for choosing to observe the participants in different lesson presentations on trigonometry was because recent literature in the Nigerian context showed that students' performance had persistently been poor in trigonometry (Ogundele et al., 2014; Oluwole, 2008; WAEC, 2011, 2012, 2014). Additionally, as one of the key topics in Mathematics, it has a multitude of application in the life of every person. One of the main factors attributed to this poor performance, according to the above authors, was the problem of teaching Mathematics to students who were learning to understand the LoLT in a multilingual classroom as earlier mentioned in Chapter One (Section 1.2). Therefore a total of 12 lessons were observed. The duration of each lesson depended on the schools' timeTable. At school A, the first three lessons before breakfast were 40 minutes each and the lessons after breakfast were 35 minutes each, while in school B, all lessons were 40 minutes. A summary of the lessons observed with the four teachers is presented in Table 4.2 below

Table 4.2:

A summary of lesson observations with four teachers

Teacher	Date of lesson observation	Duration of lessons	Lesson focus
E	17/01/2018	40 minutes	Trigonometry(Pythagoras theorem)
	19/01/2018	40 minutes	Trigonometry(calculating unknown side of a right angled triangle)
	23/01/2018	35 minutes	Trigonometry(calculating length and height of chord and equilateral triangle)
G	26/01/2018	40 minutes	Trigonometry(introduction)
	30/01/2018	40 minutes	Trigonometry(calculating unknown side of a triangle using sine rule)
	01/02/2018	40 minutes	Trigonometry(calculating triangle unknown side of a triangle using sine rule)
M	16/01/2018	40 minutes	Trigonometry(calculating value of unknown side of a triangle)
	18/01/2018	40 minutes	Trigonometry(calculating unknown side of a triangle using trig ratio)
	22/01/2018	40 minutes	Trigonometry(calculating bearing of a point on triangle)
S	25/01/2018	40 minutes	Trigonometry(introduction to types of triangles)
	30/01/2018	40 minutes	Trigonometry(the concept of sine, cosine and tangent)
	05/02/2018	40 minutes	Trigonometry(the concept of cosec, sec and cot)

These lessons as indicated in Table 4.2 above were part of the normal schools timetable and were carried out without disrupting the schools' calendar of events. There was no extraordinary planning of lessons. The teaching processes were recorded from the beginning to the end of each lesson using a video camera. The use of the video recordings was important for me, because it captured accurately the teachers' Discourse practices in multilingual classrooms and enabled me to replay what was observed during data transcribing and analysis (Cohen et al., 2011).

As I was observing and writing selected important notes on each of the lessons during observation, I employed the service of a camera person. Specific instruction given to the camera person was to stand behind the students inside the classroom to avoid distraction. I asked him to focus the lens of the video camera on the teacher and teacher's interaction with the class. Field notes were necessary and important to support the video observations to enable rich descriptions, and the diverse perspectives of teachers' Discourse practices. I was concerned with main or key points of interest on teachers' Discourse practices that the lens of the video camera might note capture (e.g. actions, settings, behaviour, conversations and total number of students in a class) and took notes during classroom video-observations.

In the second phase of data collection, I worked with the same four teachers who had participated in the first phase. This phase focused specifically on semi-structured in-depth reflective interviews with each teacher. I used reflective video interviews (Geiger, Tracey, & Janeen, 2015). Reflective video interviews as used in this study, refers to a situation where a teacher after viewing his/her recorded actions and interactions in the class during the lessons, give an explanation justifying his/her actions. These were the recorded videos of lesson presentations of the same teachers in phase one above. The use of reflective video interviews was important because it enabled teachers to recall and answer the interview questions meaningfully of the recorded practices (Geiger et al., 2015). Issues arising from the classroom recorded videos such as teachers' Discourse practices, the challenges faced by teachers while teaching students who are grappling to understand LoLT, what the teachers do to address the challenges in the multilingual Mathematics classrooms, and why they did so the way they did, were part of the interview questions (see Appendix A). These reflective interviews were carried out in the months of January and February 2018 as indicated in Table 4.3 below:

Table 4.3:

A summary of reflective interviews with four teachers

Teacher	School	Day	Date
M	A	Tuesday	30th January 2018
E	A	Thursday	1st February 2018
S	B	Wednesday	7th February 2018
G	B	Monday	19th February 2018

The reflective interviews at School A were conducted in the e-library and the staff room with teachers M and E respectively. Thus was convenient for the teachers. But during the interviews, there were a number of interruptions as other members of staff entered the room. The teachers were uneasy as they did not want other colleagues disturbing the interviews. It was not the case at school B; the reflective interviews were carried out in the Chemistry laboratory. It was carried out in this venue to avoid interruptions because all teaching staff members of school B shared one large office. It was quiet in the Chemistry laboratory, with no disturbance by other staff members and students. It was calm, orderly, and functional. These interviews gave me insight into teachers' Discourse practices, the challenges of teaching Mathematics in multilingual classrooms and understanding how teachers dealt with these challenges while helping students in such contexts. The interview with each teacher took a minimum of 25 minutes. The interviews were carried out, to enable rich description of Mathematics teachers' Discourse practices.

All the students were multilingual and most could speak at least four home languages plus English language and Pidgin English. In both schools A and B the teachers indicated that some of the students could not speak fluent English. One of the home languages in the study area is Hausa and most students could speak and understand it.

4.5 The process of data analysis

Cohen et al. (2011) noted that "data analysis involves organising, accounting for and explaining the data, in short, making sense of data in terms of the participants' definitions of the situation, noting patterns, themes, categories and regularities" (p.537). They asserted that there was no single or correct way of collecting data, analysis and presentation. How each researcher does it should adhere to the issue of suitability for purpose. Cohen et al. (2011) further argued that data analysis using qualitative approach is substantially on interpretation and the researcher has to note that there are several interpretations to be made of the data. To do an analysis of the text and Discourse practices in this study in the multilingual Mathematics classrooms, two steps were involved. It was important to identify first and foremost these Discourse practices in the text (verbal and non-verbal) obtained from teachers' videoed lesson observations and interviews. Second, it was essential to look at how and why language was used in the multilingual Mathematics classrooms together with other "(ways of thinking or feeling, ways of manipulating objects or tools, ways of using non-language symbols etc.)" by teachers involved in particular Discourse practices, so as to achieve the purpose of analysis in this study (Gee, 2005, p. 9). It was necessary to examine the identified Discourse practices, how they were carried out and why Mathematics teachers of this study performed these Discourse practices in the way they did using verbal and non-verbal symbols. I shall now explain the process of data analysis.

Before I do so, let me first and foremost focus on the more detailed links between my theoretical framework and analytical framework. In their book titled: *Doing Research/Reading Research: Re-interrogating Education*, Dowling and Brown (2010) gave a description of educational research and clearly differentiated between **theoretical** field and **empirical** field. The empirical field (which may include empirical setting) is the local territory of experience a researcher is doing (i.e. the observed position). The theoretical field on the other hand is concerned with the conceptual make-up which empowers the researcher to think about the empirical setting (Dowling & Brown, 2010). They (Dowling and Brown) argued that conducting educational research requires the expertise of a theoretical framework inside a general field and the circumscribing of an empirical setting inside an empirical field. “It is the bringing to bear of the theoretical framework on the empirical setting that enables you [researcher] to make both theoretical and empirical claims” (Dowling & Brown, 2010, p. 9). The idea of data analysis as stated by Dowling and Brown (2010) is properly conceived as a dialogic process which involves moving between the theoretical and the empirical fields. The analysis of data which takes place during the dialogic process involves the use of tools otherwise called the language of description. “This language of description [organisational language] consists of the categories that in general, have been developed during the process of the analysis itself” (Dowling & Brown, 2010, p. 86). Figure 4.1 below shows the understanding of the theoretical field, the language of description, and the empirical fields in this study.

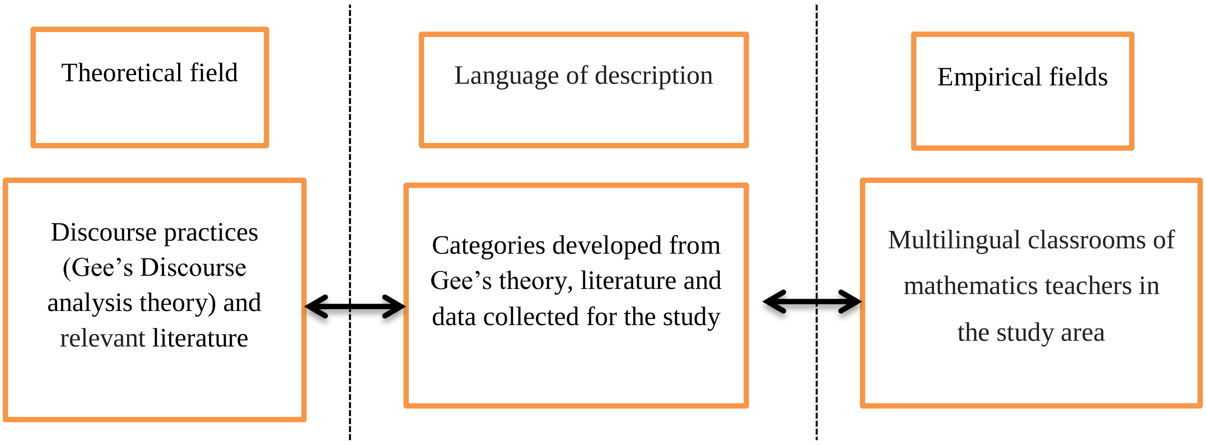


Figure 4.1: shows the empirical fields, the language of description, and theoretical field

As indicated in Figure 4.1 above, my theoretical field in this study is Discourse practices. This was the main construct drawn from Gee’s Discourse analysis theory. The sub-categories were drawn from relevant literature on studies conducted in multilingual Mathematics classrooms and data collected for this study, while the empirical fields were the multilingual classrooms of the Secondary School Mathematics teachers in the study area. The language of description in this study as I would elaborate in more detail in the subsequent paragraphs refers to all the categories and sub-categories developed before, during and after my piloting of this study. These categories and sub-categories were developed from Gee’s Discourse analysis theory, reviewed relevant literature and the data gathered from the multilingual classrooms of Mathematics teachers for this study. I focus now on explaining the process of data analysis.

In explaining how data should be analysed Gee (2005) described two methods: form-function and language-context analysis. According to Gee (2005) the former deals with the analysis of correlations between form (structure) and function (meaning) in language, while the latter is concerned with the analysis of more specific interactions between language and context. Examples of "form" include parts of speech (nouns, verbs, and adjectives) or types of phrases/clauses (Gee, 2005, p. 54). In describing what context is, Gee (2005) contended that these might encompass "the material setting, the people present (what they know and believe), the language that comes before and after a given utterance, [...] and institutional factors" (p.57). This study has adopted the language-context approach to do the analysis of the textual Discourse practices, not only for the reason that it aligns with the focus of the research, but also this approach would help in the analysis of my data to understand how the social languages were used and the interpretations of particular Discourse practices as construed by the teachers/students in the multilingual Mathematics classrooms. Gee (2005) argued that language-context approach presumes a reflexive perspective of language and context, and also asks questions on how language is used in a particular context. The word 'reflexive' means that utterances (verbal or non-verbal) affect what people take the context to be. In turn context also has an effect on what people take as the meaning of utterance.

As I indicated in the paragraph above, the analysts using language-context method would be interested in analysing the text in the context in which verbal and non-verbal language are used. As such Gee (2005, p. 111) contends "…[the] analysis involves asking questions about how language, at a given time and place, is used". In this study, the main focus of the analysis is on the text as transcribed verbatim from the teachers' use of language during teaching and learning of Mathematics in the classrooms.

4.5.1 Textual Discourse practices analysis

Textual Discourse practices analysis includes the analysis of the actual text as evinced in the verbal and non-verbal Discourses of the participants, and the interpretation of the processes involved in the construction of the Discourses during an interaction (Gee, 2005). Gee explained that the main purpose of the analysis is the pattern and links within and across utterances. The analysis involves highlighting the features (the language pattern) in a text. Reading of texts is done in a reciprocal and cyclical process as the analyst moves back and forth between the structures of the text, such as the vocabulary, grammatical terms, words that suggest the situated meanings, identities and relationships in the context (Gee, 2005). The analysis requires reading the text in order to highlight the patterns and links as uttered in the context by the research participants.

In the analysis, features of the related highlighted text which were cumulatively seen are interpreted in terms of the understanding of the research participants. Words or phrases of the text from the collected data of this study which were cumulatively identified and are in relation to each other were highlighted. In connection to the purpose and nature of the Discourses analysed in this research, besides highlighting the features of the text, I focused on the structure of the text, which is I gave accounts of the interactional direction, which included who took the lead in the interaction, the manner of changes which occurred during the Discourses and turn-taking. A reading of text provided me with insights to explore and identify the dominant Discourse practices used by the Mathematics teachers in the multilingual classrooms (see APPENDIX F).

4. 5.2 Unit of analysis

Long (2011) defines a unit of analysis as the fundamental component that is being analysed in a research project. The unit of analysis in this study is the negotiated texts (verbal and non-verbal) on Discourse practices, categories and sub-categories. In analysing the categories in the data for the DP, the texts from verbal (speech) and the non-verbal (which were the sub-categories) formed the basic unit of analysis, because it is from the verbal and non-verbal talks that the DP categories emerge. As the Discourses are the differing ways of using language, other symbolic expressions, and objects of thinking, feeling, believing, valuing and acting which can be used to identify oneself as a member of a socially meaningful group or ‘social network,’ (school/classroom in this instance). The texts from verbal and non-verbal (categories and sub-categories of Discourse practices) are the starting point for analysis of the DP. In the data analysis, I used two approaches in the organisation and presentation of the findings: the thematic and individual data organisation and presentation approach.

Individual: Here according to Cohen et al. (2011) are the entire utterances (verbal or non-verbal) of data gathered from a participant which are separately analysed and presented. Then the researcher moves on to the data analysis of the next participant and does the same until s/he finishes the data analysis of all the participants. This approach has the advantage of preserving the coherence and integrity of the participants’ utterances (verbal or non-verbal) and enables the researcher to see each individually. This method requires the researcher to look for themes, shared utterances, agreement, and disagreement (i.e., to summarise the data)

Thematic: This method of data organisation and presentation is concerned with analysing and presenting the data based on the relevant or particular theme(s). This approach is economical in terms of handling, summarising, and presenting data. My reason for using two approaches was to identify/analyse teachers’ Discourse practices in the multilingual Mathematics classrooms in a clear manner. I would therefore combine the two methods discussed above using the following points highlighted by Cohen et al. (2011):

1. Calculating frequencies of occurrences and utterances
2. Discuss the utterances of observed behaviour
3. Discuss the utterances given in interviews

Thereafter, I would pull together the observation and interview analysis systematically, and synthesise the implications of the dominant DP in the teaching and learning of Mathematics in multilingual classrooms. The Dominant DP used in this study refers to the DP that has influenced (in directing the flow of the Discourses) across data obtained from teachers’ Mathematics classrooms.

4.5.3 Data collection challenges

The main challenges I had during the data collection was the disrupted teaching (cancellation of a lesson or the cancellation of a whole day of activities in the school/classrooms). On five different occasions pre-planned observation lessons were cancelled. There was no information until I arrived at the school before I was told of the events leading to the cancellation. Some of the major events for cancellations included: Assemblies, class and/or house inspection, tree planting day, labour day, general cleaning, emergency staff meetings, cultural day, games, girl child day and security reports (Boko Haram terrorism/Herdsmen terror attacks on farmers). The disrupted teaching was more pronounced in school B than school A. On one certain occasion pre-planned lesson observations were cancelled because of security report that terrorists (Boko Haram) had planned to kidnap all the students in school B. Most schools within the State capital were closed for two weeks, because of the security report.

These challenges of data collection did not, however, adversely affect the quality of my collected data. Despite the disruption and/or cancellations of lessons, I endeavoured to video record all my participating teachers during lesson observations and interviews without skipping any lesson or interviews. To facilitate communication, I requested the mobile phone numbers of each participating teacher in the study.

4.5.4 Transcription

It is necessary to transcribe raw data before analysis so that I should have written texts. Therefore the transcription is a process which attempts to represent the actual actions and interactions of the research participants' spoken (verbal and non-verbal) from raw data to a written text (Setati, 2002). According to Setati (2002) it is imperative that the data transcribed is not just **what** the research participant said but **how** it was said.

The transcription in this study was based on the details of speech and written/symbolic systems (gesture, actions, and physical expressions), relevant to the context and focus of the research (see Appendix D & E). Gee (2005) pointed out that what is relevant for transcription is based on the analyst's theoretical judgments on the actions and interactions in the particular context being analysed. In this study, I have endeavoured to have a careful verbatim transcription of the teachers'/students' words and actions so that the transcripts would inform my analysis, findings, and conclusion and uphold the trustworthiness of the research (Gee, 2005; Setati, 2002). In particular, my transcription texts, represent the verbatim talks, symbols, gestures and actions of teachers in instances of what, why, and how they taught in engagement with mathematical tasks. I achieved these by viewing and replaying video-recordings of all the observed lessons and the reflective interviews. These were further enriched by the field notes. Due to my limited experience with textual Discourse practices analysis, the initial transcriptions only captured what teachers/students were saying, but during analysis, more detailed transcriptions were necessary. I explain below the transcription conventions used during the process of transcribing.

4.5.4.1 Conventions for the transcription

I constructed a set of transcription conventions. These conventions assisted me in remaining consistent in the transcription process. For example, I transcribed every verbal talk of teachers/students using Hausa and/or Pidgin English languages words and I did the same for the English language. The Table 4.3 below presents the conventions that I constructed.

Table 4.4:

Conventions used in the data of this study

Symbols	Meaning of the symbols
T	Mathematics teacher
Ss	Students
S	Student
R	Researcher
(…)	All kinds of pause
//	Refers to raising or falling tones
…	Incomplete statement
()	Descriptions of non-verbal symbols (gesture, movements of the body etc.) are in brackets

After transcription, I coded the texts in the order in which teachers'/students' talks and interactions were enacted (i.e. changes in who was putting forward ideas or contributing to the situation). I sorted the texts into stanzas somewhat like verses in a poem (Gee, 2005). Gee notes that "Stanzas are "clumps" of tone units which deal with a unitary topic or perspective, and which appear (from various linguistic details) to have been planned together" (Gee, 2005, p 107). A stanza in this study covered the whole section of a data in which a unit of a mathematical idea or concept was discussed. Each stanza was broken down into lines and each line contains one piece of new information. Thus, I can easily refer to a whole stanza (e.g. stanza 2), a line (e.g. stanza 2 line 33) or a more specific text within a line (e.g. Teacher E, stanza 2 line 33).

In the transcription, as indicated in the Table 4.3 above I used (…) three periods inside a bracket for all kinds of pauses to avoid confusion. I also adopted Gee's use of a double forward slash // to represent a tone unit that has a final contour (rising or falling tone which indicates some kind of closure on an information). Non-language symbols, such as gesture, movements of the body and others were described in brackets.

4.6 Validity and Reliability

Validity and reliability are constructs used mainly in quantitative research to guarantee objectivity. The understanding of objectivity is at odd with qualitative research at the level of inferences (Zhang & Wildemuth, 2009). Objectivity means that the findings arrived at are independent of colour, race, nationality, religion, moral preferences and political predispositions of the researcher.

It is impossible to achieve this kind of objectivity in conducting qualitative research, for example using observation methods, because an observation comes out of what the observer selects or choose to see and note. Qualitative researchers are, therefore, subjective in nature. Qualitative researchers bring personal subjectivity to the research. These might arise from the researchers own class, status, values, and gender. It is possible for there to be different, yet equally valid observations from different perspectives. My study is guided by the following questions:

1. What Discourse practices were used by teachers as plainly evinced in their language (verbal and non-verbal) in northern Nigeria multilingual Mathematics classrooms?
2. How do teachers use language (verbal and non-verbal) to enact practices as reflected in their Discourses in the teaching and learning of Mathematics in multilingual classrooms in northern Nigeria?
3. Why do teachers use language (verbal and non-verbal) in their Discourse practices in multilingual Mathematics classrooms of northern Nigeria?

Central to the questions as above is the what, why and how Secondary Mathematics teachers in classrooms use their Discourse practices. The analysis, therefore, focused on identifying and explaining Discourse practices. I now discuss the validity and how it accounted for in this study.

4.6.1 Validity

My research approach was qualitative, and the key instruments of the collected data were face to face semi-structured reflective interviews, field notes, and video recordings of lesson observations. Maxwell (1992) argued that the validity of qualitative research depends on the credibility of the researcher. Maxwell further reported that data is only trustworthy if the outcome of the study is consistent and reliable. He defined validity as the appropriateness of conclusions made from the collected data. In this study, accurate and complete verbatim video and audio recordings of interviews and classroom observations of participants were used to ensure trustworthiness. I recorded meaningfully the Discourse practices enacted, so that they too were captured and analysed, I used field notes, to describe the physical settings of location and actions outside the lens of the video.

Gee (2005) opined that realities change as norms and practices change, the judgment of trustworthiness may change with time even when applied to the same findings thus altering the validity of these findings. It means that validation might be open to disputes and discussions. This does not preclude that no validation holds. In a situation such as explained earlier, validation is guided by the accepted realities in the particular domain of inquiry (Gee, 2005). Yin (2003) buttressed validation as a procedure and proposed that the researcher required documents as many steps in their processes of the study as possible. In this study, I have documented a range of steps. These have served to show the trustworthiness of observation and interpretation in order to validate the work. The videoed lesson observations were examined in the pilot study I carried out, the data collection tools and the processes of transcriptions. These are all discussed in this thesis. The elucidations examine the categories of the data for the various themes, the analysis, and the succeeding explanations of the empirical results (Chapters Six to Eight). No generalisations were made in this research. This is a limitation of most qualitative research. In the light of the procedures of validation explained earlier, this study can be considered to be valid.

4.7 Ethical considerations

Ethics is an important requirement in any research activity which involves humankind. It shows sensitivity and respect on the part of the researcher to the participants in the study (Opie, 2004). I applied for ethics clearance from the Wits School of Education, in the Faculty of Humanities, University of the Witwatersrand, Johannesburg. Subsequently, I was given approval (see Appendix B); the next process was to seek permission from the Administrators, Principals, and Heads of Department from both the schools in the study area. A written information letter and consent to participate in the study from all the Mathematics teachers was sought. As the research involved observing teachers in classrooms, written information letter and consent from each of the students and the parents of those students who were below 18 years of age was obtained.

I asked the Mathematics teachers to introduce me to the students. I then explained verbally the purpose of the research, emphasising that my analysis was not focusing on students, but teachers' Discourse practices in multilingual Mathematics classrooms. As investigating teachers' Discourse practices cannot take place in a vacuum, it has to involve teachers in a classroom. Thus the students' activity/participation in one way or the other was necessary, which is why I asked for their consent. All the students were encouraged to participate in the research. Participation was voluntary and subject to signing the consent letter. Those who did not sign the consent letter were excluded systematically, those students were not videoed and audio recorded in the class during data collection. The video and audio recordings were for the purpose of data analysis.

The teachers were informed that the processed data would be kept confidential. Only I and my supervisors would have access to the data. The data could be used for academic teaching, publications and conferences purposes only. Their identities were withheld and pseudonyms were used in place of their real names and that of the schools. I also informed the Mathematics teachers that the outcome of the research would be made available to them on request at the end of my study.

The agreement of the teachers and students participation and the confidentiality of the data was respected, in the data collection, in writing up the thesis and would be respected in any future publications.

4.8 Conclusion

In this chapter, I have provided reasons for the choices I made for the population, sample and the research context of my study. A qualitative research method was adopted, and the process of data analysis has been discussed. Issues of ethics and validity were thoroughly discussed. In the following Chapter Five, I outline how the language of description was developed from Gee's Discourse analysis theory and methods, collected data and the literature. I also provide a description of how the pilot study was conducted.

CHAPTER FIVE: The Language of Description (Data Analysis Framework)

5.1 Introduction

This chapter deals with the development of the language of description for the analysis of the data collected for this study. As indicated in Chapter Three, Gee (2005) Discourse analysis theory and methods consist of two components, namely verbal and non-verbal language. Gee's Discourse analysis perspective was used in the context of multilingual Mathematics classroom of teachers' Discourse practices to develop the categories and other associated sub-categories identified from the kinds of literature in Chapter Two of the present study for the data analysis. The next section elaborates in detail on the development of Discourse practices categories.

5.2 Discourse practice (DP)

As already explained in the previous chapters of this research work, Discourse Practice refers to the regular ways of using language, other symbolic expressions, and objects of thinking, feeling, believing, valuing and acting in the Mathematics classrooms either by a teacher or shared by teacher and students in carrying out their activities (Gee, 2005). From the definition of Discourse Practice above, I have tried to adapt the analytical framework so that I now look at the categories of language and Non-language symbols of the Discourse Practices of teachers together with the building tasks and the tools of inquiry. The main reason for this choice is that Discourse Practice, the key focus in this study is mutually constructed in language (verbal/non-verbal) and is deeply inter-related with the building tasks and the tools of inquiry (Gee, 2005). These categories and sub-categories of Discourse Practices enabled the development of the language of description for this study.

These building tasks of Gee's theoretical perspective were complemented and overlapped with the tools of inquiry during teacher's actions and interactions as earlier explained in Chapter Three of this study. An example: In looking at significance as a building task (which basically refers to ascribing value to things in certain ways) complemented and overlap with situated meanings as tools of inquiry.

Gee himself noted that the meanings of things do not reside in peoples' minds, rather meanings are assembled on the spot. In exploring sign systems and knowledge as a building task (which refers to languages English and Hausa, different varieties of social languages formal, informal, mathematical language, and other non-language symbols, gestures, graphs, pictures, and equations), also overlapped and complemented social language as tools of inquiry which is already mentioned as a subset in the definition of sign systems and knowledge above.

Gee's Discourse analysis perspective was used in the context of multilingual Mathematics classroom of teachers' Discourse practices to develop the categories before the analysis while other associated sub-categories were identified during the data analysis and literature reviewed in Chapter Two of the present study. In Chapter Three of this study I stated that, Gee's theory is a sociocultural and sociolinguistic theory, the difficulty for my using Gee's theory as both theoretical and analytical framework was that I had to develop an analytical framework to appropriately capture all the categories and sub-categories of the Discourse practices in the multilingual Mathematics classrooms of my study. Gee's Discourse analysis perspective was limited in terms of providing all the necessary tools for gaining an entry into the multilingual Mathematics classrooms. To fill these gaps or overcome the challenges, I then drew on some concepts from other literature(in Chapter Two) relating to Discourse practices in the multilingual Mathematics classrooms, and then using Gee's Discourse analysis perspective in this study, to attempt the development of methodological approach which would meaningfully capture Discourse practices in the multilingual Mathematics classrooms of this study. These limitations as elaborated above were dealt with by the introduction of the works of (Adler, 2001; Essien, 2011; McClain & Cobb, 2001; Moschkovich, 2003; Setati, 2002; Tatsis & Koleza, 2008; Yackel, 2000) into the categories of Discourse practices, as I would explain in more details in the subsequent paragraphs. I drew on these researchers because these kinds of literature as above characterised several different Discourse practices in the multilingual Mathematics classrooms. In drawing from these works, means modifying and adapting the ideas to suit the data collected for my study. I now engage more fully on how these categories were developed.

DP in this research work would encompasses all the practices related specifically to teaching and learning of Mathematics. The main construct of DP, the analytical task would explain in detail how different Discourse practices could be effective during actions and interactions of teachers and students in each of the multilingual Mathematics classrooms of this study. In developing the analytical framework for this study, I, therefore, divided the main construct from Gee's theory [Discourse practices (DP)] into two categories namely; language practices (verbal) and non-language practices (non-verbal) as shown in figure 5.1 below. These categories represent teachers' verbal and non-verbal talks during interaction with students.

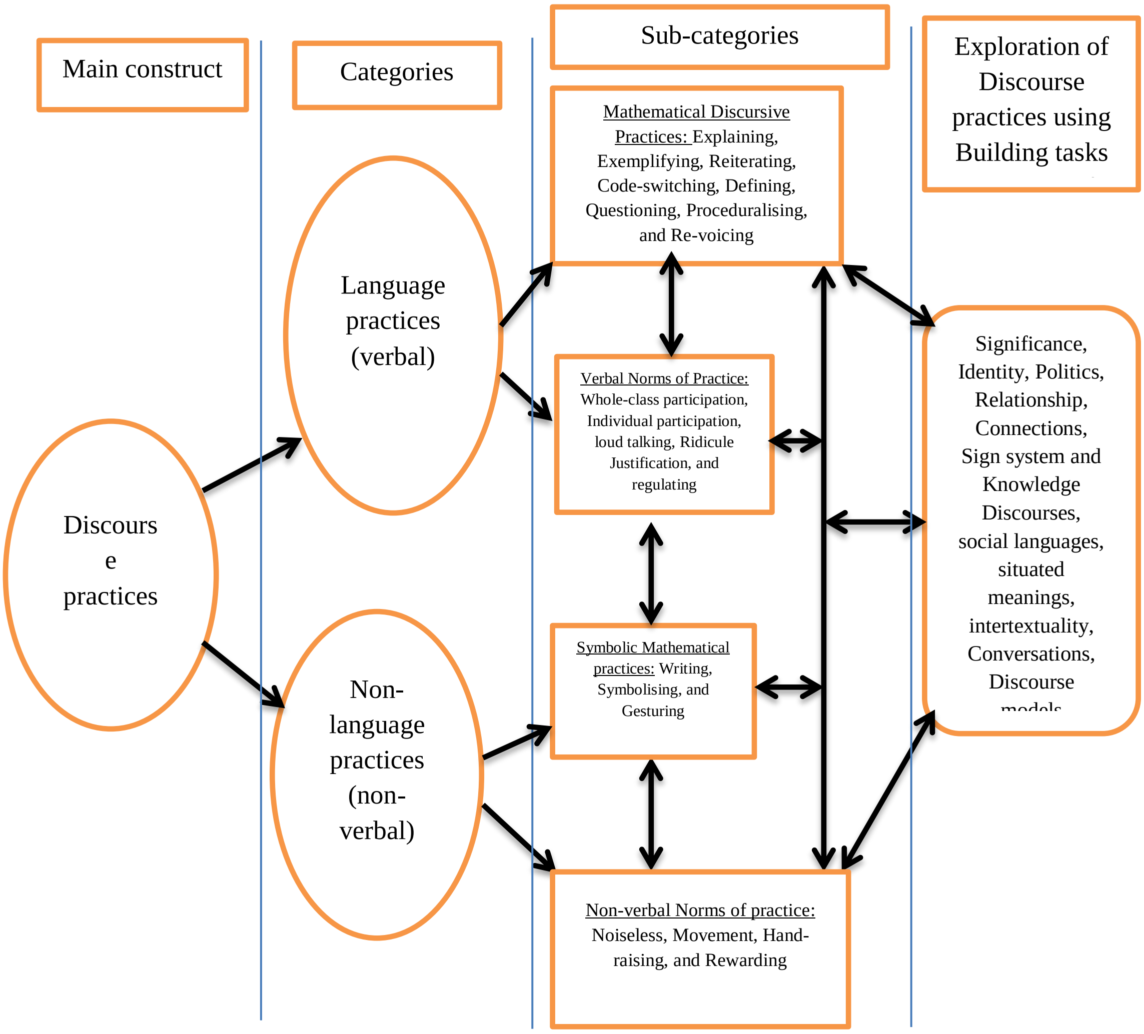


Figure 5.1: A Framework for identification and exploration of Discourse

The diagram above (figure 5.1) shows the global view of the analytical framework in this study with the categories and sub-categories from Gee's Discourse analysis perspective, collected data and the kinds of literature reviewed in Chapter Two of the study. The Lines and arrows on the diagram indicate the flow of directions and the interlinking of the analysis process.

In the attempted framework above (figure 5.1), I develop codes, code indicators and their examples for all the sub-categories. I looked through the unique verbal and non-verbal characteristics of the codes based on their indicators. It was important for me at this stage to constantly refine these sub-categories as I continually moved back and forth between the codes to set clear boundaries between them. The analytical framework as elaborated above identified and explored Discourse practices during teachers'/students' actions and interactions in the multilingual Mathematics classrooms of this study. The framework was developed to capture in a comprehensive way all the characteristics of the two categories of DP from Gee's theoretical perspective. I used codes for each of the sub-categories and indicators on how to identify each code. The analytical tasks for language and non-language practices categories were to explore and explain the different Discourse practices (see APPENDIX F).

Since the focus of this study as earlier mentioned, is on teachers' Discourse Practice in the context of multilingual Mathematics classrooms, it was not possible for me to modify, recontextualise and adopt all the 26 questions proposed by Gee (2005, pp. 110-113) for a Discourse analyst as Gee's framing of these questions was on the sociolinguistic and sociocultural perspective of learning. I, therefore, modified and adapted 15 analysis questions out of the 26 questions proposed by Gee (2005, pp. 110-113) based on the context and the focus of my study to gain insight on the emerging themes in the data. In this study, the 3 guiding questions and 15 modified and adapted analysis questions are presented in Table 5.1 below.

Table 5.1:

Guiding and Analysis Questions about the Discourse practices

Guiding Questions	Analysis Questions
1. What Discourse practices were used by teachers as plainly evinced in their language (verbal and non-verbal) in northern Nigeria multilingual Mathematics classrooms?	1. What Discourse practices are used by teacher/students in their verbal and non-verbal talks in the multilingual Mathematics classroom? 2. What sorts of relevant social relationships do teachers/students display in their Discourse practices using verbal and non-verbal skills in the multilingual Mathematics classroom? 3. What sorts of connections looking backward or forward are made within and through work during Discourses in the multilingual Mathematics classroom? 4. What languages (Mumuye and Hausa) are relevant in the verbal and non-verbal actions of the teacher and students in the multilingual Mathematics classrooms during Discourses?
2. How do teachers use language (verbal and non-verbal) to enact practices as reflected in their Discourses in the teaching and learning of Mathematics in multilingual class-rooms in northern Nigeria?	1. How do teachers make relevant (or irrelevant) in their verbal and non-verbal work, the DP in the multilingual Mathematics classroom and in what ways? 2. How do teachers make the social goods relevant (or irrelevant) in their verbal and non-verbal work during the enactment of the DP in the multilingual Mathematics classroom? 3. How are social relationships stabilised or transformed by teachers/students in their verbal and non-verbal work during Discourses in the multilingual Mathematics classrooms? 4. How do teachers make relevant (or irrelevant), the social languages in their verbal and non-verbal lessons to enact Discourse practices in the multilingual Mathematics classroom and in what ways? 5. How are the social goods (example status and power)

	relevant/irrelevant in the verbal and non-verbal teaching of students in the multilingual Mathematics classroom during Discourses?
3. Why do teachers use language (verbal and non-verbal) in their Discourse practices in multilingual Mathematics classrooms of northern Nigeria?	1. Why do teachers use language (verbal and non-verbal) to make relevant and irrelevant their Discourse practices in the multilingual Mathematics classroom? 2. Why do teachers use language (verbal and non-verbal) to play their part (roles, positions) in multilingual Mathematics classroom? 3. Why do teachers/students use verbal or written texts to set up certain relationships to the Discourses in the multilingual Mathematics classrooms? 4. Why do teachers use language (verbal and non-verbal) to connect social goods to Discourses operative in the multilingual Mathematics classroom? 5. Why do teachers use language (verbal and non-verbal) to make relevant (irrelevant), the social languages to Discourse practices and in what ways in the multilingual Mathematics classrooms? 6. Why do teachers use language (verbal and non-verbal) in their sign systems and symbols during Discourse practices in the multilingual Mathematics classroom?

As earlier elaborated that the main purpose of analysis using Gee's theoretical perspective is, "analysing language as it is fully integrated with all the other elements that go into social practices (ways of thinking or feeling, ways of manipulating objects or tools, ways of using non-language symbols system, etc.)" (Gee, 2005, p. 9). The entry points in the analysis process are the verbal and non-verbal language of Discourse practices. This is because the sub-categories emerge from the verbal and non-verbal language of teachers/students during actions and interactions in the multilingual classrooms. The two categories which are from the DP as indicated on ovals in figure 5.1 above shows that these categories work simultaneously to produce the different Discourse practices in the multilingual classrooms. The sub-categories indicated on rectangles in the diagram were identified from the main categories (verbal and non-verbal) language of the collected data plus the reviewed literature which provided the basis for answer to the 1st research question of this study. The analysis process continues with further exploration to dig deeper on how and why teachers use language and non-language symbol systems in the Discourse practices as indicated on rounded rectangle in figure 5.1. This also provided the basis for answering both 2nd and 3rd research questions of this study. The diagram (figure 5.1) above demonstrates the identification and exploration of Discourse practices in multilingual Mathematics classrooms in this research work.

5.2.1 Language practices

Language practice in this study refers to the use of discussions by teachers/students in a verbal (oral) discursive actions and interactions in a multilingual Mathematics classroom. The term discursive as used in this study would refer to the whole process of shared social interactions between two or more people: includes oral words (Chitera, 2009). It, therefore, means that teachers ascribed value in certain ways in their interactions with students by emphasising, particular words/phrases/sentences to explain a mathematical task in the classroom. To identify the language practices category in the data during Discourses, pronouns such as “you”, “I”, “s/he”, “we”, “us”, “they”, and “them” were also the focus in the analysis (see APPENDIX E). Teachers used this category of Discourse practices to engage and prompt students to answer in response to a question posed. They also used instructions (ground rules) which contributed to the stability of teaching and learning in the Mathematics classrooms.

In elaborating on the category of language practices in this study, I further sub-categorised the language practices into two parts using my collected data and the literature in Chapter Two of this study. The two categories were; **Mathematical Discursive Practice and Verbal norms of practice** which show the understanding of language practices category of DP as explained above. The sub-categories for mathematical discursive practice identified from the data (text) included Mathematical explaining, Mathematical exemplifying, Mathematical reiterating, Mathematical code-switching, Mathematical defining, Mathematical questioning, Mathematical proceduralising, and Mathematical re-voicing practices as shown in Table 5.2 below.

Table 5. 2:

The category and sub-categories of language practices

LANGUAGE PRACTICES	
Mathematical discursive practices	
Sub-categories and Codes	Indicators and their examples
Mathematical Explaining practice (ExP)	Utterances made by teachers which elaborate on a mathematical concept or idea so that the students understand the reason plus purpose of the concept. It is identified from the data when additional insight into a concept/idea is provided. Example, we also say…, It could also be…? etc. Infect Esmonde (2009) and Rowland (2012) noted that it includes utterances which are designed to explain why (i.e. logical thinking and verification), and the how (i.e. to outline an approach).
Mathematical Exemplifying practice (EP)	Mathematical exemplifying practice in this study refers to any selected question or set of questions by the teacher/students in class with the view of illustrating and generalising the solution. Thus, mathematical exemplifying practices are identified from the data during instances where the teacher/students thought of a set of questions or one question and regarded it as an example (Zodik & Zaslavsky, 2008). Teachers could provide an example to illustrate a mathematical approach (e.g. find x if $2x + 3 = 180^{\circ}$ or set of examples on concepts of triangles etc.) (Bills et al., 2006; Zaslavsky & Zodik, 2007). It, therefore, means that explanations of a particular procedure were not regarded as an example except if the teacher or the students specifically referred to it as an example of a more general question. These questions or set of questions were provided by the teacher/students in forms of pre-planned, spontaneous, or exercise examples during Discourses.
Mathematical Defining practice (DfP)	When teacher and/or students provide a detailed account in words (verbal talks) of the exact nature, scope or meaning of a mathematical term or concept during their interaction in the class, it is referred to as mathematical defining. Two types of definitions (namely extracted and stipulated) were

	identified in the Mathematics classroom (Edwards & Ward, 2004). In their thinking Edwards and Ward (2008) noted that definitions in the Mathematics classrooms are mostly stipulated definitions. Extracted definitions according to the authors as above refer to lexical definitions (definitions extracted from a body of evidence). Stipulated definitions are an explicit and self-conscious setting up of meaning-relation between some words and some object or the act of assigning an object to a name or vice-versa.
Mathematical Questioning practice, (QP)	Mathematical questioning practice refers to occasions when teachers want to interrogate/cross-examine/probe the understanding of students in their Mathematics classrooms. Teachers might ask students to respond in class to improve their language skills, and at the same time develop their conceptual mathematical understanding. Two mathematical questioning types (namely, funneling and focusing) as described by Wood (1998) were explored and identified. Funneling is a guided question leading students to a particular solution. Focusing is a more open style of mathematical questioning. The teacher has to uncover what the students are thinking, prompting them to provide an explanation and remaining open to a task being solved in another way.
Mathematical Reiterating practice (RP)	When teacher/students repeatedly or kept on emphasising what was discussed in the previous lesson(s) to remind the students or refresh the memories of some (or even the whole class) to create a better understanding of their current discussion (Essien, 2013). It could also be a repetition of what another person in the Mathematics class has said to be sure that they understood what had been discussed. This agrees with Andrews (2009) understanding of mathematical reiteration that these are terms when "the teacher focuses [students] attention on mathematical ideas covered earlier…". RP was identified from the text (data) through the use of particular words/phrases/sentences such as 'am I correct?', 'Another person has said this…', and 'Is that what you mean?'
Mathematical Re-voicing practice (RvP)	This might include explicit verbal, moves by teachers and students. RvP essentially tries to repeat some or all of what has been said in a preceding tone as the basis for a shift in the interaction (Enyedy et al., 2008). It could also involve repeating what has been said using the correct mathematical language. E.g. Let me repeat what s/he has said in a simple mathematical terms.
Mathematical	This is the use of Words/phrases/sentences from one language to a different

Code-switching practice (CsP)	language, or perhaps alternating between two or more languages in the same conversation (Adler, 2001; Essien, 2010; Setati, 2002; Zabrodskaja, 2007).
Mathematical Proceduralising practice (PP)	This is a step by step approach to solving a particular mathematical problem (Setati, 2002). It may involve the use of words or phrases such as, 'what next?', 'from here, where do we go next?', and 'what do we do again?'

Verbal norms of practice

Sub-categories and Codes	Indicators and their examples
Loud talking norm (LN)	Teacher/students are expected to talk loudly enough for everybody in the class to hear, using words/phrases such as 'louder please', 'I can't hear you', speak louder' and so on.
Whole-class Participation norm (PW)	This is a situation for the whole class to participate in any given mathematical task. Words/phrases such as 'are you all following?', 'do you all understand?', 'who has not contributed or talk in this class' are used. This whole-class participation by the teacher/students includes conversational interactions (e.g. IRE), group discussion, and choral responses during Discourses; (Clarke, 2004 ; Clarke, Xu, & Wan, 2013).
Individual Participation norm (IP)	This is a situation when one person at a time in class participates in any given task. It would involve taking turns or successively participating in. Words/phrases such as 'one after another', 'one by one', and 'next person after this one' were used to indicate IP.
Justification norm (JN)	The use of Words/phrases/sentences such as 'that is why….?', 'because', 'can you explain why?' in expressing an opinion or giving a reason for certain activities in the Mathematics classroom.
Regulating norm (RN)	The use of Words/phrases/sentences such as, 'you are making noise', 'open your books please', keep quiet' 'just sit down and, 'let me check your homework,' etc.; in the Mathematics classroom (Setati, 2002).
Ridicule norm (RuN)	These are instances where teacher/students might be laughed at or be mocked if s/he made a mathematical and/or grammatical mistake in the classroom

I have also introduced concepts from the kinds of literature which characterise verbal norms of practices in the Mathematics classrooms. These were similar to the ones identified so far from my data. As earlier indicated in Chapter One, the purpose of this study is to identify and explore what Discourses exist in the Nigerian multilingual Secondary School Mathematics classrooms as well as why and how they are used. In order to achieve the purpose of my study, verbal norms of practice refer to patterns and ground rules which might contribute to the stability of teaching and learning in the Mathematics classroom had to be examined as well (McClain & Cobb, 2001; Tatsis & Koleza, 2008; Yackel, 2000), without these types of Discourse practices, teaching and learning would be almost impossible in some setting as anarchy would be the order of the day. The verbal norms of practice sub-categories are interlinked and interrelated to the Mathematical Discursive Practices sub-category of this research work as indicated in Table 5.2 above. The sub-categories of verbal norms of practice included: Whole-class participation, Individual participation, Loud talking, Justification, Regulating and Ridicule. These sub-categories were adapted and recontextualised to suit the data of the present study from the kinds of literature reviewed. Table 5.2 above, shows the category and sub-categories of the language practices with their codes, indicators, and examples. I now focus on the non-language practices category of DP.

5.2.2 Non-language practices

The non-language practices category of DP refer to gestures, graphs, pictures, and equations, which represent different ideas, knowledge, and beliefs (Gee, 2005). The non-language practices are used differently (in these case Mathematics teachers/students) according to their different experiences and attitudes. Teachers communicate using non-verbal practices and certain forms of knowledge which are relevant or not in the Mathematics classrooms. Teachers used several non-language practices including gestures, symbols, and graphs to make relevant or more important some mathematical concepts than others. It seems I can now categorise non-language practices into two parts namely, **Symbolic Mathematical practice and Non-verbal norms of practice**. The reason is that the Non-verbal norms of practice sub-category are also interlinked and interrelated to the Symbolic Mathematical practices sub-category as indicated in Table 5.3 below.

Table 5.3:

Category and sub-categories of the non-language practices

NON-LANGUAGE PRACTICES	
Symbolic Mathematical practices	
Sub-categories and Codes	Indicators and their examples
Mathematical Symbolising practice (SP)	Involves the uses of symbolic systems to represent and communicate mathematical concepts in the class. (Jones, 2013) focused on three uses of diagrams in the Mathematics classroom, which included diagrams in Mathematics textbooks, students' problem solving diagrams and diagrams used by the teachers when teaching the subject.
Mathematical Writing practice (WP)	These are times where teacher/students write in the lessons. The teacher would write on the board and ask students to write or copy what s/he has written. The teacher would give dictation (i.e. asking students to write his/her words down). (Urquhart, 2009) identified three kinds of writing prompts in the Mathematics classrooms: content, process and affective prompts.
Mathematical Gesturing practice (GeP)	Mathematical gesturing practice is the specific bodily (hands, head, shoulder, legs, and even eye) movement by the teacher in the classroom in order to communicate or illustrate a particular idea/concept during interaction with students. Toastmasters (2011) gave 4 types of gestures such as Descriptive, emphatic, suggestive and prompting. In another study Cook, Friedman, Duggan, Cui, and Popescuc (2016) identified other kinds of gestures in the Mathematics classroom which facilitate teaching and learning. These include bimanual beat, content, pointing and spontaneous gestures.
Non-Verbal Norms of practice	
Sub-categories and Codes	Indicators and their examples

Noiseless norm (NN)	The expectation in the Mathematics classroom that all students must be silent or very quiet during teaching and learning.
Movement norm (MN)	This refers to the physical change of the teacher's/students' positions in the classroom during the teaching and learning process. It also includes wriggling the body, as well as moving and interacting with the class. Two types of movement norms were identified: mindful movement (otherwise called purposeful movement) and non-mindful movement (Beaudoin & Johnston, 2011)
Hand-raising norm (HN)	These are instances in the Mathematics classroom where the teacher/students point or lift their hands to volunteer for a task. They includes waving hands to answer a question or declining to answer
Hand-clapping norm (HCN)	These are instances where teacher/students applaud each other in the class to show their satisfaction plus recognition of their efforts of achievements.

Table 5.3 above shows how the symbolic Mathematical practices category was further sub-categorised into Mathematical Writing, Mathematical Symbolising, and Mathematical Gesturing as characterised from the collected data for this study. While the non-verbal norms of practice sub-category are Noiseless, Movement, Hand-raising and Hand-clapping norms. In Table 5.3 above, I presented the category, of non-language practices with their codes, indicators, and examples. I shall now describe my pilot study.

5.3 A description of the pilot study and its benefits

A pilot study usually provides researchers with unforeseeable methods or ideas on how to deal with challenges, before conducting the study (Cohen et al., 2011). Such ideas and methods would help in refining and modifying the research focus, methodology, and the analytical procedures. In particular Cohen et al. (2011) noted that research instruments should be piloted (tested) before conducting the main study. Enumerated in Cohen et al. (2011) are 18 functions of a pilot study, principally to increase the reliability, validity and practicability of the research instruments. After piloting, one might then make the necessary refinements and modifications to the instruments, procedures and analytical farming in preparation for the study. This reduces unforeseeable challenges which might lead to a greater amount of valid, solid findings in the study.

My interest in the pilot study was to test how the research instruments and data collection procedure would work in the conduct of the study. I piloted my instruments for data collection in one of the selected Secondary Schools in northern Nigeria. During the pilot study, I worked with one Mathematics teacher who taught in the selected Secondary Schools. In piloting, I checked for clarity on how the interview questions asked would address the research questions. The results of the pilot study helped me refine and modify my instruments and procedures. The procedure for conducting the interviews needed some adjustments to facilitate a sufficiently rich seam of data.

The pilot study also contributed in shaping my idea of the study area, particularly in the selection of teachers. I had earlier proposed to work with six teachers in the study, one each from a Secondary School. It turned out that only four Mathematics teachers, two from each schools (which I called school A and school B) met the criteria for selection earlier explained in Chapter Four of this study.

As a new researcher, the pilot study interviews helped me develop the skill of interviewing in a semi-structured situation and also enabled me to improve my research instruments with my supervisors. Gee's theoretical perspective (Gee, 2005) initially appeared to provide illuminating tools for understanding teachers' Discourse practices. However as I began to apply this theory in the analysis on the data collected for the pilot study it became problematic, not sufficiently well-defined to capture what had happened mathematically during the teacher's Discourses. There was a need for refinement of the methodological approach in order to expose and reveal the Discourse practices that were used by the teacher in a better way. Secondly, the teacher's Discourse practices in the pilot study were used in an assumed manner as the methodological framing did not pinpoint and set clear boundaries of what precisely I was looking at in each category and sub-categories of the Discourse practices. Therefore to enhance the analytical process, there was a need to clarify these issues. After much reading, I strengthened the framework to expand these Discourse practices.

5.4 Conclusion

This chapter presented the language of description through the reciprocity connecting the theoretical field and the empirical field. I used Gee's theoretical and methodological perspective, reviewed kinds of literature and my collected data in the context of multilingual Mathematics classrooms to develop the language of description. The methodological perspective assisted me in analysing the data collected for this study as well as how it was used in the analysis. In Chapter Six, I provide my analysis and the empirical results of two teachers in school B of this study.

CHAPTER SIX: Empirical results of School B

6.1 Introduction

The main purpose of this study is to explore, identify, examine and understand teachers' Discourse practices used in multilingual Mathematics classrooms in northern Nigeria Secondary Schools. In this chapter, I present the empirical results of Discourse practices for two teachers in school B in response to the research questions: What Discourse practices were used by teachers as plainly evinced in their language (verbal and non-verbal) in northern Nigeria multilingual Mathematics classrooms? How do teachers use language (verbal and non-verbal) to enact practices as reflected in their Discourses in the teaching and learning of Mathematics in multilingual classrooms in northern Nigeria? In Chapter Three, I indicated that Discourses according to Gee (2005) were concerned with the use of language/non-language symbol systems. I used these two features of Gee's Discourse analysis theory, namely language and non-language as my categories plus sub-categories from relevant kinds of other literature on studies conducted in multilingual Mathematics classrooms together with my collected data for this study as language of description, to enable entry into the Mathematics classrooms of two schools (A and B) in my study area.

As discussed in Chapter Four, the term textual Discourse practice analysis is the analysis of the actual text as used in the discussions (verbal and non-verbal) by the participants, as well as the interpretation of the processes involved in the construction of the Discourses during an interaction (Gee, 2005). The distinctive features of Gee's Discourse analysis theory are: (1) it is concerned with obtaining and clarifying facts that "helps to explain how and why language works the way it does when it is put into action" (Gee, 2005, p. 8). (2) It is also concerned with contributing, in terms of understanding important issues of interest to the researcher. Therefore, the analyses in this research involved identification of teachers' Discourses and how were they carried out in the class. In accordance with what Gee (2005, p. 115) explained that the method of analysis developed by him, was not intended as a set of "rules" to be followed "step-by-step", nor should it be used as a “recipes” or “manuals”, but should serve “as thinking devices to encourage others to engage in their own discourse-related reflections”. Textual Discourse practices analyses of this study were based on Gee’s conceptualisation.

This chapter presents the empirical results of in-depth analyses of two teachers’ classrooms observations transcripts in school B. The categories and sub-categories developed before, during and after my pilot study helped in supporting the process of the analyses as discussed in the following sections. I start with a lesson description of individual teachers in their classrooms and deal with the analysis of the categories and sub-categories of the Discourse practices, and then I give the summary for each teacher followed by an overview analysis of the two teachers while looking for emerging patterns across all the enacted DP.

The central interest of this analysis is on the dominant DP in classrooms of teachers and their implications for teaching and learning of Mathematics. As explained in Chapter Four that dominant DP used in this study refers to the DP which has influence (in directing the flow of the Discourses) across data obtained from teachers’ Mathematics classrooms. As indicated previously, the purpose of this analysis is to explore, identify, examine and understand teachers’ dominant DP during teaching**.** The lessons transcript is divided into Stanzas. In this study, a Stanza is an organised group of lines with a unitary topic/concept that was produced by teacher/students’ work in the classroom. A line refers to an idea conveyed through teachers’/students’ use of verbal/non-verbal talks (text) (Gee, 2005). The Stanzas were selected and divided based on critical incidents of discussions on the concepts on trigonometry which teachers taught. The length of Stanzas was not uniform. The lines containing a unit of information were numbered for easy referencing (see APPENDIX F).

6.2 Framing the analysis: Discourse practices

The analysis of the DP categories comprised Gee's (2005) Discourse analysis theory and method: language (verbal and non-verbal). In the analysis process, I started with reading the transcripts. This was for the purpose of identifying the building tasks and tools of inquiry as constructed by the Mathematics teachers/students in the class. For example, one of the features I focused on was how pronouns such as “you”, “I”, “s/he”, “we”, “us”, “they”, and “them” were used. It will become clear to the reader in the following Stanzas that these pronouns as above revealed the identities of teachers/students in the class. To guide the exploration of teachers’ dominant DP and to ensure that I had a focused analysis, I used the following reformulated questions from Gee (2005) Discourse analysis theory and method as summarised in table 6.1 below:

Table 6.1:

Research Questions and specific analysis Questions

Research Questions	Specific analysis Questions
1. What Discourse practices were used by teachers as plainly evinced in their language (verbal and non-verbal) in northern Nigeria multilingual Mathematics classrooms? 2. How do teachers use language (verbal and non-verbal) to enact practices as reflected in their Discourses in the teaching and learning of Mathematics in multilingual classrooms in northern Nigeria?	1. What Discourse practices are used by teacher/students in their verbal and non-verbal talks in the multilingual Mathematics classroom? 2. How are the social goods (example status and power) relevant/irrelevant in the verbal and non-verbal teaching of students in the multilingual Mathematics classroom during Discourses? 3. What sorts of relevant social relationships do teachers/students display in their Discourse practices using verbal and non-verbal skills in the multilingual Mathematics classroom? 4. What sorts of connections looking backward or forward are made within and through work during Discourses in the multilingual Mathematics classroom? 5. What languages (Mumuye and Hausa) are relevant in the verbal and non-verbal actions of the teacher and students in the multilingual Mathematics classrooms during Discourses? 6. How do teachers make relevant (or irrelevant) in their verbal and non-verbal work, the DP in the multilingual Mathematics classroom and in what ways? 7. How do teachers make the social goods relevant (or irrelevant) in their verbal and non-verbal work during the enactment of the DP in the multilingual Mathematics classroom? 8. How are social relationship stabilised or transformed by teachers/students in their verbal and non-verbal work during Discourses in the multilingual Mathematics classrooms? 9. How do teachers make relevant (or irrelevant), the social languages in their verbal and non-verbal lessons to enact Discourse practices in the multilingual Mathematics classroom and in what ways?

The questions in Table 6.1 above were asked on the DP categories and sub-categories of the data obtained from teachers'/students' work in class. The questions thus provided illuminating results for the DP categories and sub-categories in the data as the reader will see in the sections below. In my analyses of the DP of teachers in the schools/classrooms, frequencies for the dominant DP were never regarded as a big issue, because textual Discourse practice analysis goes far beyond looking at the rate of occurrence of verbal/non-verbal communication. In fact, the analysis approach as construed by Gee (2005, p. 142) "is not primarily about counting things". In discussing each of the DP, I considered how each was produced using the codes. In my data analysis, codes of the DP sub-categories were used. The importance of using codes of the sub-categories during analysis of data was that it helped me to locate the dominant DP across the transcripts easily. I explored each of the sub-categories using the code indicators and their examples to determine the dominant DP across the data. In coding my transcripts, I paid close attention to the ideas conveyed through teachers'/students' use of verbal/non-verbal communication from the text signifying a particular DP based on its indicator as earlier discussed (Gee, 2005). Each idea of verbal/non-verbal talk uttered by teachers/students was coded. To illustrate the statement: "A triangle is a plane figure bounded by three straight lines", represents a code for Mathematical defining practice (DfP). Also, instances of repeating this Mathematical definition as above were coded as Mathematical reiterating practice (RP). I have organised the enacted DP categories and sub-categories into Stanzas. I, therefore, selected the categories and sub-categories of dominant DP in such a way that a Stanza covers a section of an interaction of the data, where one mathematical concept was discussed in the class for the purpose of getting ideas about the **distinctive** characteristics for each DP (see APPENDIX F). I now discuss below all the dominant DP that was enacted through teacher G's use of verbal/non-verbal talks in class. But first, let me give a brief overview of the lessons

6.3 Lesson description of teacher G in School B

Only two weeks after resumption of school after the December 2017 holidays; teacher G had his first lesson on trigonometry (triangles). This was followed by series of other lessons on the same topic. The textbook (New General Mathematics for Senior Secondary Schools 2) used by teacher G in his teaching was recommended and approved by the Nigerian Federal Ministry of Education (FME).

Teacher G's lessons were conducted in SS2D (grade 11 equivalent in South Africa) class of school B in the research area. Noise from other classrooms interfered during all my lesson observations. Hence to minimise it, teacher G had to move again and again in and out during his lesson presentations to control the other noisy classes. The lessons were the normal school's programme. The class was multilingual and the average number of students in the three lessons I observed was 80.

6.4 Lessons overview

Teacher G began the first lesson by asking the whole class what is a triangle, after which he went ahead and gave students the definition of a triangle. He then moved further to sketch and discusses types of triangles. Teacher G informed the class that in the next lessons, they would calculate the angles and sides (length) of triangles using Sine and Cosine rules.

In the second lesson, teacher G used an example for calculating the angles and sides of the triangle. Using Sine rule, he took the students through a step-by-step approach to arrive at the answers. Teacher G did most of the talking during the teaching process.

The third lesson focused on examples for calculating the angles and sides of triangles using Sine rule. The same step-by-step approach used in the second lesson was applied in the teaching process. Teacher G solved one example with the students as a whole class activity and allowed them to solved the second example themselves as homework. He then informed them that the next lesson would focus on the use of cosine rule. The three lessons lasted for a total of 2 hours.

The Dominant DP which featured significantly through the consistent usage of verbal/non-verbal talks of teacher G across the categories and sub-categories of the data and which is important to the overall purpose of this study are present in the Table 6.2 below;

Table 6.2:

Categories and sub-categories of dominant DP

Categories and sub-categories of Teacher G's DP			
Categories	Sub-categories	Dominant DP	Frequencies for the DP
Language practices (verbal)	Mathematical discursive practice:	Mathematical Explaining practice (ExP)	21
		Mathematical Exemplifying practice (EP)	14
		Mathematical Reiterating practice (RP)	41
		Mathematical Code-switching, practice (CsP)	8
		Mathematical Defining, practice (DfP)	8
		Mathematical Questioning practice (QP)	34
		Mathematical Proceduralising, practice (PP)	4
		Mathematical Socialising practice (SiP)	2
		Mathematical Generalising practice (GP)	1
		Mathematical Re-voicing practice	16

		(RvP)	
	Verbal Norms of practice	Whole-class participation norm (PW)	28
		Individual participation norm (IP)	19
		Loud talking norm (LN)	1
		Justification norm (JN)	7
		Ridicule norm (RuN)	2
		Regulating norm (RN)	66
Non-language practices (non-verbal)	Symbolic Mathematical practice:	Mathematical Symbolising practice (SP)	58
		Mathematical Gesturing practice (GeP)	52
		Mathematical Writing practice (WP)	29
	Non-verbal Norms of practice	Rewarding norm (RwN)	5
		Noiseless norm (NN)	6
		Movement norm (MN)	50
		Hand-raising norm (HN)	15

To be specific and also reiterate, the dominant DP as indicated in Table 6.2 above refers to the practices which had influenced (in directing the flow of the Discourses) across data obtained from teachers' Mathematics classrooms. Three DP (mathematical symbolising practice, regulating norm and mathematical reiterating practice) seems to feature predominantly in teacher G's Mathematics classroom, going by the cumulative flow in the direction of Discourses in class and even as indicated in their frequencies in Table 6.2 above. I now discuss below one by one the dominant DP featured through teacher G's use of language/non-language practices.

6.5 Mathematical Discursive practice

The sub-categories for Mathematical Discursive practice identified from the data included Mathematical questioning, Mathematical defining, Mathematical explaining, Mathematical exemplifying, Mathematical reiterating, Mathematical code-switching, Mathematical proceduralising, and Mathematical re-voicing as shown in Table 6.2 above.

6.5.1 Mathematical Questioning practice (QP)

As indicated in Chapter Five Mathematical questioning practice refers to occasions when teachers want to interrogate/cross-examine/probe the understanding of students in their Mathematics classrooms. Teachers might ask students to respond in class to improve their language communication skills, and at the same time develop their conceptual mathematical understanding. Mathematical questioning practice can be used by teachers to evaluate or estimate the ability of students to note similarities or dissimilarities in their understanding of formal Mathematical language and informal Mathematical language. In this study two types of mathematical questioning (namely, funneling and focusing) as described by Wood (1998) were explored and identified. Funneling is a guided question leading students to a particular solution, while focusing is a more open style of mathematical questioning which necessitates attention by the teacher. The teacher has to uncover what the students are thinking, prompting them to provide an explanation and remaining open to a task being solved in different way.

Mathematical Questioning was one of the dominant Discourse practices identified in teacher G's class during Discourses. In Stanza 1 below, I highlight and discuss some instances of how mathematical questioning was used by teacher G in his class. The teacher began his lesson by asking students a funneling question: **"What is a triangle?"** (See Stanza 1, line 1). He then paused for a moment and instructed them to write as he dictated Mathematical definition of a triangle.

Stanza 1

1. T (Teacher writes the topic on the board and asks students a question).**What is a triangle?** (…) WRITE, WRITE//. A triangle is a plane figure//. (Teacher dictating verbally).

Plane figure (…) **A triangle is a plane figure//. Bounded//. Bounded by three straight lines//.** (Teacher selectively writing words on the board). A triangle is a plane figure bounded by three straight lines//. Right?//

2. Ss Yes// (chorus)

3. **T I didn't say a triangle is a plane figure bounded by a line//. Did I…?// (Teacher gesturing with hands). A line, I said STRAIGHT lines//. So that means just write down what I said//. Is this line STRAIGHT?//**

4. Ss Yes// (chorus)

5. **T This one did they come together?// (Teacher pointing to the board and gesturing with hands) Do you know this line?//** Is this a rectangle?// Are you here?// Right?//

6. Ss Yes// (chorus)

7. T (Teacher continued with the class) A STRAIGHT LINE is the shortest distance//. A straight line is the shorted distance between two points//. Don't worry//, I still explain so that you can understand what I am saying//. Listen once again//. Can you pass through the mountain?// (Teacher demonstrating and gesturing with hands) What do you do?// Which of the two make it straight?// Which makes it straight?// A line is a distance between two points//. And a straight line is a distance between two points (…).

Subsequently, he continued with the development of the lesson using the same type of funneling questions such as: **"This one did they come together? Do you know this line? Is this a rectangle?"** As indicated in Stanza1 line 5 these were funneling questions, because they were used as prompts to lead the students while eliciting for short responses and at the same time regulating their behaviour during Discourses. Teacher G appeared to be portraying few instances of **focusing** questions within the Mathematics classroom. He used a few focusing questions which inspire communicating mathematically in the class. When the teacher asked students focusing questions on straight lines, it was the case in line 7 Stanza 1 above. As visible in Stanza 1 above, teacher G went ahead to elaborate on the meaning of straight lines without engaging students so that they could improve their language communication skills and at the same time develop their conceptual Mathematical Discourse. This way and manner of Discourses by the teacher will probably yield little or no result in the productive teaching and learning of Mathematics in the classroom.

Consequently, I concur with the argument of Clarke et al. (2013) that, teachers especially those teaching in the Mathematics classrooms (e.g. teacher G) need to move beyond short and simple focusing questions which elicit short choral answers. They should adopt the types of questions which combine both focusing and funneling to foster logical reasoning in the students' thinking and communicating verbally in the class. By doing so, students could be helped to improve their mathematical language communication skills. Another DP used by teacher G in his lesson was mathematical defining. The next section focuses on that.

6.5.2 Mathematical Defining practice (DfP)

Among the dominant practices in teacher G's class was the mathematical defining. When teachers and/or students provide a detailed account in words of the exact nature, scope or meaning of mathematical term or concept during their interaction in the class, it is referred to as mathematical defining. Two types of mathematical definitions (extracted and stipulated) were identified in the Mathematics classroom by Edwards and Ward (2004). They (Edwards & Ward, 2004) noted that Mathematical definitions in the classrooms are in most instances, stipulated. Extracted definitions according to the authors above refer to lexical definitions (definitions extracted from a body of evidence), while stipulated definitions are an explicit and self-conscious setting up of meaning-relation between some words and some object or the act of assigning an object to a name or vice-versa. Teacher G engaged his students in discursive talks in the lesson on trigonometry (triangle) by instructing them to write, after which he dictated a stipulated definition: **"A triangle is a plane figure bounded by three straight lines"** (see Stanza 1, line 1). It was a stipulated definition because he provided an explicit and self-conscious meaning of triangle. Furthermore, in Stanza 2, lines 3, 7, 9, 11 and 13 below, show some instances of how mathematical defining practice was carried out by the teacher in the class. This same pattern of stipulated definition used here on the triangle and its types was also applied to other concepts taught by teacher G during his lessons.

Stanza 2

1. T (The teacher continued with the lesson). Now types of triangles//. Somebody should give us one// (…). Yes//. (Teacher calls out a student)

2. S Right angled triangle//

3. T That means right angled triangle has one angle that is 90 degrees//. (Teacher sketching and gesturing). That is why we call it, right angled triangle//. Yes another triangle, you//. Not you, the other person. (The teacher calls and points at a student)

4. S Equilateral triangle//

5. T WHAT?// (…)

6. S Equilateral triangle//

7. T Equilateral triangle//. Equilateral that means is from the word equal//. Right?// Equilateral triangle means all the sides and all the angles are equal//. (Teacher sketches and points to a triangle on the board). If this one is 10 units this one and this one will also be 10 units each//. And all the angles are 60 degrees each, equilateral triangle//. Next one//. Yes, you. (The teacher points at a student)

8. S Isosceles triangle//

9. T Isosceles triangle is a triangle in which, just two sides are equal and the base angles are also equal//. Yes, you//. (The teacher calls another student)

10. S Scalene triangle//

11. T Scalene triangle//. This triangle, none of the side are equal, none of the angle are equal//. Next one//. Yes, you//. (The teacher calls a student)

12. S Obtuse angle triangle//

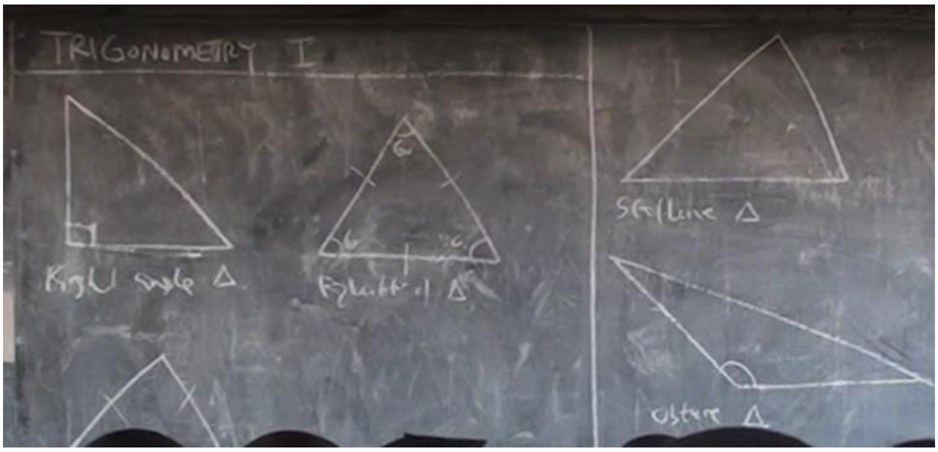
13. T Obtuse angle triangle//. One, of the angles there//. One, one, one of the angles is more than 90 degrees//. Are you there?//

14. Ss Yes// (chorus)

15. T (Teacher sketches a triangle on the board). What do you have?// This, triangle to me is very, very important triangle. Because out of it you can get all this other triangles from it//. So, to me scalene triangle is a black man//. What did I say?//

16. Ss Scalene triangle is a black man// (chorus)

17. T We are blessed with black skin//. We are not going to consider right angled triangle//. We are not going to consider rest of the triangles//. You don't know?//

18. 

One interesting aspect of the observation that became clearly visible in the discursive language used by the teacher concerning mathematical defining as a practice is that he seemed not to give students any opportunity to attempt or contribute their understanding of the concepts during Discourses in the class. In not involving students to attempt or contribute their understanding, it is likely that teaching and learning might be impaired. Again, a closer look at the Stanzas1 and 2 above, suggest that teacher G was enacting his identity as an authority and expert in his area of discipline. For example, in Stanza1 line 3 the teacher uttered the following statements: **"I didn't say a triangle is a plane figure bounded by a line. Did I…? A line, I said STRAIGHT lines."** The use of the personal pronoun **"I"** several times in referring to himself, indicates an authoritative identity because the teacher seemed to instruct the students to obey without questioning what he asked them to write in class. He further instructed: **“So that means just write down what I said”** in an emphatic tone while talking to students. The keywords indicating authoritative identity are **“I”** and **“Just”.** Other keywords or terms such as **“Bounded”,** and **“STRAIGHT lines”** on the stipulated definition of triangle seemed to be made significant by teacher G throughout his lessons, he re-emphasised the words extremely loudly in an authoritarian voice during his teaching. This way of emphasis with the extra stress of the words or terms as above, showed that he was portraying these terms as social goods in the Discourse so far enacted, an important ingredient for understanding triangle. From the above discussion, it seems logical to draw a conclusion that the assertion made by Edwards and Ward (2008) was true regarding G’s classroom as most of his Mathematical definitions were stipulated.

6.5.3 Mathematical Reiterating practice (RP)

As earlier indicated in the previous chapter that mathematical reiterating practice can be identified from the text (data) through the use of particular words/phrases/sentences such as ‘am I correct?’, ‘Another person has said this…’, Say it again please…? And ‘Is that what you mean? When teacher/students repeatedly said something or keep on emphasising what was discussed in the previous lesson (s) to remind them or refresh the memories of some students or the whole class to enable the better understanding of their current discussion. It could also be a repetition of what another person in the Mathematics class has said to be quite sure that, their understanding of what is been discussed is the same. The above descriptions agree with Andrews (2009) understanding of Mathematical reiterating practice. Andrews noted that these are occasions in which “the teacher focuses [students] attention on Mathematical ideas covered earlier…” Mathematical reiterating practice was a dominant featured DP in teacher G’s class and was enacted simultaneously with Mathematical explaining practice and in most instances together with mathematical questioning practice. In the interactions with students as shown in Stanza 3 below, teacher G seems to be repeating certain words/phrases while explaining mathematically, to highlight principal ideas such as “**solved this**

triangle", "**You have solved the triangle"**, and "**We are not going to consider other triangles"** (see Stanza 3 lines 1, 2, 6 and 9).

Stanza 3

1. T **Solving triangle means**//, if I give you a triangle like this// I said you should solved this triangle//. Listen to me all of you//. If I say **solved this triangle//.** SOLVE// (Teacher gesturing and demonstrating with the sketch on the board)

2. T **Meaning you should find all the angles//. Are you listening to me?// The length of the sides and the space occupied//. That means the area//. If you do that// (…) that means you have solved the …//. You have solved the triangle complete//. Is that clear?//**

3. Ss Yes// (chorus)

4. T So in this case we are not…//. We are not going to consider right angled triangle//. Imum?//

5. Ss Yes// (chorus)

6. T **We are not going to consider rest of the triangles//.**

7. T (Teacher gesturing). Are you with me?//

8. Ss Yes// (chorus)

9. T In right angled triangle we use SOHCAHTOA//. And the other ones, so we don't need them//. **We are not going to consider other triangles//**. We will only consider scalene triangle//. Are you with me now? This, this, this triangle to me is very, very important triangle//. (Teacher gesturing and pointing to the sketch on the board). Because out of it you can get all this other triangles from it//. So, to me scalene triangle is a black man//. Because you can get all colours from it//. **We are blessed with black skin//**

10. Ss Yes// (chorus)

11. T So we are going to use two methods: 1) Sine rule, Sine rule// and what?// 2) Cosine rule//. Look up//. In triangle A, B, C//. When you write in triangle A, B, C//. Then come back to this place//

12. T (Teacher gesturing and demonstrating on the board)

13. T Write in triangle A, B, C//. Then come back to this//. And write again in triangle A, B, C//. Are you all here?//

14. Ss Yes// (chorus)

15. T (Teacher writing and stating the formula aloud)

16. T $\frac{a}{SinA} = \frac{b}{SinB} = \frac{c}{Sinc}$ (…)//. And also, if you reverse the formula

17. T (Teacher gesturing with hands and writes the formula in reverse order)

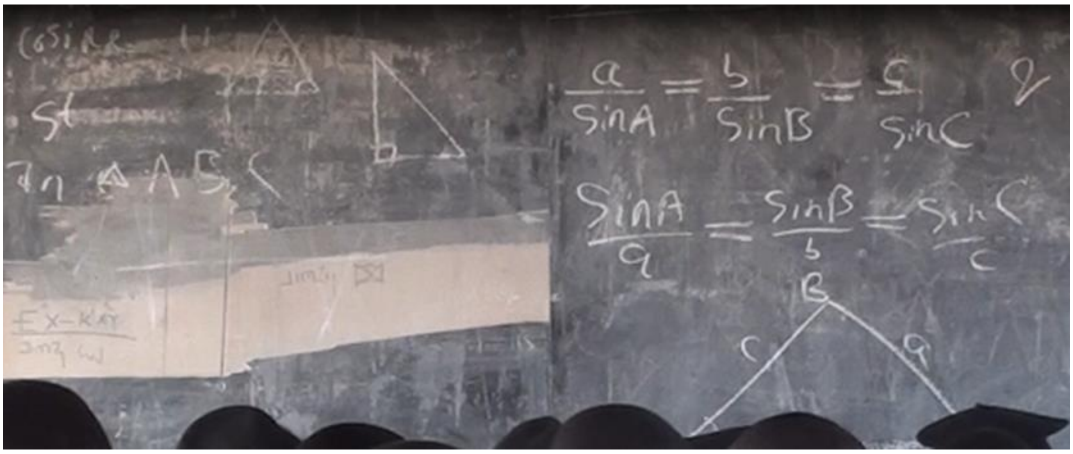
18. T $\frac{SinA}{a} = \frac{SinB}{b} = \frac{SinC}{c}$ //If you reverse it

19. T (Teacher pointing to the formulae)

20. T If you reverse it//, you will still get the answer//. Now look up//. This A//

21. T (Teacher pointing at capital letter A of the Sine rule on the board as he gestures and demonstrate)

22. T Can you see//. **When I talk LISTEN AND LOOK AT ME//**

23. 

Teacher G mathematically reiterated these words as above; to be sure that the students understood and wrote what he asked them to do during Discourses, before moving to another concept. He used mathematical reiterating practice as memory aid on very few occasions, so as to emphasise ideas he had previously said, or what someone else had said, thus enabling better understanding for both of them. These interactions suggest that teacher G considered the knowledge of solving triangles significant in his Discourse and he appeared to make them relevant and stabilised by discursive language use while reiterating mathematically. The practice of Mathematical explaining was featured significantly together with Mathematical reiterating. The next section discusses Mathematical explaining as a dominant DP in this study.

6.5.4 Mathematical Explaining practice (ExP)

As indicated in Stanza 3 above, shortly after several repetitions of words, teacher G verbally elaborated on what it meant to solved triangle. In line 2 Stanza 3 specifically, teacher G explained using statements such as: "**Meaning you should find all the angles. Are you listening to me? The length of the sides and the space occupied. That means the area. If you do that (…) that means you have solved the …. You have solved the triangle complete."** The teacher continued with the Discourse on the kind of triangle (scalene triangle) to be solved and the methods that would be used in solving it during his lesson presentation (see lines 9-11 Stanza 3). The teacher grappled to elaborate the Sine rule by demonstrating with gestures (see lines 12-21 Stanza 3). After a closer look at the faces of his students and judging their lowered responses and facial expressions in class, it was apparent to teacher G that he had not successfully achieved the intended purpose. In line 22 Stanza 3 teacher G expressed his worry through the following words: **"When I talk LISTEN AND LOOK AT ME//".** This statement is an indication that the teacher was having challenges in dealing appropriately with Mathematical explaining during the lesson. One out of the two issues seems to be at play here; either the teacher assumed that the students' attentions were divided during the class as they were writing a note or perhaps he thought they did not understand his language. Although students' attention during writing might contribute to the challenge, what seemed to be a strong factor in the struggle of Mathematical explaining was their limited understanding of the teacher's language use. Subsequently, the teacher continued demonstrating and describing a step-by-step approach using the Sine rule in solving Mathematical problems involving the scalene triangle.

Teacher G's talks in Stanza 3 above seem to be best described as Mathematical explaining practice. It is so because it is about providing detailed accounts of how Sine rule should be applied to solving problems involving the scalene triangle. He was revealing relevant facts on the concepts in the classroom. These explanations were meant to help students acquire the knowledge of Mathematical Discourse. However, teacher G was the only one doing most of the talking during his class. Successful explanations might achieve the intended purpose if the teacher involves students in understanding the how and the why of the concept under discussion (Esmonde, 2009), something important which seemed to be lacking in teacher G's class. His use of language in emphasising with extra stress in talking to the class suggested he understood the challenges of the students (their ability to quickly comprehend LoLT) and appeared to be willing to help them. Mathematical explaining as evinced by teacher G in his lessons seemed to suggest that the scalene triangle was made relevant in the Discourse. Using an illustration of a skin colour the teacher seemed to compare scalene triangles with black Africans. He told the students that; **"We are blessed with black skin"** (see line 9 Stanza 3). It was baffling to see how the teacher compared the scalene triangle with the humans' skin colour. In the comparison as above, teacher G made the black African identity of the whole class visible and recognisable. As far as the focus of his lesson was concerned, he appeared to regard other triangle types irrelevant. Mathematical explaining practice appeared to be enacted simultaneously with Mathematical exemplifying practice in the lesson. The two practices are different. The former deals with the words teachers use which explain and elaborate on a mathematical concept or idea so that students understand both the how and the why of the concept. It is identified from the data when additional insight into a concept/idea is provided, while the latter focuses on any selected question or set of questions given by the teacher/students in class with the view of illustrating and generalising the solution for the calculated task. In the section that follows I discuss Mathematical exemplifying as used in teacher G's class.

6.5.5 Mathematical Exemplifying practice (EP)

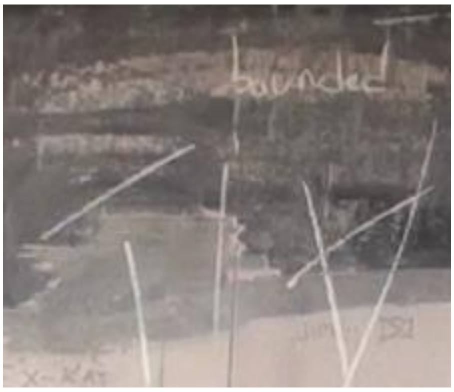
This refers to any selected question or set of questions by the teacher/students in class with the view of illustrating and generalising the solution. This practice was identified from the data during instances where the teacher/students thought of a set of questions or one question and regarded it as an example (Zodik & Zaslavsky, 2008). Teachers can provide an example to illustrate a Mathematical approach (e.g. find x if $2x + 3 = 180^{\circ}$ or set of examples on concepts of triangles etc.) (Bills et al., 2006; Zaslavsky & Zodik, 2007). Examples play a critical role in the teaching and learning of Mathematics. Zodik and Zaslavsky (2008) pointed out that teachers' selection of examples "may facilitate or impede students' learning", and as such presents a challenge during classroom interaction. The findings of Zodik and Zaslavsky (2008) are relevant to this study. The greatest importance of a teachers' work is the ability to make a decision by careful advance planning or to unexpectedly take a decision on the spot in reply to a situation in the classroom. Two kinds of Mathematical exemplifying practices namely: pre-planned and spontaneous were identified and examined in teacher G's classroom.

Pre-planned examples are examples which could be inferred from the teacher's actions and words showing an evidence of thoughtful and advance preparation of the lesson. These examples appeared in the teacher's lesson plan, worksheets and the textbooks used during teaching and learning of Mathematics. Spontaneous examples show clear evidence of being used on the spot. This includes situations involving the selection of unplanned examples. A total of 14 examples were generated by teacher G and only 2 examples were generated by the students. I now discuss below some of the examples generated by teacher G, as the main focus of this study is on the teacher.

As mentioned above teacher G's language use made relevant 14 examples on trigonometry (triangle) and in particular the scalene triangle in the class. Throughout the classroom observations it was evident that some of the examples used by teacher G were planned in advance (i.e., pre-planned) while others were formulated on the spot in responding to the interaction within the classroom. In Stanza 4 below some of these instances are presented to open discussion on how enactment of Mathematical exemplifying by the teacher appeared to provide an understanding on the Discourse of teaching and learning Mathematics in the northern Nigerian context.

According to Bills et al. (2006), the importance of an example in the Mathematics classrooms is not how little or much. It is rather what teacher/students do with the example, how they perceive, probe and generalise. In starting his lesson on trigonometry teacher G generated a spontaneous example. The case of spontaneous example was observed as indicated in Stanza 4 lines 1-5 teacher G behaved like this: **"If I draw like this. Is this line STRAIGHT? This one did they come together? This one has come together. That gives you the triangle. I think is something like this."** Clearly teacher G had a lesson plan, but no example on the drawing. He constructed the example on the spot during the lesson in class to illustrate with a sketch of lines forming a triangle. It was a spontaneous example because it was provided without premeditation. The keywords used during the construction of this kind of example were: **"like"** and **"this"**. The teacher kept on correcting and cleaning parts that did not fit in until he attained to the desired example which met the intended purpose. Nevertheless, in lines 7 and 17 Stanza 4, the teacher used a keyword such as **"example"** in providing a pre-planned example to the students on how to solved a particular task in the Mathematics classroom. It was a pre-planned example because the teacher was reading the question directly from the worksheets prepared in advance for the lesson. However, the observations show that most examples used during Discourses by teacher G in the Mathematics classroom were spontaneous sketches of diagrams, as well as the solution. Worthy of note in the observations was how he used very few Mathematical problems to work out as a whole class activity, so that students could learn by answering similar questions in tests or examinations. Furthermore, teacher G seemed to give students pre-planned examples as homework. It is evident in line 17 Stanza 4 below where the teacher gave students **example 2** as homework.

Stanza 4

1. T This is a STRAIGHT line//. **If I draw like this//. (Teacher sketching and gesturing). Is this line STRAIGHT?// This one did they come together?// This one has come together//. That gives you the triangle//. I think is something like this/**/. Right?// Any way (…). Is this a rectangle? 

2. Ss Yes// (chorus)

3. T Rectangle, we still have demarcations//. Then you have the very small one like this//. Can you see that now//. If I draw like this//. (Teacher sketching). Rectangle, we still have demarcations//. Then you have the very small one like this//. It have a very small width//. Listen once again//. This a mountain//. (Teacher gesturing and pointing to the board). Draw a line like this//. And you are travelling to let's say from point A to point B//. Can you pass through the mountain?// 

4. Ss No// (chorus)

5. T Which make it straight?// If I do like this, do like this, that means this and this have the same length that is what it shows//. (Teacher gesturing and pointing to the board). If I do like this that means all of them have the same length//. You have a triangle like this// Right?//

6. Ss Yes// (chorus)

7. T And remember we use surd to solved other triangles//. But not right angled triangle//. **Example 1**(…). In triangle A, B, C, in triangle A, B, C, angle B (…). That means you write capital B, angle B//. Just $B = 39°$//. Then $C = 82°$ and side a = 6.73cm//. That means this a is side//. Find c//, Find the remaining angle A of triangle A, B, C Taken?// Of

which a, eee,// put a I mean small a side a, write small letter $a = 12.5$ cm, a is 12.5 cm taken?// To find the value, what do we use?// We use sine rule//. Which says that $\frac{a}{SinA} = \frac{b}{SinB} = \frac{c}{Sinc}$

8. Ss Yes// (chorus)

9. T Capital $C = 116°, 116°$//. If you observe, one of the angle is $116°$//. One of the angle given is $116°$//. Where is our small a?//

10. S Small a is 12.5cm//

11. T Small is 12.5cm// Or in fact, let us calculate the A on this one So angle $A = 180° - (39° + 82°) = 180° - 121°$ $This\ is\ what$?

12. Ss 59°// (chorus)

13. T Just cross multiply and solved the problem//. Now $cSin\ 59 = (6.73Sin82)cm//$. Remember you want to find$c//$. You have to divide both side by the coefficient of $c//$. Right?// So $c = \frac{6.73\ Sin\ 82°}{Sin\ 59°}$//. What is the answer?//

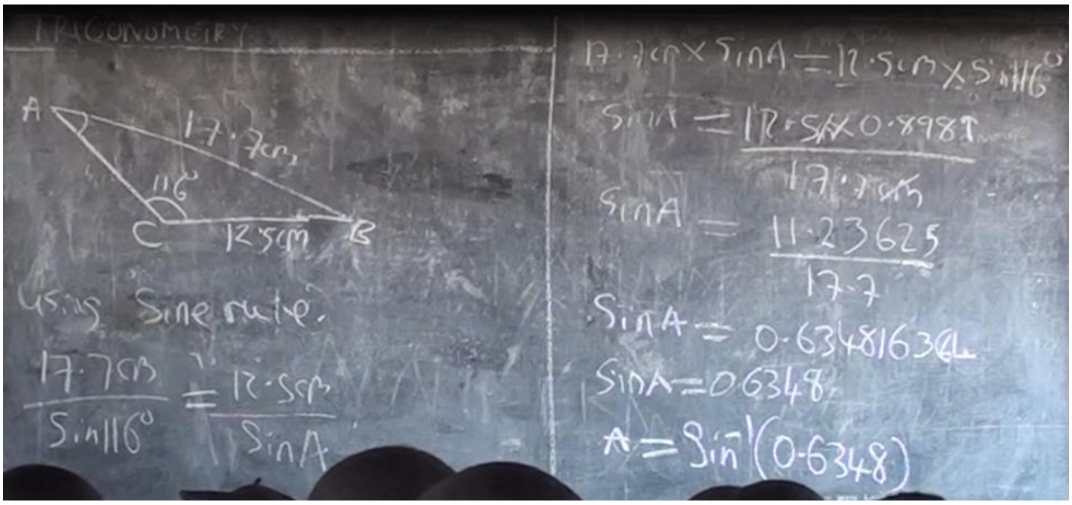
14. Ss 17.7cm// (chorus)

15. T 17.7cm//. You can even see it that is longer than the other side

16. Ss Yes// (chorus)

17. T **Example 2:** in a triangle A, B, C, angle A is 54.2, angle A is 54.2 degrees taken? Angle B is 71.5 degrees 71.5, degrees and small side a is 12.4cm, 12.4cm find b//. I am not

going to do this one on the board//. I will give you, I will live for you to just solved//



The observations in the classroom indicated that 8 out of 14 (more than half) examples generated by teacher G during his teaching were spontaneous, while 6 were pre-planned. One obvious observation that became clearly evident during teaching and learning of Mathematics in class was that these pre-planned examples were mostly from the textbook. A closer look at the above on spontaneous and pre-planned examples indicated that teacher G attended to student’s challenges majorly as he become aware of them during the lesson, not in advance. He seemed to use Mathematical exemplifying in explaining the procedures for working out Mathematical tasks in the class. He appeared to be more concerned with teaching the content of trigonometry so that students could learn and apply the knowledge in similar examples. Mathematical exemplifying practices appeared to be reduced to a sequence of actions to make the students more knowledgeable in the content of trigonometry. One significant aspect of the observation I noted during the Discourse of Mathematical exemplifying in the lessons was, how teacher G made connections to past and future topics in Mathematics such as “surds”, which was relevant to trigonometry (see Stanza 3 line7). Gee (2005) called this Intertextuality. Intertextuality is the switching or mixing of text from one variety of language (social language) to another.

6.5.6 Mathematical Proceduralising practice (PP)

This is a step-by-step approach to solving a particular Mathematical problem (Setati, 2002). It might involve the use of words or phrases such as, ‘what next?’, ‘from here, where do we go next?', and 'what do we do again? From Stanza 4 above, it was clear that the Mathematical Proceduralising practice was used at the same time as Mathematical exemplifying and Mathematical explaining. Teacher G was demonstrating the solution of a mathematical task using an example: **"In triangle A, B, C, in triangle A, B, C, angle B (…). That means you write capital B, angle B. Just $B = 39°$. Then $C = 82°$ and side $a = 6.73\ cm$. That means this a is side. Find c, find the remaining angle A of triangle A, B, C"**. This example involves finding the side and the remaining angle of a given scalene triangle (see Stanza 4 line 7). Using Sine rule: $\frac{a}{SinA} = \frac{b}{SinB} = \frac{c}{SinC}$, the teacher took the students through a step-by-step procedure: **"Just cross multiply and solved the problem. Now $cSin\ 59 = (6.73Sin82)cm$. Remember you want to find c. You have to divide both side by the coefficient of c. Right? So $c = \frac{6.73\ Sin\ 82°}{Sin\ 59°}$. What is the answer?"** He then arrived at the answer: $\mathbf{17.7cm}$, without justifying the approach for the calculation (see lines 7-16).

These observations suggested that he valued and made important Mathematical Proceduralising in his language use as a Discourse of the subject. Teacher G's approach for the calculation in his class was similar to what Setati (2005c) stated, Mathematical procedural Discourse is where the emphasis in teaching Mathematics is aimed at establishing the steps which should be taken to calculate certain mathematical problems with no development of the concepts. This Discourse practice would limit students to merely accepting procedures. Even though solving Mathematics requires knowledge of algorithms, this must be backed-up with a great deal of conceptual understanding, so that students would know why and how the steps were undertaken in calculating problems.

6.5.7 Mathematical Re-voicing practice (RvP)

In Stanza 5 below teacher G used Mathematical re-voicing in his discursive language together with Mathematical reiterating. Mathematical reiterating practice happens when teachers/students keep on repeating or emphasising what was taught in the previous lesson (s) to remind them or refresh the memories of some, or the whole class to have a better understanding of the current lesson (Essien, 2013).

While Mathematical re-voicing practice essentially tries to repeat some or all of what has been said in a preceding tone as the basis for a shift in the interaction (Enyedy et al., 2008). It could also involve repeating what has been said using the correct mathematical language.

Two instances of Mathematical re-voicing are presented below. Re-voicing mathematically was enacted using correct (formal) Mathematical language and grammatical expressions. In line 1 Stanza 5 below, the teacher repeated a Mathematical definition with expansion: **"A STRAIGHT LINE is the shortest distance. A straight line is the shorted distance between two points."** G Mathematically re-voiced the definition of a straight line with the addition of the words: **"between two points".** As described by Planas and Morera (2011, p. 1357) this repetition could be identified in two ways; "linguistically exact copy, or as a reformulation". In other studies, Krussel et al. (2004) and Moschkovich (2007b) recommended that the use of Mathematical re-voicing was an essential part of a teachers work in the classroom. The Mathematical re-voicing practice used by teacher G reflected the challenge in the classroom he grapples with while helping students who themselves are also learning to read and write in English language.

Stanza 5

1. T **A STRAIGHT LINE is the shortest distance//. A straight line is the shorted distance between two points//**. A line is a distance between two points//. And a straight line is a distance between two points//. Now types of triangles//. Somebody should give us one// Yes//. Not you, the other person//

2. S **Equilateral triangle//**

3. T What?

4. S Equilateral triangle//

5. T Equilateral triangle//. Equilateral that means is from the word equal//. Right?//

6. Ss Yes// (chorus)

7. T Equilateral triangle means all the sides and all the angles are equal//. Right?//

8. (Teacher gesturing)

9. Ss Yes// (chorus)

10. T And each angle are 60 degrees, emum?// Yes another triangle, you//

11. S Acute triangle? (…)

12. T WHAT? Acute triangle?// (…) **BANSANIBA// (I don't know)//. COME//.** You said acute triangle?//

13. S Yes sir//

14. T **Come, come, come//. KUN SAN LISAFI IRIRI NE (you know Mathematics are of different kinds)//. BANSAN ABIDA YAKE NUFE BA KOO?// YAUWAAA// (I don't know what he meant now?)**// Right?// Draw it, the acute triangle//.

15. T (Teacher gave a pieces of chalk to the student to draw acute triangle, and he is unable to draw)

16. T Why do, do…you say something that you can't even draw it?// Yes, you//

17. S Scalene triangle//

18. T Scalene triangle//

19. T (Teacher writing on the board, then he turn and regulate the students)

20. T I don't want everybody to speak (…), yes//

21. S 6.7cm//

22. T 6.7cm//. What are we ask to find?

23. Ss c// (chorus)

24. T BAGA C NAN BA?//.(Don't you see letter C here?) Ehen// see c now//. Heeey//. WHAT IS WRONG WITH YOU?// KAI INGONA (you be careful)// go to 60, 60 are you there?// IN KUNGAMA, SAI A JA LAYI (If you finished, then draw a line)

In lines 2-5 of Stanza 5 above for example, was an instance where teacher G used formal Mathematical language in the pronunciation of **"Equilateral triangle"** to correct a student. Teacher G Mathematically re-voiced the word in English using formal Mathematical language. This challenge has to be addressed if students are presented and taught words or terms from the Mathematics register and how they are used in a Mathematical Discourse.

6.5.8 Mathematical Code-switching practice (CsP)

Interactions in teacher G's class as indicated in Stanza 5 above were mostly done in English. The use of Mathematical code-switching practice was limited to two languages (English and Hausa). Mathematical code-switching practice refers to the alternating between two or more languages within the same conversation (Adler, 2001; Essien, 2010; Setati, 2002; Zabrodskaja, 2007). Or is the use of Words/phrases/sentences from one language to a different language (Chitera, 2011; Halai, 2009)

An interesting observation which seemed significant was that the teacher appeared to be the only one switching between English and Hausa during the lessons. It is clear in lines 12 and 14 where he switched in his discursive language to improve the understanding of a triangle type. The teacher uttered the following words**: "Come, come, come. KUN SAN LISAFI IRIRI NE (you know Mathematics are of different kinds). BANSAN ABIDA YAKE NUFE BA KOO? YAUWAAA// (I don't know what he meant now?)// right?// Draw it, the acute triangle."** G's switch to the Hausa language was for the purpose of clarifying ideas on the acute triangle, as well as managing students' behaviour in the class. Teacher G also seemed to switch to a more comfortable language to enable effective communication during Discourses. As indicated in Stanza 5 line 24, this was the case when he used the words: **"BAGA C NAN BA? (Don't you see letter C here?) Ehen, see c now. Heeey. WHAT IS WRONG WITH YOU? KAI INGONAKA (you be careful),**

go to 60, 60, are you there? IN KUNGAMA SAI A JA LAYI (If you finished, then draw a line).” He told the students what to do while solving a Mathematical task in the class. It should be noted that the English language is the LoLT. The teacher and the students do not share the same home language, although Hausa language which the teacher frequently uses is understood by the majority of students in the class.

G used Hausa in his class not only for managing and regulating behaviour but also for clarification of Mathematical concepts. It should be noted that the teacher was not only switching language to prepare and regulate students but also related it to the discussion in the Mathematics class. Planas and Civil (2013) study on language-as-resource argued that the complexity of using home languages by students to learn Mathematics “may be addressed through classroom practices in which the students’ home languages successfully become a vehicle in the construction of Mathematics knowledge” (p.2). In a related study on using language as a transparent resource in the teaching and learning of Mathematics in a Grade 11 multilingual classroom in South Africa, Setati et al. (2008) found that the use of multiple languages was beneficial for students. The use of Hausa language in G’s class was valuable in the construction of the social goods (the knowledge of Mathematics). As teacher G and the students did not share the same home language, the use of Hausa might evince the political and cultural significance to the knowledge of Mathematics. By politics, I am referring to how social goods are, or ought to be distributed. Gee (2005) explained that social goods refer to anything a certain number of people believe to be a source of power, worth and/or status. Students need the knowledge of Mathematics (the social goods in this instance) to succeed in several professions in Nigeria. Hausa language as used in teacher G’s class was for the purpose of teaching this vital subject (Mathematics). It also suggests that Hausa possesses great potential of it being used in the teaching and learning of Mathematics in multilingual classrooms.

Other forms of DP in G’s class like Mathematical generalising practice (GP) and Mathematical socialising practice (SiP) did not feature much during his Discourses, compared to the ones analysed and discussed above. Mathematical generalising practice was only used once (see Stanza 4, line 11). This was during the use of Mathematical proceduralising practice. In this study, common Mathematical statements such as 'parallel lines never meet', $a + b$ will always equal $b + a$ and 'the interior angles of any triangle add up to 180 degrees' are Mathematical generalising practice. On the other hand, Mathematical socialising practice refers to the uses of other concepts/terms such as 'kilometre (KM)' and/or centimetre (CM), from the Mathematics and other subject areas by teacher/students in their discussions. Few examples of Mathematical socialising practice applies in the data (see Stanza 4, lines 7-17). It seemed that G did not make important this DP as in his Discourses.

6.6 Verbal Norms of practice

As discussed in Chapter Two of this study, it is practically impossible to focus on Discourse practices in the Mathematics class without looking at the norms of practice. The norms of practice are interlinked and intertwined in the Discourse. I now present the discussion of the verbal norms of practice as featured in G's class. The verbal norms of practice sub-category include: Whole-class participation, Individual participation, Loud talking, Justification, Regulating and Ridicule norms of practice.

6.6.1 Whole-class Participation norm (PW)

This happens when the whole class participates in any given mathematical task. Words/phrases such as 'are you all following?', 'do you all understand?', 'who has not contributed in this class' are used to indicate this norm. This whole class participation by the teacher/students includes verbal interactions (e.g. IRE), teacher-led discussions, small-group discussions, follow-up whole class discussions and choral responses during Discourses (Clarke, 2004 ; Clarke et al., 2013; Yackel, 2000). The Whole class norm was used in teacher G's lessons exemplified in line 6 Stanza 6 below, this was mostly in form of teacher-led discussions and choral responses of short, simple mathematical questions and answers. The teacher said: **"Write in triangle A, B, C. Then come back to this. Are you all here?"** The question asked by the teacher as above was merely eliciting a response. Teacher-led class are situations in the Mathematics class when the teacher leads the whole class in participation during the lesson, while choral responses are instances for teacher/students to verbally say the same thing at a time during whole-class activity (e.g. Yes/no or true/false).

Stanza 6

1. Ss Good morning Sir// (chorus)
2. T Good morning students and sit down//. We are going to define sine rule and what?// Apply it on a problem to be solved//

3. T (Teacher writing on the board)

4. T **Write//(…). Sine rule state that//. Sine rule says that in triangle A, B, C//. Look at me//. Just say, just say that in triangle A, B, C (…)**

5. T (Teacher gesturing and demonstrating on the board)

6. T **Write in triangle A, B, C//. Then come back to this//. Are you all here?//**

7. Ss Yes// (chorus)

8. T Is what?// All of you do it//. All of you look up here//. If you have it?// Please open to page 238 now// Are you there?

9. Ss Yes// (chorus)

10. T I am not going to do this one on the board// I will give you, I will leave for you to just solved//. I know most of you can draw…//. Most of you can draw it now//. Draw it slow//, slow//. Don't worry//, I still explain so that you can understand what I am saying//. **Now, listen//. Listen once again/**/. Somebody should give us one// Yes//

11. S You said that eeee//

12. T Be louder//. Ehen// Look at me//. Yesterday I…// (…). STOP WRITING//. Listen first//. Do it quick, we don't have time//. Let me see your own?// Don't… HEY//, I said you should live small space// (Teacher gesturing and moving within the class to check students' work in their note books). You don't adhere to simple instruction?// Please where is your own?// I know why I said you should leave that space// **LET ME SEE YOUR OWN//. You are not even writing//**

13. S I don't have a pen//

14. T **YOU DON'T HAVE A PEN//. GO OUT AND GET A PEN//. GET OUT, GET OUT//.**

Another instance of using whole-class Participation norm in the class as shown in line 4 Stanza 6 above, it was when the teacher asked the class to write down what he was dictating and at the same time using mathematical writing practice: **"Write (…). Sine rule state that. Sine rule says that in triangle A, B, C. Look at me. Just say, just say that in triangle A, B, C (…)."** These observations in the Mathematics classroom suggest that teacher G used the whole-class participation norm in form of teacher-led discussions and choral responses. It appeared that mathematical communication with the students was used little. Students' need to talk to learn and comprehend what the teacher was saying during Discourse (Clarke, 2004). Students who are timid and weak at Mathematics could become discouraged.

6.6.2 Regulating norm (RN)

As shown in Table 6.2, the regulating norm was one of the dominant in teacher G's class. Regulating norm refers to instances of using Words/phrases/sentences such as, 'you are making noise', 'open your books please', keep quiet' 'just sit down and, 'let me check your homework' (Setati, 2002). Teacher G tried to prepare and control the students' behaviour in class. He was preparing the students, getting them organised for the lessons, checking their work and instructing them on what to do in the class. In line 10 Stanza 6 above, teacher G instructed students on how to solved a mathematical task by first drawing a triangle in their notebooks. He then urged them with the following words: **"Now, listen//. Listen once again//."** The teacher's use of language in reiterating the keyword "listen" suggested that the class had to be organised, quiet, and a controlled. This is consistent with Pimm (1987) who stated that most teachers always placed an emphasis on a quiet, controlled, conducive environment for a meaningful teaching and learning of mathematics.

On examination of the transcript, it was apparent that teacher G uses commands to control the students in class. In lines12-14 Stanza 6, the teacher used verbal commands in giving the following instructions: **"LET ME SEE YOUR OWN//. You are not even writing? S- I don't have a pen. T- YOU DON'T HAVE A PEN?// GO OUT AND GET A PEN//. GET OUT//, GET OUT//."** He stressed the words in a loud and emphatic voice, showing that he was possibly worried that the student had not obeyed him. By doing that, the student quickly stood up and walked out of the class in search of a pen. He obeyed the teacher's instruction. This interchange was authoritarian identity. The teacher used the voice of authority in rebuking and instructing the student during Discourses.

6.6.3 Justification norm (JN)

Justification norm is one of the norms of practice featured in teacher G's class. Justification norm is the use of Words/phrases/sentences such as 'that is why….?', 'because', 'can you explain why?' in expressing an opinion or giving a reason for certain classroom activities. The teacher used the justification norm together with mathematical questioning and mathematical explaining practice. There is a clear example in line 1 Stanza 7 below, where the teacher provided reasons for making scalene triangle important among other types. The teacher used the following words: **"this triangle to me is very, very important triangle, because out of it you can get all these other triangles from it."** It is clear from the words above that the teacher was justifying important the triangle under consideration in the class.

Stanza 7

1. T This, this, **this triangle to me is very, very important triangle// (Teacher gesturing and pointing to the board), because out of it you can get all this other triangles from it//.** You can get isosceles triangle, right angled triangle eee, and others from it//. So, to me scalene triangle is a black man//. Because you can get all colors from it//.What did I say?// (…)

2. Ss Scalene triangle is a black man// (chorus)

3. T **So next, that is the first THING//. Is the sketch//. IN FACT// this is where maths are, maths//. Because once you didn't get here, you cannot progress forward**//. So with this thing now, we want to find the value of angle A

Again, as evident in lines 3 Stanza 7 above, the teacher justified the importance of sketching the triangle before the solution of a given mathematical task using words such as: "**so next, that is the first THING//. Is the sketch//. IN FACT, this is where maths are, maths//. Because once you didn't get here, you cannot progress forward"**. It was quite clear that the justification norm occurred in teacher G's lessons during the Discourse of mathematical explaining and mathematical proceduralising practice. The use of the justification norm seemed to have the potential for productive teaching and learning of Mathematics in the class. It is important that students understand why certain approaches are used in the Mathematics class to achieve solutions.

Some of the norms of practice like the loud talking (LN), Individual Participation (IP), and Ridicule norm (RuN) were less prominent when compared to the ones analysed and discussed in teacher G's class. Loud talking norm did not feature significantly (see Stanza 6, line12) in the lesson as well as the individual participation norm. Loud talking norm refers to a situation in which teacher/students are expected to talk loudly so that everyone in the class can hear. This is apparent by the words/phrases such as 'louder please', 'I can't hear you', and 'speak louder'. On the other hand, the individual participation norm applies when one person at a time in class participates in any given task. It could involve taking a turn or one after another. There was very little individual participation norm in the data. It appeared that teacher G did not regard this DP as significant.

6.7 Mathematical symbolic practice

The DP sub-categories of mathematical symbolic practice are mathematical writing, mathematical symbolising and mathematical gesturing as characterised from the data of this study. I present the analysis of these practices which featured dominantly in teacher G's class.

6.7.1 Mathematical Writing practice (WP)

These are times when teacher/students write in a Mathematics lesson. It includes situations that the teacher will write on the board and ask students to write or copy what s/he has written. The teacher asks students to write down what s/he had written during the class. Urquhart (2009) identified three kinds of writing prompts in the

Mathematics classrooms: content, process and affective prompts. These three mathematical writing prompts (according to Urquhart) reflect some aspects of teaching and learning Mathematics. Content prompts are concerned with concepts and relationships, process prompts deal with algorithms and problem solving, and affective prompts focus on students' attitudes and feelings (Urquhart, 2009)

In the Symbolic Mathematical practice sub-category, mathematical writing is inseparable and interlinked with mathematical symbolising practice. In the lines 1 and 2, of Stanza 8 below the teacher stated: **"WRITE, WRITE. A triangle is a plane figure."** As earlier described in the sections above, teacher G attempted the use of mathematical writing practice by first writing the topic: trigonometry on the board and gave dictation after. He used the content prompt to encourage students to write his words down. It was a content prompt because the mathematical writing practice was all about the concepts of triangle.

Stanza 8

1. T **WRITE, WRITE//. A triangle is a plane figure//**

2. (Teacher writing on the board)

3. T STOP WRITING//. Listen first//**This is a STRAIGHT line//. If I draw anyhow…//**

4. (Teacher demonstrating with his hands the sizes of rectangles drawn on the board)

5. 

6. T Can you see that now//. This a mountain

7. (Teacher sketching on the board)

8. 

9. T Draw a line like this

10. (Teacher seriously gesturing while talking. He then sketched a triangle on the board)

11. 

12. T This angle is the 90 degrees// Yes another triangle//

13. (Teacher sketching and describing sides and angles of an equilateral triangle on the board)

14. 

15. T Look up//. If I do like this, do like this, that means this and this has the same length that is what it shows

16. (Teacher gesturing, describing and sketching on the board)

17. 

18. T This mark shows that they are equal//. COME//

19. (Teacher calling out the student by gesturing)

20. T You said acute triangle?//

21. (Teacher expressing surprise)

22. S Yes sir//

23. T Come, come, come//. You have two types of triangles//. Right?

24. (Teacher raise his two fingers)

25. Ss Yes// (chorus)

26. (Teacher writing on the board)

27. T We are going to define sine rule and what?//. Apply it on a problem to be solved//

28. (Teacher writing on the board)

29. T Write//(…). Sine rule states that//. Write in triangle A, B, C//. Are you all here?//

30. Ss Yes// (chorus)

31. (Teacher writing and stating the formula aloud)

32. T $\frac{a}{SinA} = \frac{b}{SinB} = \frac{c}{Sinc}$ (…)

33. 

He then sketched several sizes of rectangle and again used content prompts for students to copy as he wrote words which they might not be able to spell correctly on the board. Similar instances of mathematical writing practice were featured at the same time by his sketching triangles in the class during the lesson (see Stanza 8 lines 9, 26, 28, and 29).

Teachers in the Mathematics class can use Mathematical writing effectively as a Discourse practice to deepen students' learning as well as helping them to gain new understanding (Urquhart, 2009). Some students are better in their verbal communications, while others are not as good. Teaching them to write well mathematically might require the teacher's instructions and practice. This supports mathematical reasoning during lessons and helps students internalise the characteristics of effective communication in the class. Teacher G attempted to demonstrate and highlight one aspect (content prompt) of writing. The teacher would have clarified matters if he had used two or three of the writing prompts to connect the ideas of each unit of the topic. If he had done this, the students would have understood the concepts more fully.

6.7.2 Mathematical Symbolising practice (SP)

As shown in Stanza 8 G used mathematical symbolising practice to describe diagrams in his teaching and learning strategies for solving a mathematical task. It involved the uses of symbolic systems to represent and communicate the concepts in the class. Jones (2013, p. 37) in a study reported that "a picture [or diagram] is worth a thousand words or the equivalent hearing a hundred times is not as good as seeing once". Jones focused on three uses of diagrams in the Mathematics classroom. These included diagrams in Mathematics textbooks, students' problem solving diagrams and diagrams used by the teachers when teaching. The results of Jones (2013) study suggested that diagrams were most valuable in aiding the teaching and learning processes. G demonstrated the uses of diagrams in his class as the reader would see in the paragraphs below.

In sketching the diagrams, teacher G devoted a reasonable amount of time describing, and demonstrating. He made significant use of several non-verbal talks, in representing and communicating the lesson on the triangle. There was no ambiguity. He translated the symbolic mathematical language into English so that students could learn the concept. For example in lines 3-9, Stanza 8 above the teacher explained: **"This is a STRAIGHT line. If I draw anyhow…"** He drew two different sketches (rectangle and a mountain) to demonstrate the concept of a straight line.

According to Jones (2013) diagrams are visual aids used by teachers in class for communicating information during teaching and learning of Mathematics. From the discussion of teacher G's classroom observation above, it is important to use diagrams, but the teacher should guide and direct the students. As evinced in the Stanza 8, teacher G had to draw the students' attention to how the diagrams were related to the mathematical problem under discussion. Teacher G indeed attempted the use of mathematical symbolising practice productively in teaching students to understand the knowledge of trigonometry during his lessons.

6.7.3 Mathematical Gesturing practice (GeP)

Mathematical gesturing practice in this study refers to specific bodily (hands, head, shoulder, legs, and even eye) movements by the teacher in the classroom in order to communicate or illustrate a particular idea/concept while interacting with the students. According to Toastmasters (2011) there are 4 types of gestures: Descriptive, emphatic, suggestive and prompting. In another study Cook et al. (2016) identified other kinds of gestures in the Mathematics classroom which facilitate teaching and learning. These include bimanual beat, content, pointing and spontaneous gestures.

Mathematical gesturing was evident as indicated in Stanza 8 line 33. In fact, teacher G attempted to use the different kinds of mathematical gesturing practice so that the students would grasp the concept of trigonometry during his lessons. G's gesturing practice was consistent with the following study. Cook et al. (2016) showed that gesturing in the Mathematics classroom facilitated the teaching and learning of Mathematics. The Mathematical gesturing practice used in teacher G's classroom was productive during teaching and learning.

6.8 Non-verbal norms of practice

Non-verbal norms of practice are noiseless, movements, hand-raising, and rewarding norm. I present below the analysis of these non-verbal norms of practice in the following sections.

6.8.1 Noiseless norm (NN)

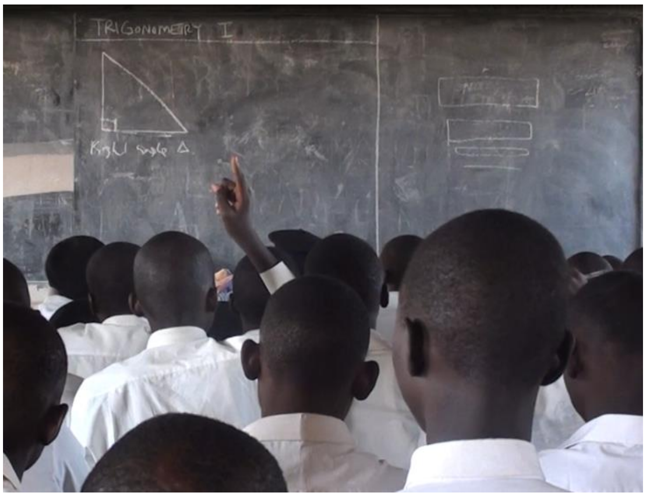
The noiseless norm is the expectation in the Mathematics classroom that all students must be silent or very quiet during teaching and learning. The observation in teacher G's class showed that this norm was adhered to during the lessons. It appeared that the students are already aware and had become used to this norm. Shortly after the arrival of the teacher in the class the students maintained an absolute silence without been told or reminded. It was easier for the teacher to create a safe teaching and learning environment which yielded positive results. Although there were times when the teacher moved in and out of the class to stop other classes being noisy, this gave some students the chance to talk to one another in the class. The class abided by this norm. This contributed to the stability of productive teaching and learning. The above observation seems to be in harmony with Pimm's (1987) explanation that in most classrooms teachers always place emphasis on a quiet, controlled, and conducive environment for the meaningful teaching/learning of Mathematics

6.8.2 Movement norm (MN)

This refers to the physical change of the teacher's/students' positions within the Mathematics classroom during the teaching and learning process. It also includes wriggling the body, as well as moving and interacting with the class. Two types of movement norms were identified: mindful movement (purposeful movement) and non-mindful movement (Beaudoin & Johnston, 2011). The observation (see Stanza 9 lines 6-9) shows that teacher G mindfully moved within the class for three different purposes during teaching and learning in his lessons.

Stanza 9

1. T Yes, hey this boy//

2. 

3. S Obtuse triangle//

4. T No sir, we don’t have obtuse triangle, yes//

5. S Scalene triangle//

6. T Scalene triangle,(Teacher sketched scalene triangle on the board), this triangle, none of the side are equal, none of the angle are equal

7. 

8. T You don’t know?//

9. Ss Yes//

10. T Good girl, I love that, good drawing, use your hand. Don’t use biro. (Teacher asks students to draw the sketches on the board, while moving and encouraging them).

The first reason for his movement was to demonstrate and show some concepts on the board. Secondly, he moved to check, correct, encourage and commend students' work. Thirdly, teacher G moved to regulate students' behaviour in the class. Teacher G showed the importance of evaluating students' classwork as well as creating a good relationship within the class.

When mindful movement was investigated in one Mathematics classroom, Beaudoin and Johnston (2011) reported that students greatly enjoyed the lesson. If students are motivated by the physical mindful movement of the teacher/students in the Mathematics classroom, it might create an increase in the students' academic achievements.

6.8.3 Hand-raising norm (HN)

These are instances in the Mathematics classroom where the teacher/students put up their hands to volunteer for a task. This includes waving hands to answer a question or waving to decline an answer. This norm was visibly seen (in Stanza 9 line1) during the lesson. This was mostly by volunteer students to answer questions, while teacher G pointed to call out one at a time. Hence the hand-raising norm as used in class during Discourses was intrinsically linked to individual participation norm. It seems teacher G was using this norm to maintain order and stability in the Mathematics class for productive teaching and learning. In the preceding sections and paragraphs of this research work, I have analysed and discussed in details the dominant DP enacted by teacher G in the Mathematics classroom. I now turn to elucidate as well on the lesson observations of teacher S.

6.9 Lesson description of teacher S in school B

Teacher S conducted all his three lessons on trigonometry with particular focus on triangles in SS2C (grade 11 equivalent in South Africa) class of school B in the research area. The textbook (New General Mathematics for Senior Secondary Schools 2) recommended and approved by the FME was used by teacher S in his teaching. The lessons were part of the normal school's day. The class was multilingual with students' average population for the three lessons totalling 70.

6.10 Lessons overview

Teacher S started the first lesson by preparing the students' minds on the topic as he explained that trigonometry and geometry were related. He had taught geometry in this class before and felt the students needed an additional knowledge of trigonometry. He then went ahead to ask them several questions on an angle. Teacher S attempted the definition of an angle using illustrations and demonstrating with sketches of straight lines coming together to meet at a point and forming an angle. The lesson proceeded to 3 different types of angles. Using several sketches on the board, teacher S took time to show students how to identify these kinds of angles

Next, he focused on the types of triangles and then asked a student to define a triangle. The student attempted the definition and was assisted by the teacher. The lesson continued with the teacher regulating students taking turns to mention the 4 types of triangles while he described them. The lesson ended with finding the solution to one mathematical problem involving unknown angles of a triangle. Then homework was given to the students.

In the second lesson, teacher S reminded students of the description of the three sides of a right angled triangle with a given angle. He then moved ahead to sketch and introduce the concepts of trigonometrical ratios; Sin, Cos, and Tan and briefly attempted the definitions of these trigonometrical ratios. Teacher S concluded the lesson with the derivations of trigonometry identities using Pythagoras theorem. He then solved one example and gave a mathematical task to students for the application of trigonometrical identities as homework.

In the third lesson, teacher S briefly revised the previous lessons on trigonometrical ratio and identities. He then introduced another concept of Cosec, Sec and Cot, which refers to the reciprocal of Sin, Cos and Tan respectively. In applying concepts of Cosec, Sec and Cot, teacher S took the students through the step-by-step derivations of 2 Pythagorean identities using a sketch of right angled triangle. Teacher S concluded the lesson by applying the Pythagorean identities in finding the solution of mathematical tasks. The three lessons lasted for a total of two hours two minutes.

The dominant DP which featured significantly through the use of verbal/non-verbal talks of teacher S across the data and which is important to the overall purpose of this study are present in Table 6.3 below;

Table 6.3:

Categories and sub-categories of DP in Teacher S' classroom

Categories and sub-categories of teacher S' DP			
Categories	Sub-categories	Dominant DP	Frequencies for the DP
Language practices (verbal)	Mathematical Discursive Practices	Mathematical Explaining practice (ExP)	35
		Mathematical Exemplifying practice (EP)	18
		Mathematical Reiterating practice (RP)	131
		Mathematical Code-switching, practice (CsP)	5
		Mathematical Defining, practice (DfP)	18
		Mathematical Questioning practice (QP)	107
		Mathematical Proceduralising, practice(PP)	15
		Mathematical Re-voicing practice (RvP)	85
	Verbal Norms of Practices	Whole-class participation norm (PW)	40
		Individual participation norm (IP)	18
		Justification norm (JN)	19
		Regulating norm (RN)	106
Non-language practices (non-verbal)	Symbolic Mathematical practices:	Mathematical Symbolising practice (SP)	116
		Mathematical Gesturing practice (GeP)	90
		Mathematical Writing practice (WP)	58
	Non-verbal Norms of practices	Rewarding norm (RwN)	4
		Movement norm (MN)	26
		Hand-raising norm (HN)	18

Table 6.3 is an overview of the dominant DP categories in teacher S' classroom. Mathematical reiterating practice (RP) has the highest frequency under the mathematical discursive sub-category. Regulating norm (RN) emerges as the most frequent norms of practice while mathematical symbolising practice was frequently featured under the symbolic mathematical practice sub-category. As earlier mention, by dominant, I meant the DP which influences (in directing the cumulative flow of the Discourses) across data obtained from teachers' Mathematics classrooms. I now discuss below one by one the dominantly featured DP through teacher S' use of language/non-language practices.

6.10.1 Mathematical Questioning practice (QP)

To reiterate, there are two types of Mathematical questioning (funneling and focusing) as described by Wood (1998). These were explored and identified. Funneling is the guided kind of questions asked to lead students towards a particular solution, while focusing refers to a more open style of Mathematical questioning which necessitates attention by the teacher to what the students are thinking, and prompting them to provide an explanation plus remaining open to a task being explored in several ways. As visible in Stanza 10 below, Mathematical questioning practice was a predominantly featured DP in teacher S' classroom. Mathematical Questioning practice was used by teacher S to start the lesson. In line 1 Stanza 10 the teacher used the focusing kind of question: **"what do you understand by an angle?"** to probe for students' previous knowledge on the topic (trigonometry). After mathematically reiterating the above question, he called on a student by name to answer. On realising that no student was ready to volunteer, he attempted the Mathematical definition of an angle.

Stanza 10

1. T Now what, what, **what do you understand by an, an angle?//** What is an angle?// What does, do you know, what is, what is an angle?// What is an angle?// Yes Glory// Do you want to say something?// (…) Nobody?// So when you have lines//. Two lines, two straight lines// When you have two straight lines meet at a point//. They form what is call an angle//. You can draw any two lines provided that they meet at a point//. What do you understand by triangle?// Yes// nobody?// (…) Yes you// triangle?//

2. S **A triangle is a shape that has three equal sides**

3. T Yes// eee she is correct//. **But not all triangles that have three equal sides//. As you know we have different types of angles//. So any plane figure bounded by three straight lines is called a triangle**//. I hope we are moving?//

4. Ss Yes sir// (chorus)

5. T Types of triangles//. (…) How many types of triangles do we have?// How many types of triangles do we have?// Yes, yes somebody, yes you

6. (Teacher call out a student to answer by pointing at him)

7. S 4

8. T 4// Yes somebody said 4//. Can I…//, can somebody mention number one for us?// Yes you at the back.// Mention them//. Let me hear?//

9. S Right angled triangle//

10. T Right angled triangle.// What, which, which type of angle is this?//

11. (Teacher sketching on the board)

12. T So this, this shape is what is call a right angled triangle.// Now listen// A right angled triangle is the type of triangle that one side is equal to 90 degrees

The teacher continued with the elaboration on triangles by asking the class, **"What do you understand by a triangle?"** One student attempted to answer the question and was assisted by the teacher. Next, teacher S focused on triangle types by prompting students to get short answer. He regulated their behaviour as they took turns in mentioning types of triangles (see Stanza 10, lines 5-10).

Teacher S presented instances of both funneling and focusing questions. He asked questions to encourage productive communication in the class. This same pattern played out when he asked students to take turns in mentioning triangle types. Teacher S elaborated on each type of triangle without engaging students so that they could improve their language skills and at the same time develop their conceptual mathematical Discourse.

This observation suggested that teacher S' classroom was using IRE (Initiation-Response-Evaluation) Discourse approach. Enumerated in Moschkovich (2007b) study are some common Discourse practices in multilingual classrooms such as IRE. This is a format of interaction in classrooms and whole class discussions. Of relevant to this study is how this kind of literature indicates teachers (e.g. teacher S) heavy reliance on the IRE pattern of interaction. Multilingual classrooms should be organised in such a way that teachers will help students to act in different ways using language (verbal and non-verbal) in their different Discourse practices. They should adopt the type of questions which foster logical reasoning in students which would assist them to think critically and communicate verbally in the Mathematics class. In doing so, students could be helped to improve both in their language communication skills and conceptual understanding of Mathematics.

6.10.2 Mathematical Defining practice (DfP)

As earlier discussed in the preceding sections that this study explored two types of mathematical defining practice (extracted and stipulated) (Edwards & Ward, 2008). Stanza 10, lines 2, 3, and 12 show instances of how Mathematical defining practice was used in teacher S' class. In line1, Stanza 10 the teacher asked for a stipulated definition of an angle from the students. The students were unable to attempt the definition. He moved ahead and mathematically defined an angle. Subsequently, in line 2, Stanza 10 a student gave a stipulated definition of triangle: **"A triangle is a shape that has three equal sides"** in response to a question posed by the teacher. Again in line 3, Stanza 10 the teacher tactically gave the correct Mathematical definition of the triangle by making the following statements: **"But is not all triangles that have three equal sides. As you know we have different types of angles. So any plane figure bounded by three straight lines is called a triangle."** This approach of Mathematical defining practice used on angle and triangle was also applied on triangle types plus other concepts during the lessons.

The teacher used Mathematical defining practice during the class. On the other hand, the teacher had to use different strategies, as the students were unable to answer correctly. One reason for this is that the students struggle to understand English (LoLT). Another interesting factor related to the one mentioned above is the students' awareness of the Mathematics classroom. The use of formal Mathematics language in the class is important. Students need to draw from it within the context of the lessons when asked to define. These factors as mention above needed to be dealt with by the teacher to create a productive and communicative classroom.

6.10.3 Mathematical Explaining practice (ExP)

Mathematical explaining practices are utterances made by teachers which elaborate on a Mathematical concept or idea so that students understand both the how and the why of the concept. It is identified from the data when additional insight into a concept/idea is provided. This is apparent in Stanza 11 below that Mathematical explaining practice was used in teacher S' class together with Mathematical questioning, Mathematical reiterating, and Mathematical symbolising. Teacher S asked students to compare two angles in terms of size. In lines 1-5 the teacher reiterated and used a sketch on the board to utter the statement: **"This one is bigger and this one is smaller."** He was introducing the concepts (types of angles) by giving explanations. Next, he continued with the explanation of the different types of angles. The teacher maintained this trajectory of explaining mathematically on other concepts during his lessons without asking students for their inputs.

Stanza 11

1. T Is this angle the same thing with this?// This angle is bigger than this one.// Right?

2. Ss Yes/No (mixed responses)

3. (Teacher gesturing and pointing at two angles of the sketch on the board)

4. Ss No// (chorus)

5. T Are you sure?// This one is bigger than this one.// Look at the board.// **This one is bigger and this one is smaller.//** So angles varies depending on their type.// Types of

angles.// We have types of angles.// When it is…?// when the two lines are at the perpendicular side.// They form what is call the 90 degrees angle

6. (Teacher demonstrating and gesturing with one hand placed over another)

7. T which is the right-angled.// Right?//

8. Ss Yes// (chorus)

9. T RIGHT-ANGL IS AN ANGLE AT WHAT?//

10. Ss 90 DEGREES// (chorus)

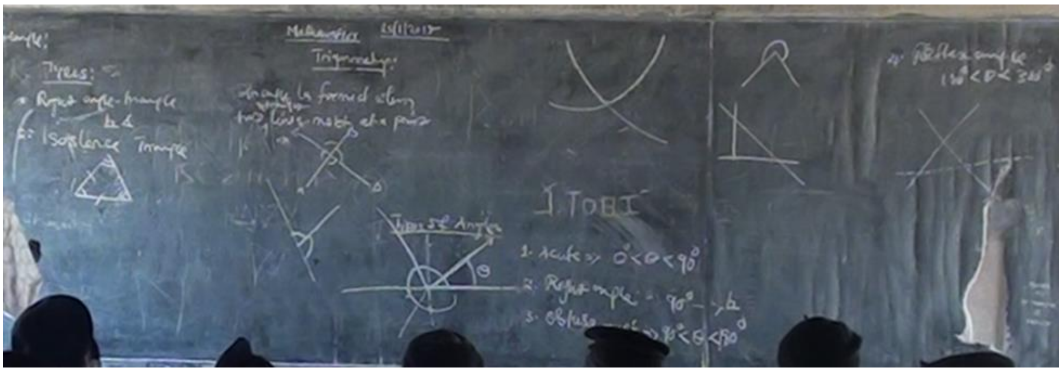
11. T RIGHT-ANGLED IS AN ANGLE AT//

12. Ss 90 DEGREES// (chorus)

13. T Now what about the angle in between…?// From zero to is not up to 90 degrees.// It has a range.// So this angle is call an acute angle.// Say it let me hear//

14. Ss AN ACUTE ANGLE// (chorus)

15. T An acute angle is any angle between 0 to 90.// Is that OK?// Is more than zero but less than 90



Rowland (2012) argued that "most time, we cannot pass on what we know and understand for ourselves ready-made and gift-wrapped" (p. 4). This was explicit in teacher S' class, in that he kept on struggling to explain mathematically by changing the communicative language approach and the pattern of Discourse during whole class participation or individual participation. He tried to help them understand. Teacher S' Mathematical explanations in Stanza 11 above, were predominantly formal Mathematical language. He spoke in the English language to communicate with the students. English was valuable in teacher S' classroom. This is not just the function of mathematical language but shows that the use of English language is encouraged and well accepted in the classroom. It is, therefore, reasonable to argue that teacher S' Discourses of language use in Mathematical explaining served a dual purpose to the students in enabling both linguistic and mathematical knowledge in the classroom. As mentioned earlier, mathematical explaining appears to be enacted simultaneously with mathematical reiterating in the lesson. In the section that follows I discuss mathematical reiterating practice as plainly visible in teacher S' class.

6.10.4 Mathematical Reiterating practice (RP)

Stanza11, made explicit that Mathematical reiterating was one of the dominant DP in teacher S' class together with Mathematical defining, Mathematical questioning, and also with Mathematical explaining practice. In his interactions with students as in line 5 Stanza11 above the teacher, reiterated the statement: **"This one is bigger than this one",** while explaining mathematically the concepts of angle and its types. Teacher S repeatedly explained **"the right-angled"** to be sure that the students understood the concept, before moving to another. He asked students to reiterate words/phrases after he had told them, so that they would commit them to memory (see Stanza 11, lines 9-15). Andrews (2009) referred to this strategy as exercising prior knowledge. The strategy adopted by the teacher seemed to be yielding good results for him, but continued use of this approach might lead to more rote learning. The interaction in the class suggested that teacher S considered Mathematical reiterating significant Discourse practice in the teaching and learning of Mathematics. He appeared to value it and made it relevant.

6.10.5 Mathematical Exemplifying practice (EP)

Teacher S' used several forms of examples (pre-planned, spontaneous, or exercise) in teaching the concepts of trigonometry. In particular, his focus was on right angled triangles in the class (Zodik & Zaslavsky, 2008). Here are some instances in Stanza 12 on how enactment of Mathematical exemplifying practice by the teacher appears to provide an understanding of Mathematics teaching and learning in the northern Nigerian context.

In teacher S' class, most examples were given to clarify or illustrate a concept during a whole class activity. In an attempt to exemplify the workability of the identity equation he had derived on the board as indicated in lines 1-5 Stanza 12 below, the teacher enacted an spontaneous example by asking the students: **"Give me any number",** and they responded to him **"18 and a half"**. He then substituted the value in the identity equation: $(\boldsymbol{Sin}\ \mathbf{18.5})^{\mathbf{2}} + (\boldsymbol{Cos}\ \mathbf{18.5})^{\mathbf{2}} = \mathbf{1}$ **.** Using a calculator the teacher and the students were able to find the answer as one. The teacher then concluded by instructing students that any number substituted into the identity equation would always give one as the answer. In the instance as above, teacher S gave spontaneous examples to help students apply the knowledge with similar mathematical problems, but with little or no conscious decisions in selecting them. Watson and Mason (2006) noted that if teachers used examples without consciously selecting them, then rather than gain the practical experience which would lead to generalisation and conceptualisation, the students might end up in merely a drill and practice. The teacher gave exercise examples to clarify some Mathematical concepts (see Stanza 12, lines 5-13). Teacher S gave exercise examples to students in form of homework, for them to practise after normal class activities (see Stanza 12, line15).

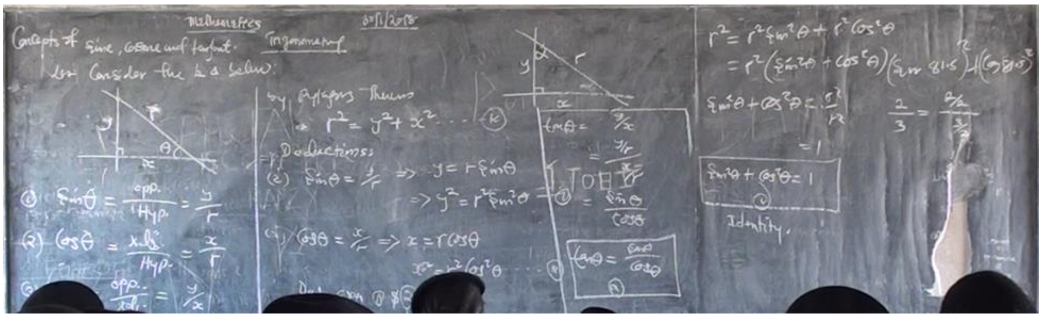
Stanza 12

1. T So give me example let me hear//. Mention any number between 0 to 90 degrees//. You will see something like this// (Teacher demonstrating and gesturing with one hand). Right angled// We said it has a sign, like this//.**Give me any number//**

2. Ss **18 and a half// (chorus)**

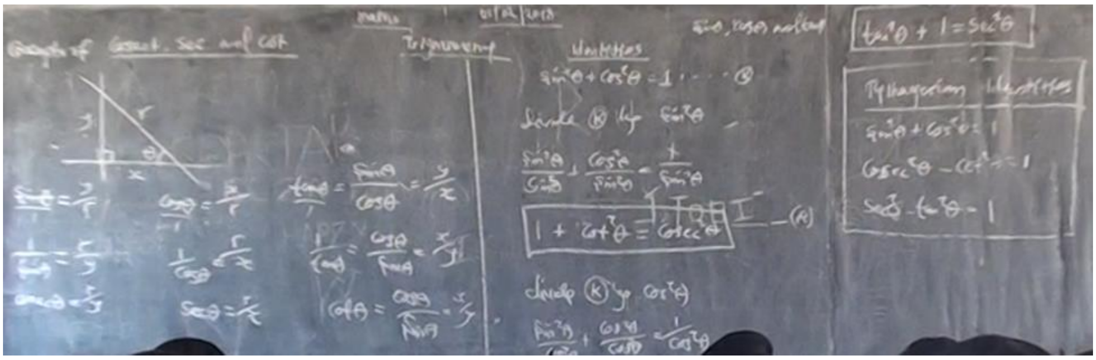
3. T 18 and a half**//** $(\boldsymbol{Sin}\ \mathbf{18.5})^{\mathbf{2}} + (\boldsymbol{Cos}\ \mathbf{18.5})^{\mathbf{2}} = \mathbf{1}$//. You have calculator//. Put it inside bracket//. Put everything inside bracket//. Open your bracket//. You got your one,

right?//



4. Ss Yes// (chorus)

5. T Any number you get, close your eyes and pick any number, if you put it here and perform that and this perform this, it will give you one, that is why it is call an identity// (Teacher gesturing with one hand). Now copy so that we can solved some problems//. Write, write, write//. Given that Sec x is equal to 5 all over 3 calculate without using Table i) Cos x ii) 1 + Tan x all over 1-Tan x iii) 3 + Cosec x all over 1 + Cosec x//. **What is given in the question?**//



6. Ss **Sec // (chorus)**

7. T **Sec what?//**

8. Ss Sec x// (chorus)

9. T Sec x//. Given that, this is Sec x equal to what?//

10. Ss 5// (chorus)

11. T 5 all over what//

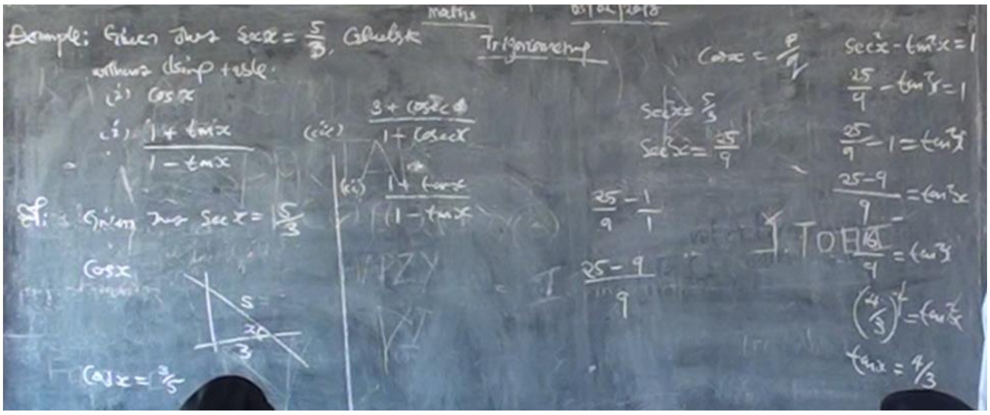
12. Ss 3// (chorus)

13. T Now how can I translate this one?// (Teacher gesturing pointing to the board). What is Cos x?//. This is $y = r\ Sin\theta$//. Now this implies that $y^2 = r^2 Sin^2\ \theta$//. So I will have $x^2 = r^2 Cos^2\ \theta$//. Now, by Pythagoras theorem// $r^2\ (Sin^2\ \theta + Cos^2\ \theta) = r^2$//. Dividing both side by this r^2//. We get $Sin^2\theta + Cos^2\theta = \frac{r^2}{r^2}$//. And what is $\frac{r^2}{r^2}$//. The numerator and denominator are the same//. Any number divided by itself//. This is our $Sin^2\theta + Cos^2\theta = 1//$, we call it an identity//. This is identity// That is where we will stop on this topic for now// Ok//

14. Ss Yes// (chorus)

15. T Please solved this as homework iii) 3 + Cosec x all over 1 + Cosec x//

16. Tomorrow we continue with geometry//.



The teacher mathematically explained the solution of an example in the class. The teacher appeared to share the importance of the trigonometry content so that students could gain knowledge and apply that to similar examples. One interesting and important aspect of the observation I noted was how the teacher showed a mastery of content in teaching students the procedures of deriving the Pythagorean identities. His ways of Mathematical exemplifying seemed to be a “show-off”, an expert in his subject area. He exhibited an identity of a mathematician. It let much to be desired. It was defective.

6.10.6 Mathematical Proceduralising practice (PP)

In Stanza 12, Mathematical proceduralising was used simultaneously with Mathematical exemplifying, Mathematical questioning and Mathematical explaining practice in teacher S’ class. The teacher and his students were calculating a

Mathematical task involving finding the values of trigonometric ratios such as Cos, Tan and Cosec. In line 5, Stanza 12 the teacher asked: “**What is given in the question?”** In reply, the students answered; it is **“Sec”**. The teacher reiterated the answer given by the students in form of the question: **“Sec what?”** This pattern of interaction as in teacher S’ class was his way of introducing a procedure for a Mathematical task. Subsequent discussions in the class were procedural descriptions of what should be done to solved or calculate the problem. Students’ responses to solution of the task were procedural as the reasons for using the methods or procedures were not stated by teacher S. The Mathematical proceduralising used in Stanza 12 by teacher S seemed to be enacted in similar patterns throughout his lessons.

Worthy of note is that teacher S and his students used formal Mathematical language in solving the problem. Pimm (1987) argued that formal Mathematical language (during Procedural discourse) was often regarded as the hallmark of Mathematical practices (activities). The use of formal Mathematical language during the Discourse of Mathematical Proceduralising as a practice in teacher S’ class was made significant.

6.10.7 Mathematical re-voicing practice (RvP)

Stanza 13 below indicates that teacher S mathematically re-voiced his practices while reiterating during lessons. In Stanza 13 below I present two occasions of Mathematical re-voicing in teacher S’ class. Mathematical re-voicing practice was used by teacher S to correct wrong Mathematical language and grammar. Shortly after dealing with angles and triangles in the class, line 7 Stanza 13, shows that the teacher stated: **“Now let’s move on…. Types of triangles can somebody mention number one for us. Yes you at the back”**. A student attempted the pronunciation of the term isosceles triangle, but struggled with the pronunciation. Teacher S in his Discourses repeatedly asked the student to pronounce the term isosceles again and again, possibly with the hope that the student might realise his mistake (see lines 8-14 Stanza 13). The teacher had to correct the student’s pronunciation. The teacher mathematically re-voiced the word “isosceles” by reiterating, as he turned the Mathematics class into an English language class for a moment. The next challenge came with a new triangle (equilateral triangle). The teacher devoted a reasonable time to mathematically re-voice and reiterate the pronunciation of equilateral to enable better understanding and enhance students' participation (see lines 18-26, Stanza 13).

Mathematical re-voicing, as used by teacher S in instances of the formal mathematical language of triangle types, shows the challenges in the classrooms that the teacher grapples with while helping students who themselves are learning to read and write in English language (LoLT). There appeared to be a lack of what Adler (2001) and Clarkson (2009) suggested in teacher S' class that, students should be taught progressively using three distinct dimensions: informal to formal mathematical language, verbal to written Mathematics and home language to LoLT. In his effort to deal with the challenge of wrong pronunciation of the triangle types by students the teacher had to correct them, trying not to discouraging them. Formal mathematical language was valued and made relevant by teacher S in his Discourses during lessons.

6.10.8 Mathematical Code-switching practice (CsP)

Interactions in teacher S' class as indicated in Stanza 13 were mainly in English. The use of Mathematical code-switching was restricted to three languages (English, Hausa and Pidgin English). An interesting observation was that the teacher switched in and out of English, Hausa, and Pidgin English in his attempts to explain the concepts of trigonometry. The teacher switched from English to Hausa as indicated in line 5 Stanza 13 below by uttering the words: **"ZAN DAGA DAYA A KAN DAYAN (I will lift one line on top of the other one)".** He used these words to describe and illustrate the shifting position of a line that was drawn to overlap another line in forming an angle. Other instances of switching were mainly for the purpose of regulating students in the class. For example, in line 29 Stanza 13 the teacher switched from English to Pidgin English using the words: **"OOYAH, you have a calculator, Put it inside bracket"**, while instructing students in the class to perform a mathematical task.

Stanza 13

1. T When you have two straight lines meet at a…, meet at a …//. When you have two straight lines meet at a point//. How many lines are there?// (Teacher demonstrating and gesturing with one hand)

2. Ss Two// (chorus)

3. T Two lines right?//. The angle there is zero degrees// Right?//

4. Ss Yes// (chorus)

5. T The angle is zero degree//. When I decide to left one on the other//. **ZAN DAGA DAYA A KAN DAYAN// (I will lift one line on top of the other one).** Angle at straight line is what?//

6. Ss 180 (chorus)

7. T 180 degrees//. TUU// (ok)//. **Now let's move on…//. Types of triangles// Can I// can somebody mention number one for us//. Yes you at the back** (Teacher pointing to a student)

8. S Isoceles triangle//

9. T SAY IT LET ME HEAR YOU//

10. S Isoceles triangle//

11. T Isoceles triangle//. I//, say it, I//

12. Ss I// (chorus)

13. T Isosceles//

14. Ss Isosceles// (chorus)

15. T Now the next one is what?// Is this one understood?//

16. Ss Yes (chorus)

17. T Yes//, you//(Teacher pointing to a student)

18. S Equiliteral triangle//

19. T Did you hear what he said?// SAY IT AGAIN//

20. S Equiliteral triangle//

21. T Say it again//

22. S Equiliteral triangle//

23. T Equal// Equal//. Say equal//

24. Ss Equal// (chorus)

25. T Equilateral triangle//

26. SS Equilateral triangle//

27. T In this triangle//(Teacher pointing to the board). This is what is call an interior angle of a triangle//. The sum of interior angle of a triangle is equal to 180 degrees//. We said a is equal to 35 degrees, if a is equal to 35 degrees, now, am going to use this a and this angle to calculate this. Look at the board very well, now we want calculate b. how do I find the value of b? Yes

28. S a plus 35 plus b equal to 180

29. T She said since we have gotten the value of a equal to 35//. And this covers the whole triangle//. So 35 plus 35 plus b will give us the sum of interior angles in a triangle//. Raise up your hand, if you know the answer correctly, your hands//. Let me see hands up, if you know the answer// Koo?// (right?)//. The number will be the same// (Teacher gesturing). The number will remain the same//. **OOYAH// You have calculator// Put it inside bracket//**

30. (Teacher moves near a student and show him how to write it in the not book)

31. T Put everything inside bracket//. Open your bracket//. And press your calculator//. Open bracket//

The switching done by teacher S suggests re-emphasising and reaffirming the subject matter. The students' inability to understand the explanation using the LoLT persuaded the teacher to switch. Teacher S switched to help students who could not express themselves well in the LoLT. The action of switching by the teacher can build a good relationship with the students. This would contribute to the effective teaching and learning of Mathematics. Setati (2005b) echoed this view. The use of the students' home language is evidence of group membership and personal connections. Thus using Hausa and Pidgin English language is a support, helping students to have a deeper Mathematical understanding in the class. Rather than seeing it as a problem, the switching in and out of English, Hausa, and Pidgin English languages is a vital resource for helping students to get deeper insights. Next I will now focus on the verbal norms of practices sub-category of DP in teacher S' classroom.

6.11.1 Whole-class Participation norm (PW)

In Stanza 14 below there is an example of whole-class participation norm which was used in forms of choral responses during calculation of the Mathematical task. Right from the beginning of the lesson as indicated in line 4 Stanza 14, teacher S engaged the students using the following words: **"Sit down then we start the lesson. So let's just go back to trigonometry. Before we go back again to geometry. Is that OK?"** It was obvious that choral response from students had been one of encouragement: **"is that OK?"** Students responded in the affirmative. It is similar to teacher G's class where answers were elicited using questions which encourages choral responses. Other instances of using whole-class participation in the Discourses in line 22 Stanza 14 was when the teacher instructed the class: **"WRITE, WRITE, WRITE so that we can use the remaining time to solved a problem. Three minutes to write this"**. All students were engaged to copy the Mathematical task already worked out on the board. He also gave them homework. Teacher S valued and made whole-class participation norm significant in his Discourses during Mathematics lesson

Stanza 14

1. Ss Good morning Sir// (chorus)

2. T Good morning students//. And how are you?//

3. Ss We are fine//

4. T **Sit down then we start the lesson//. So let's just go back to trigonometry//. Before we go back again to geometry//. Is that OK?//**

5. Ss Yes// (chorus)

6. T So they are almost the same geometry//. What is an angle?// Mention any number that is reflex angle//. SAY IT LET ME HEAR//

7. Ss 340, 350// (mixed response)

8. T What do you understand by triangle?// Triangle?// (…) Yes you// (…) triangle?//

9. S A triangle is a shape that has three equal side//

10. T Yes you at the back//

11. S Right angled triangle//

12. T How many types of triangle do we mention so far?/

13. S 4//

14. T 4 types of triangles// Is that Ok?//

15. Ss Yes// (chorus)

16. T Can we mention all?//Mention them let me hear//

17. Ss Right angled triangle// (chorus)

18. T Ehen?//

19. Ss Isosceles triangle// (chorus)

20. T Ehen?//

21. Ss Equilateral triangle, scalene triangle// (chorus)

22. T This is identity number one correct//. **WRITE, WRITE, WRITE//. So that we can use the remaining time to solved a problem//. Three minutes to write this//** (…). While you are writing//. So there is a way we summarise the three for easier memorization//. SOH, CAH, TOA//. WRITE, WRITE, WRITE//. Do it as homework//. And Submit it tomorrow//. Now copy so that we can solved some problems//(…). WRITE, WRITE, WRITE//. Remember what we said while writing//. **Don't make noise**//. The first one is what? Interior//. What about the outside?// Exterior//. Now, what will be the sum?// Yes//, you

23. S 360 degrees//

It was obvious that the whole-class participation norm plus interaction goes much further than simple recitations and memorising of concepts. It requires the recall of information the students have previously learned. Teacher S used whole-class Participation to sustain students' interest during the solution of a Mathematical problem (see lines 6, 17-21, Stanza 14). The teacher also used the whole-class participation norm for the purpose of evaluating students' mental reasoning during Discourses (see lines 12-16 Stanza 14). Clarke et al. (2013) noted that choral responses demonstrated a range of different ways teachers engaged students in their lessons. It was clear that the whole-class participation in the form of choral responses and conversational interaction had become a norm. Teacher S used Whole-class Participation norm to stimulate students. The use of the whole-class Participation norm in mathematical Discourse requires more attention than it apparent in teacher S' class.

6.11.2 Individual Participation norm (IP)

One person participates at a time in class. It involves taking turns or successively participating in a given Mathematical problem. Words/phrases such as 'one after another', 'one by one', and 'next person after this one', were used to identify the individual participation norm.

The individual participation norms were identified from the data by the use of the personal pronouns: s/he, you and me. In Stanza14, line 8 the teacher called out a student: "What do you understand by a triangle? Triangle? (…) Yes, you (…) triangle?" He called the student to elaborate on the concept of angle. Teacher S seemed to value individual participation, making the identity of students significant using the personal pronoun; "you" in calling them to take turns in answering questions. Teacher S made the individual participation norm relevant as he evaluated the understanding of what he had previously taught. I did observe that there was a lack of opportunity given to students to communicate mathematically in the lesson during individual participation. The teacher's strategy of affording fewer opportunities to individual students' participation might yield little or no improvement in their Mathematical abilities.

6.11.3 Regulating norm (RN)

In Stanza 14 line 22 is the regulating norm. This as used in Stanza 14 was similar to the one in Stanza 6 (used by teacher G). It was interesting to observe that teacher S used the regulating norm for the purpose of instruction in solving a problem, preparing, and regulating students' behaviour in his Discourses. In line 22, Stanza 14 for instance, he uttered the following words:

> This is identity number one correct//. WRITE, WRITE, WRITE//. So that we can use the remaining time to solved a problem//. Three minutes to write this// (…). While you are writing//. So there is a way we summarise the three for easier memorization//. SOH, CAH, TOA//. WRITE, WRITE, WRITE//. Do it as homework//. And Submit it tomorrow//. Now copy so that we can solved some problems//(…). WRITE, WRITE, WRITE//. Remember what we said while writing//. **Don't make noise**//. The first one is what? Interior//. What about the outside?// Exterior//. Now, what will be the sum?// Yes//, you ask students not to make noise.

The highlighted words: **"Don't make noise**", suggest an authoritarian voice similar to the one used in Stanza 6 by teacher G. Teacher S' use of the regulating norm seems to be like the observation of Setati (2002) in her study. She noted that regulating in the Mathematics classroom involved the teacher using the voice of authority to give instructions to students. Another characteristic of the regulating norm as was featured; it was only used by the teacher. The students either obeyed the instructions through their actions or responded with words such as yes/no.

6.11.4 Justification norm (JN)

From Stanza 14 above and as indicated in Stanza 15 below the justification norm in teacher S class was used during whole-class discussion. The class was discussing how to find the remaining unknown angle of an isosceles triangle. In line 1 of Stanza 15, the students were grappling to justify the answer which the teacher solved on the board.

Stanza 15

1. T You have to state the reason why?// Why is it that a is equal to 20?// The reason is that the base angle of an isosceles triangle//. Ok, Ok// If you say so//, what will be your reason?// (Teacher gestures and pointing to the board) Your reason is sum of angles in a triangle// You still have others// Because this once are at your level//. I will not use this?// Because the question is not talking about adjacent//. Will I going to use Sin?

2. Ss No// (chorus)

3. T Because the question is not talking about opposite//. Because zero divided by itself is not equal to one//. Because I know, I taught you something like this in our last class//. And if Sec is given//. And the question is find Cos?// Why can't you put this one here?// And bring this one down that is all// (Teacher gestures and pointing to the board). Can someone tell us why are we going to use the last identity? ($\sec^2\theta - \tan^2\theta = 1$) // Why?// (…)

4. S Because the Sec is given//

5. T Ehen// (Teacher gestures and pointing to the board)

It was also the same grappling to give a reason in line 3, where the teacher asked for a reason why using the last identity ($\sec^2\theta - \tan^2\theta = 1$) would be appropriate. The teacher paused for a while and gave justification for the use of the last identity. One reason why the students grappled was that they were not used to communicating mathematically in class. Most of the time, the teacher did all the talking. When they were called to talk, it seemed strange. Teacher S appeared to structure his whole-class discussion in such a way that the reasons for using Mathematical formulae and methods were provided, together with the regulating norm, questioning and explaining mathematically in the class.

6.12.1 Mathematical Writing practice (WP)

Writing mathematically is an integral part of teaching and learning and also a means to acquire new perspectives. This was used by teacher S together with Mathematical symbolising practice. Following from previous Stanzas and in line 3 Stanza 16 below, teacher S wrote the topic: trigonometry (triangle) on the board. Afterwards, he engaged students with an elaboration of several illustrations on sketches and prompted them to copy (see line 20 Stanza16).

Stanza16

1. T sit down then we start the lesson//
2. Ss Thank you sir// (chorus)
3. (Teacher writes the topic on the board)
4. T Look at this//
5. (Teacher sketching and showing students the positions of angles on the board)
6. 
7. T This one is also an angle//. You have a line like this//. How do you look at this?//
8. (Teacher sketching on the board)
9. 
10. T Did the two lines meet at a point?// I will shift one to stop somewhere here//
11. (Teacher sketching, gesturing and demonstrating on the board)

12. 

13. T Can you look at it, now//. Can you see it//

14. Ss Yes// (chorus)

15. (Teacher gesturing and pointing to the board)

16. 

17. Ss Yes// (chorus)

18. T What is this?// **Anywhere you see something like this in Mathematics it means what?//** I want to shift the line; the line is shift, right?//

19. (Teacher gesturing, sketching and demonstrating on the board)

20. 

21. T To a point somewhere here//. So this, this shape is what is call a right angled triangle//

22. (Teacher sketching on the board)

23. 

24. T This is an isosceles triangle//

25. (Teacher sketching and describing an isosceles triangle on the board)

26. 

27. T Something like this//. Now copy so that we can solved some problems//(…) WRITE, WRITE, WRITE//. Remember what we said while writing//

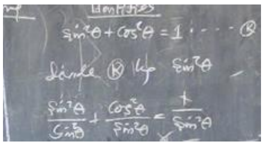
28. (Teacher cleaning the other side of the board and then pointing to the writing on the board as he reads)

29. T **Now stop writing everybody//. If you done with that//. I can only be telling you what to write//. All of you stop writing//**

30. (Teacher gestures and pointing to the board)

31. T Now look at the board//. What is given in the question?// This one is another equation//

32. (Teacher writing on the board)

33. 

34. T Let me label this one, say equation ®//. Do you know we obtain this thing from (K)?// Where we divide each member in (K) by Sin square ϴ//.

35. (Teacher gesturing and pointing to the board)

36. T Divide this one by Sin square ϴ//. You will now have one//. Divide this one by Sin square ϴ//. You will now have Cot square ϴ//. Divide this one by Sin square ϴ//. You will now have Cosec square ϴ

37. 

The teacher appeared to be asking students to read and understand the written words on the board as evidence of the logical processes of solving any Mathematical problem. He said the following words: **Now stop writing everybody//. If you are done with that//. I can only be telling you what to write//. All of you stop writing** (see Stanza 16, lines 24 and 29). Here, he used the process prompt. He instructed the students on what to do. At the same time he drew on the board throughout the lessons. Urquhart (2009) suggested in a book titled: Using Writing in Mathematics to Deepen Student Learning that like reading, teaching students Mathematics writing skills can improve their capacity to learn about themselves and others. Furthermore, Casa et al. (2016) noted that writing mathematically supported thinking and assisted students in internalising the features of effective communication in the class. Teacher S' way of valuing and making Mathematical writing practice relevant in the classroom seemed to suggest that he believe the practice might support and help students to understand the characteristics of logical communication.

6.12.2 Mathematical Symbolising practice (SP)

Stanza 16 is an example of how teacher S dealt with non-verbal Mathematical language. He used Mathematical symbolising practice to interact with the students. The diagrams in Stanza 16 above seemed to be similar to those used by teacher G in Stanza 8, as both of them were teaching the same topic (trigonometry). Mathematical symbolising practice was extensively used by teacher S to help students identify the shapes of angles and triangles during the lessons. In sketching the diagrams, line 18 Stanza 16 for example the teacher made particular reference to Mathematical shapes where he asked the students: **"Anywhere you see something like this in Mathematics it means what?"** This statement suggested that the diagram applies only to the Mathematical context, thus requiring the knowledge of the symbolic mathematical language. Thereafter, teacher S performed several explanations (see lines 15, 17, 19 and 25 Stanza 16) using the sketched diagrams of the problem to translate the shapes in class so that the students would understand.

Teacher S used these diagrams as illustrations. He translated the Mathematical symbols into a verbal language to help the class. Jones (2013) noted that the uses of diagrams in Mathematics classrooms are valued. They should be viewed as an integral part of the lessons. Teacher S' use of diagrams in the Mathematics classroom was helpful to students.

6.12.3 Mathematical Gesturing practice (GeP)

Mathematical gesturing practice in this study refers to specific bodily (hands, head, shoulder, legs, and even eye) movements by the teacher to communicate or illustrate a particular idea/concept during interaction with students. Types of gestures include: descriptive, emphatic, suggestive and prompting gestures. Lines 13, 20, and 30, Stanza 16, are instances of how teacher S used Mathematical gestures for the purpose of demonstrating trigonometrical concepts to the students. He made the tasks during Discourses relevant by demonstrating and explaining the concepts/ideas. In Stanza 16, lines 15 and 28, Mathematical gesturing practice was the focus of attention by the teacher while giving the description and application of diagrams during his lessons. He made the trigonometric identities relevant by devoting reasonable time to illustrate the derivation using the mathematical gesturing practice during the lessons. Next, I consider the discussion of non-verbal norms sub-categories of DP enacted by teacher S in his classroom of this study in the subsequent sections.

6.13.1 Noiseless norm (NN)

It seems to be an established ground rule in school B on the awareness of the noiseless norm by the students as seen in the observations. Soon after teacher S entered the class; the students immediately maintained silence for teaching and learning process to begin. It was interesting to observe how the students maintained this throughout the lessons. S was able to have meaningful and productive Discourses with the class. The class was orderly, and most students were able to participate in the solutions of a Mathematical task in the class. No wonder UNESCO (1984) reported that a safe environment free from noise could be an essential contributing factor to productive teaching and learning in the Mathematics classrooms. The teaching and learning environment plays a major role as demonstrated in teacher S’ lessons.

6.13.2 Movement norm (MN)

The movement norm in this study refers to the physical changes of the teachers’/students’ positions within the classroom. It also includes wriggling the body, as well as moving and interacting with the class. Two movement norms were identified: mindful movement (purposeful movement) and non-mindful movement

(Beaudoin & Johnston, 2011). The mindful movement was used by teacher S in demonstrating mathematical concepts on the board. Unlike teacher G who moved to regulate students' behaviour in the class, teacher S, on the other hand, used this norm during whole-class activities as students engaged in copying or writing notes, he moved among them explaining the concept.

Stanza17

1. T So give me example let me hear// Mention any number between 0 to 90 degrees
2. Ss 80 degrees
3. T 80// Right?//
4. Ss Yes//
5. T 80 is an acute angle// Right?
6. Ss Yes
7. T Another one again//
8. Ss 60
9. T They are, they are many, 1, 0.5, degree, 1 degree, 20, 40, 50 all of them are what?
10. Ss Acute angle//
11. T Now, if this is ϴ, with, tell him,// Let me just mention this to be angle ϴ// I want you to find this angle// I want you to find this angle//
12. (Teacher calling and pointing to a student)

13. 

14. S The down side//

15. (student pointing to the sketch on the board)

16. T *b*//, the down side// Right?// (Teacher moving in between students in the class)

17. 

18. Ss Yes//

19. T So we said that number one, an acute angle// (Teacher writing on the board)// This implies that this is greater than zero// Can you see it

20. (Teacher gesturing and pointing to the board

In lines 16 and 17 of Stanza 17 teacher S deliberately did that to establish a good relationship with the students and at the same time evaluate their classwork. The observations of S' class seemed to agree with the research work conducted by Shoval (2011) on mindful movement and physical activity, which shows a positive correlation between academic achievement and teaching/learning.

6.13.3 Hand-raising norm (HN)

As teacher S' called out individual students to contribute during teaching and learning process, the hand-raising norm was present and was used by volunteers in the class to answer questions. In lines 12 and 13 of Stanza 17, hand-raising was used in individual participation norm. Teacher S valued this norm to maintained orderliness in the classroom. In the section that follows I will provide a summary of the discussion of the dominant DP carried out in the classrooms of school B.

6.14 Discussion on school B

The textual Discourse practice analysis was used to identify, explore, and understand the dominant DP of two multilingual Mathematics teachers' classrooms, from the obtained data in this research work. The empirical results showed a range of dominant DP as indicated in Tables 6.2 and 6.3. These tables indicate that the teachers work across and within the two main categories of DP (language and non-language). Both teachers seem to have the same pattern of presentation in structuring the flow of their verbal and non-verbal talks in the classrooms using categories and sub-categories of DP. They both used more language category (verbal communication) compared to the non-language (non-verbal) category of the DP. The teachers differed in their foci on the content coverage of the topic (trigonometry), although they both dealt with the introductory part of the topic, covering the same concepts such as lines, straight lines, angles, triangles and its types. Teacher G was more concerned with teaching the scalene triangle using Sine and Cosine rule, while teacher S focused on the right-angled triangle using Pythagorean identities.

Re-comparing the empirical results in this chapter with the kinds of literature (Chapter Two) and the Discourse practices in the multilingual Mathematics classrooms, it suggests that some of these DP in school B are similar. The Discourses in the two classes of school B focus on the interaction between students with the teacher at the centre being professional and expert. These DP occurred when the teacher was engaged in Mathematical explaining and giving instruction to students, rather than allowing the students to contribute their input. The teachers did most of the talking. The production of the DP was confined by the Mathematics teachers.

6.15 Conclusion

In this chapter, I have explored and analysed the DP categories and sub-categories of two teachers in their classes at school B. The dominant DP identified in the

Mathematics classrooms at the school and how they were enacted has been scrutinised and examined. Suggestions were made based on the empirical evidence for the teachers to consider.

CHAPTER SEVEN: Empirical results of School A

7.1 Introduction

In Chapter Six, I explored and described dominant DP of two teachers from school B. To remind the reader, dominant DP as used in this study refers to the DP that has influence (in directing the flow of the Discourses) across data obtained from teachers' Mathematics classroom. This chapter presents the analyses of dominant DP of the remaining two teachers from school A totally four participants in this study. The analysis focuses on the categories and sub-categories of DP identified from teachers' talks during teaching and learning as visible in northern Nigerian multilingual Mathematics classrooms. Like school B, teachers in this school did not share common home languages with the students. Textual Discourse practice analysis as mentioned previously in this study is the concern with the analysis of the actual text as uttered (verbal and non-verbal) by the participants, and the interpretation of the processes involve in the construction of the Discourses during an interaction (Gee, 2005). The purpose of looking at two teachers each from two schools in this study is not to set up a binary contrast, but in order to get ideas about what the pillars of a continuum may look like (Gee, 2005).

This chapter deals with the presentation of the empirical results from the classroom observation of two teachers (E and M) from school A. I begin with the lesson description of individual teachers in their classrooms and deal with the analysis of the category and sub-categories of the Discourse practices, and then I give a summary of each teacher, followed by an overview analysis of the two teachers while looking for emerging patterns. To guide the exploration of teachers' dominant DP and to ensure that I have a focused analysis, I paid attention to verbal/non-verbal communication in the transcript using the following questions:

1. What is the discursive Mathematical talk in each stanza?
2. Does the talk portray the verbal norms of practice in the Mathematics class?
3. Is it a non-verbal mathematical talk?
4. Is the verbal norms complemented by the non-verbal?

7.2 The emergent dominant DP of teachers at School A

In my data analysis I use codes of the sub-categories of the DP. The importance of using the sub-categories in my data coding and analysis was that it helped me to discover the dominant DP across the categories. I explore each of the sub-categories using the code indicator and their examples as earlier discussed in Chapter Five of this study in order to determine consistent patterns across the data. In order to gain a deeper insight and further explore the identified dominant DP, I asked the following questions for each of the dominant DPs to guide the analysis process.

1. What Discourse practices are used by teacher/students in their verbal and non-verbal talks in the multilingual Mathematics classroom?
2. How are the social goods (example status and power) relevant/irrelevant in the verbal and non-verbal teaching of students in the multilingual Mathematics classroom during Discourses?
3. What sorts of relevant social relationships do teachers/students display in their Discourse practices using verbal and non-verbal skills in the multilingual Mathematics classroom?
4. What sorts of connections looking backward or forward are made within and through work during Discourses in the multilingual Mathematics classroom?
5. What languages (Mumuye and Hausa) are relevant in the verbal and non-verbal actions of the teacher and students in the multilingual Mathematics classrooms during Discourses?
6. How do teachers make relevant (or irrelevant) in their verbal and non-verbal work, the DP in the multilingual Mathematics classroom and in what ways?
7. How do teachers make the social goods relevant (or irrelevant) in their verbal and non-verbal work during the enactment of the DP in the multilingual Mathematics classroom?
8. How are social relationships stabilised or transformed by teachers/students in their verbal and non-verbal work during Discourses in the multilingual Mathematics classrooms?

9. How do teachers make relevant (or irrelevant), the social languages in their verbal and non-verbal lessons to enact Discourse practices in the multilingual Mathematics classroom and in what ways?

Not all questions as reformulated and adopted from Gee's (2005) theory were applicable to certain DP, therefore the questions were asked selectively on the DP based on its applicability. Some of the questions under some building tasks might not have provided illuminating results for the various DP categories and sub-categories in my data (Gee, 2005). As mentioned in Chapter Six, in the analysis of the dominant DP of teachers in schools, frequencies for the DP were never taken as a big issue. This is because textual Discourse practice analysis goes beyond looking at the rate of occurrence of verbal/non-verbal language. In discussing each of the DP, I considered how each was produced or formed using the building tasks and the tools of inquiry. In coding my transcripts, I paid close attention to the “idea units” conveyed through the teachers’/students’ use of verbal/non-verbal discussions signifying a particular DP based on its indicator (Gee, 2005, p. 125). Therefore each unit of verbal/non-verbal talks uttered by teachers/students was counted. As earlier illustrated in the previous chapters, the statement “A triangle is a plane figure bounded by three straight lines”, represented one code of mathematical defining practice (DfP). Instances of repeating this definition were coded as Mathematical reiterating practice (RP). I organised the stanzas so that the DP of teachers is discussed to depict the distinctive characteristics of each one. I now discuss all the dominant DP made visible through teacher E’s use of verbal/non-verbal lessons. But first let me start with lesson description.

7.3 Lesson description of teacher E in School A

It is one week after the December 2017 holidays I observed the first lesson of teacher E. The focus of her lesson was on the use of Pythagoras theorem in solving Mathematical problems involving right angledd triangles. This was followed by two other lessons on the practical application of the Pythagoras theorem and trigonometry ratio. The textbook (New General Mathematics for Senior Secondary Schools 2) used by teacher E in her teaching was recommended and approved by the Nigerian Federal Ministry of Education (FME).

Teacher E's lessons took place in the SS2D (grade 11 equivalent in South Africa) class located in school A of the research area. The lessons were part of the normal school programme. The class was multilingual and the average number of students for the three lessons was 20.

7.4 Lesson overview

Teacher E used a sketch to briefly introduce an approach for solving side of a right angled triangle, by application of an acronym (SOHCAHTOA) of trigonometrical ratio and finding its values. She gave an example on the board of a right angled triangle with square box partition of sides, illustrating the application of Pythagoras' theorem. Teacher E first asked students to identify the hypotenuse and using layman's language she told them that the longest side of the right angled triangle referred to the hypotenuse. She did most of the talking and writing while prompting students to respond to short answers such as yes/no and simple arithmetic answers. Teacher E used a step by step strategy. Four examples on calculating the sides of a right angled triangle using Pythagoras' theorem were considered, as whole class activities and home works were given to the students.

Teacher E started the second lesson with a solution of the homework given to students in the previous lesson. This was a Mathematical task involving the use of special angles (30°, 45°, and 60°) and finding trigonometrical ratios (Cos, Sin and Tan). She engaged the students in a step by step strategy, for solving the Adjacent, the hypotenuse and the opposite of right angled triangles. Teacher E considered other examples involving an equilateral triangle. She engaged students in the solution of the problem, elaborating on finding the altitude. The teacher set homework from their textbook, to be submitted the next day.

The Third lesson was a continuation of a similar Mathematical task in the last class. Teacher E began the lesson with sketches of two triangles on the board consisting of angles 30°, 45°, and 60°. After partitioning them into two right angled triangles, she engaged students with the solution of the problem, elaborating on finding the unknown sides of the triangles using trigonometrical ratio (Cos, Sin and Tan).

Teacher E concluded the lesson by explaining the differences between the angles of elevation and depression. She then gave a solution to the practical problem written on the board using Pythagoras' theorem and trigonometrical ratio, she set homework based on a similar problem. The three lessons lasted for a total of one hour 55 minutes. The Table 7.1 below provides an overview of categories; sub-categories and frequencies for the dominant DP identified in teacher E's class.

Table 7.1:

Categories and sub-categories of dominant in teacher E's classroom

Categories and sub-categories of Teacher E's DP			
Categories	Sub-categories	Dominant DP	Frequencies for the DP
Language practices (verbal)	Mathematical discursive practices	Mathematical Explaining practice (ExP)	23
		Mathematical Exemplifying practice (EP)	18
		Mathematical Reiterating practice (RP)	83
		Mathematical Code-switching, practice (CsP)	3
		Mathematical Questioning practice (QP)	127
		Mathematical Proceduralising, practice (PP)	7
		Mathematical Re-voicing practice (RvP)	61
	Verbal Norms of practices	Whole-class participation norm (PW)	15
		Justification norm (JN)	9
		Regulating norm (RN)	8
Non-language practices (non-verbal)	Symbolic Mathematical practices:	Mathematical Symbolising practice (SP)	95
		Mathematical Gesturing practice (GeP)	10
		Mathematical Writing practice (WP)	44
	Non-verbal Norms of practices	Noiseless norm (NN)	12
		Movement norm (MN)	7

Table 7.1 above indicates the dominant DP categories and sub-categories in the class through teacher E's use of verbal/non-verbal DP with their frequencies. Under the sub-category of verbal norms of practice, the whole-class participation norm and

regulating norm were consistently dominant. I now discuss below one by one the dominant DP featured through teacher E's use of language/non-language categories of DP

7.5 Mathematical discursive practices

The sub-categories for Mathematical discursive practices categories identified from the data include Mathematical questioning, Mathematical defining, Mathematical explaining, Mathematical exemplifying, Mathematical reiterating, Mathematical code-switching, Mathematical proceduralising, Mathematical socialising, Mathematical generalising, and Mathematical re-voicing practice as shown in Table 7.1 above.

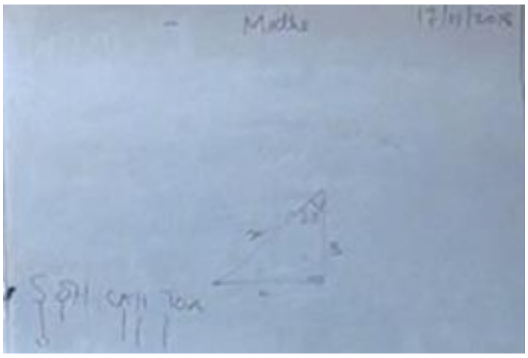
7.5.1 Mathematical Explaining practice (ExP)

Teacher E's Mathematical explanations focused on the use of Pythagoras rule in her lessons as indicated in Stanza 1 below. The teacher used a sketch to explain an approach of a trigonometrical ratio for solving side of a right angledd triangle. She then continued with her Mathematical explanations using a sketch on the board to illustrate, the application of Pythagoras' theorem on a right angledd triangle. In line 1, Stanza 1 teacher E first asked students: **"So who will tell me the rule of Pythagoras theorem?"** Afterward she mathematically explained that **"Pythagoras theorem says (…), a sum of the square of the two sides is equal to the square of the hypotenuse. $\boldsymbol{a^2 + b^2}$ will give us $\boldsymbol{c^2}$."** Next, she explained how to work out a task involving the use of special angles (30°, 45°, and 60°) and finding trigonometric ratio (Cos, Sin and Tan). The teacher engaged students in a step by step strategy for solving the Adjacent, the hypotenuse and the opposite of right angledd triangles.

Stanza 1

1. T Supposed you are given angle A or Angle B or Angle C..,//. Is left for you to know//, if is the angle …// (…). Assuming you have…//(…) a triangle like this//. You are asked to find the hypotenuse?// **Normally for you to know the side where the hypotenuse is//. In a lay man's way the longer side//.** Or the side facing the right angled//. You know what to use by what?//Means of a SOHCAHTOA//. So can we start with Pythagoras theorem?// **So who will tell me the rule of Pythagoras theorem?// Pythagoras theorem says what?// Pythagoras theorem says// (…), a sum of the square of the two sides is**

equal to the square of the hypotenuse//. $a^2 + b^2$ will give us c^2//I hope you have remember?…//



2. Ss Yes//

3. T Let me give an instance//. We have here to be 3cm//. And we have 4cm and you are asked to find the hypotenuse//. So from Pythagoras rule//. We said x^2 i.e. the square of the hypotenuse is equal to x^2//.we have… emm $3^2 + 4^2$//. So 3^2 Will give us what?// 3^2 Means 3 times 3//. 3 times 3 will give us?

4. Ss 9//

5. T 9 Plus//

6. Ss 16//

7. T 16//. So $9 + 16$ will give us what?//

8. Ss 25//

9. T 25//. So we have $x^2 = 25$//. **So now we take proper examples now// (…). Open your book1// (…) page 4…//, page 133//. Can we see this one//. Is a WAEC question//**

As demonstrated above, teacher E accounted for most of the Mathematical explanations during the lessons. She used Mathematical explaining practice to make the right angledd triangle significant. During her Mathematical explanations of the hypotenuse in line 1, Stanza 1 above, she uttered the statement: **“Normally for you to know the side where the hypotenuse is, in a lay man’s way the longer side”**. Her use of the word **“layman”** seems to indicate that she was referring to the use of ordinary English. The discussion in the class focused on solving the task without regard to the reasons for using the procedure. In her talks during Discourses teacher E was projecting her identity (Gee, 2005) as an expert in the subject area. She wanted the students to follow what she was teaching them without justification. She used personal pronouns such as **“you, we, me, and us”** to project her identity. She presented herself as qualified Mathematics teacher.

7.5.2 Mathematical Exemplifying practice (EP)

Teacher E relied heavily on the pre-planned examples in the textbook during her teaching. She used several pre-planned examples to demonstrate the application of Pythagoras theorem for solving or calculating the Mathematical task involving right angledd triangles. The teacher made significant pre-planned examples of past WAEC-SSCE questions which were in the textbook she used. In Stanza 1, line 9 above, she said the words: **“So now we take proper examples now (…). Open your book1 (…) page 4…, page 133. Can we see this one, is a WAEC question”**. This happened several times during her lessons. The teacher was concerned about the fact that students had to write an external examination (WAEC-SSCE). Therefore her Discourses during Mathematical exemplifying concentrated on preparing students for WAEC-SSCE using Pre-planned textbook examples. Teacher E showed the relevance of past WAEC-SSCE questions during Mathematical exemplifying practice. Pre-planned examples were given by the teacher as homework to students so that they could practise the exercises after class.

Most examples used by teacher E in the class were pre-planned to illustrate the solutions of Mathematical problems and generalise the approach. She used very few spontaneous examples of problems to work out as a whole class activity so that students could acquire the ability to answer similar questions in tests or examinations. The findings of Zodik and Zaslavsky (2008) are of relevant to teacher E’s use of mathematical exemplifying. The most important part of teaching work is the ability to make a decision using careful advance planning or unexpectedly make on the spot in reply to a situation in the Mathematics classroom. What seemed to play out in teacher E’s class fell short of the findings of Zodik and Zaslavsky (2008).

7.5.3 Mathematical Questioning practices (QP)

One of the dominant DP identified in teacher E's class was Mathematical questioning practice. Stanza 1 above illustrates this was used in the class. She used the practice of questioning mathematically to encourage the whole class to participate. Teacher E did not direct her questions to a specific student in the class. Instead, she asked simple questions to elicit short choral answers from the students. For example, lines 3-8 of Stanza 1 showed that the teacher prompted the students' response to a simple addition or multiplication task. Only a few students answered to the questions as they were aware that she would eventually explain the answer.

In harmony with the argument posited by Clarke et al. (2013) those who teach Mathematics need to progress beyond short and simple focusing questions which elicit short choral answers. They should adopt the type of questions which incorporate both focusing and funneling questions to promote logical reasoning, to encourage students' thinking and communicating verbally in the Mathematics class. For multilingual Mathematics classroom to be more communicative during teaching and learning, the teacher has to strategically organise her questions so that students do not shy away from answering. The teacher needs to spread her questions throughout the lessons by calling on individual students to respond. This method enables the teacher to assess how many students are engaged in the lesson and how many need encouragement to participate. In doing so students would then be helped to improve their Mathematical language communication skills. Another DP used by teacher E in her lessons was Mathematical reiterating practice. The next section focuses on that.

7.5.4 Mathematical Reiterating practice (RP)

Mathematical reiterating practice as dominantly featured DP in teacher E's class was simultaneously used with Mathematical explaining together with Mathematical questioning. In the interactions with students indicated in Stanza 2 below, teacher E seems to repeat certain words/phrases while explaining mathematically to clarify the principal ideas. In lines 1-7 Stanza 2 teacher E repeated the following words: **"Pythagoras theorem".**

Stanza 2

1. T So can we start with **Pythagoras theorem**?// A **Pythagoras theorem** is not a new topic//. We started it from your JSS classes//

2. (Teacher gesturing)

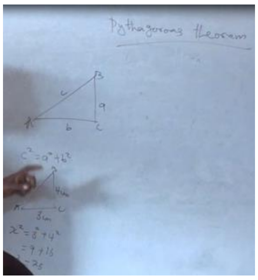
3. T Imum?// **Pythagoras theorem**//. So who will tell me the rule of Pythagoras theorem?// **Pythagoras theorem** says what?// Is a scientist//

4. (Teacher gesturing and moving)

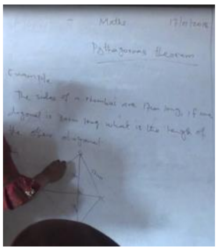
5. T The P**ythagoras** is somebody//. Is a scientist that came up with a rule//. So who will tell me what Pythagoras said?//

6. (Teacher cleaning the board and drawing a sketch) 

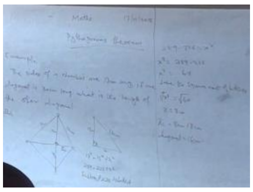
7. T **Pythagoras theorem** says// (…), a sum of the square of the two sides is equal to the square of the hypotenuse//. We have this//. This is the hypotenuse//

8. (Teacher pointing to the sketch) 

9. T We have…//, I said we are going to build on what you know already//. Imum?// There is nothing new//. Just to add to what you know//. We have…//, this is the hypotenuse//. We said the square of the two other sides// (…). So now let us look at this//

10. (Teacher pointing to the sketch a rhombus on the board) 

11. T If you look at this//. We have a right angled//. So let me bring out one

12. (Teacher sketched out a segment of the rhombus on the board) 

13. T We have this//. So here is 17cm//. And we have here too as 17cm//. The base//. We don't know the value//. **So by the help of Pythagoras theorem//. So what does the rule said?// So which side is our right?// What is the value of our right angled?//** The hypotenuse//

14. (Teacher writing on the board)

15. T What is the value of the hypotenuse?//

16. SS 17cm//

17. T 17cm//. Very good//. So the hypotenuse which is 17 square//. Is equal to what?// We have 15 square plus x^2//. Now we want to make x^2 the subject//. So// (…), 17// let's subtract…//. 17 times17 will give us what?//

18. Ss 289//

19. T 289 is equal to 15 times 15//, will give us what?//

20. Ss 225//

21. T 225 plusx^2//. Now let's subtract 225 to both sides//. Imum?// So we have 289 minus 225 is equal to x^2//. Or x^2 Is equal to 289 minus 225//. So 289 minus 225 will give us what?//

22. Ss 64//

23. T- Imum?//

24. Ss 64//

25. T We have…// 5, so 9 minus 5 will give us 4//. Now you take the square root of both side//. Now we have our x square is equal to the square root of 64//. So your x will give us what?//

26. (Teacher writing on the board)

27. T The square root of 64 is what?//

28. Ss 8//

29. T 8//. Now if here is 8cm, here is 8cm//. And this diagonal is divided into two equal part//. So the line//. The diagonal AC//. Will give us what?// 8 times 2//. Imum?//

30. Ss 16//

31. T 8 times 2//. So the diagonal//. The other diagonal will give us…?// Let's call it line…//. Line AC//. Will give us 8cm plus 8cm//. Because, if you solved it//. Will still give you this is 17//. This is 15//. So here will give us 8//

32. (Teacher pointing to the sketch)

33. T So the diagonal is what?// Equal to 16cm//

She mathematically reiterated to remind students what they had learned on the Pythagoras rule, while the students were in junior classes and as well holding their attention and interest. This interaction suggested that teacher E considered Pythagoras' theorem as social goods (Gee, 2005) as she stressed it, again and again, to make it relevant and stabilised by the discursive language use of the Mathematical reiterating practice.

7.5.5 Mathematical Proceduralising practice (PP)

In Stanza 2 teacher E focused the attention of students on Mathematical calculations. Teacher E wrote a question on the board and sketched a right angled triangle. In line 13, Stanza 2 she asked the students: **“So by the help of Pythagoras theorem, so what does the rule say? So which side is our right? What is the value of our right angled?”** These questions were meant to prepare the students for the Mathematical procedural description of what she intended. Teacher E elaborated step by step to find the answers without giving any reason (see lines.15-33, Stanza 2).

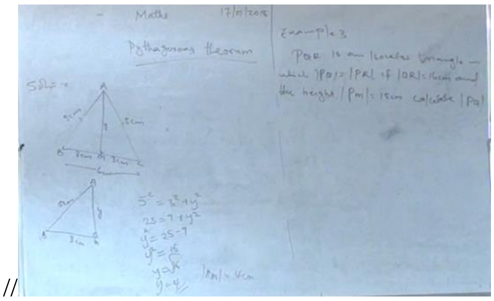
She demonstrated how to calculate angles/sides of a right angled triangle using Pythagoras theorem during lessons. There was much used of Mathematical proceduralising practice in her class. Mathematical proceduralising as indicated in Stanza 3 was used in a similar pattern throughout her lessons. The students’ responses were short and direct. One interesting factor worth noting is the use of Mathematical language in proceduralising, which suggested that the teacher made it significant. Teacher E’s approach is similar to that of Setati (2005a) which explained Mathematical procedural Discourse practice aimed at establishing the steps which should be taken to calculate certain mathematical problems. There is, however no development or explanation of the underlying concept.

7.5.6 Mathematical Re-voicing practice (RvP)

In Stanza 3 below teacher E used Mathematical re-voicing together with Mathematical reiterating. As earlier discussed in the previous chapters of this study Mathematical reiterating practice refers to instances that teacher/students repeatedly said something or keep on emphasising what was said previously to remind them or refresh the memories of some or the whole class to enable a better understanding of their current discussion. While Mathematical re-voicing practice essentially tries to repeat some or all of what has been said earlier as the basis for a shift in the interaction. It could also involve repeating what has been said using the correct Mathematical language.

Stanza 3

1. T Who will tell me, what you understand by an isosceles triangle?// **Tell me the properties of an isosceles triangle//**



2. Ss 2 sides are equal/2sides are alike //

3. T 2 sides are **alike//** HOW?//

4. Ss 3cm//

5. T **Equal to 3cm each**//. For you to find the value of Sin 45//. They want you to use the trig ratio//. The trigonometry ratio they want you to use…//. Instead of you going to your four figure table, you just cross multiply//. Cross multiply you just multiply root 2 times 2//. Now let's start with a)//. Now let's call…//. Let's give it a name z//. Now multiply both side by 2//. Now let's use your language, simple way//. So if you cross multiply//. Is it open the light or switch on the light?//

6. Ss Switch on the light//

7. T So who will try this?//. Who will try this to get the value of x using trig ratio?//. So Tan//. Tan 30 will give us what?//. Tan 30 will give us what? Tan 30 will give us what?//. **Do you know my problem with this class?//.YOUR MOUTH//. THERE IS… //.DO YOU KNOW DUSA (CHAFF). A LOT OF CHAFF IN YOUR MOUTH//. You know it//. You don't want to talk//**. Tan 30 in your trig ratio is what?//

8. Ss 1 all over root 2//

9. T And Tan 30, will give us our opposite which is x//. Are we together now?// **KOO (Ok)//**

10. Ss Yes//

11. T So 17 times 15//. Will give us what?//

12. Ss 255//

13. T We have 255 minus 289 into 289//. Will give us 1 times 225//. So we now subtract 255 minus 225//. Will give us what?//

14. Ss 30//

15. T 30 **KOO?// (OK, or alright)//**

16. Ss Imum//

17. T so we have 30 over 289//

18. S I want to ask a question?//

19. T ASK, ASK//

20. S I want to ask where we get that Sin? That Sin 30//

21. T Are you seeing well?// So where is your glasses**?// OH YAAH//.** Put your glasses//. Put your glasses on//. Then ask your question//

Mathematical re-voicing was used together with Mathematical reiterating for the purpose of developing Mathematical language. Using formal Mathematical language in lines 1, 2 and 3 Stanza 3 above teacher E corrected the students' mixed response to her question: **"Tell me the properties of an isosceles triangle?"** She corrected the students by mathematically re-voicing the word **"alike"** and further asked **"how?"** She did that to be sure the students learned the concept of equality. In line 5 Stanza 3 as the teacher now used the word **"equal to 3cm each"** meaning the two words (**alike and equal)** are not mathematically the same. Mathematical re-voicing, used in her class, was to emphasise what had been said to ensure a better understanding of their current discussion (see Line 5 Stanza 3). Mathematical re-voicing, as reported by Enyedy et al. (2008) is a practice which promotes a deeper conceptual understanding by engaging students in discussions and fostering

Mathematical argumentation. Mathematical re-voicing is a special form of reported speech, as argued by Enyedy et al. (2008). Mathematical re-voicing practice was used by teacher E and her students to encourage academic discussion by showing how students' knowledge of understanding was related to the ideas of others in a common mathematical interaction in multilingual classrooms (Morais & Neves, 2001).

7.5.7 Mathematical Code-switching practice (CsP)

Teacher E used English, the LoLT extensively during her lesson presentations. E switched to Hausa and Pidgin English language to regulate students' behaviour and explain the Discourse so that the students understood the mathematical task that was under discussion. She habitually used the Hausa word: **"KOO"** meaning 'ok' or 'alright' as a prompt (see lines 9 and 15, Stanza 3). Teacher E also used the Hausa word: **"DUSA"**, and the Pidgin English word: **"OH YAAH"** to regulate students' behaviour in class (see lines7 and 21, Stanza 3).

The use of English language as LoLT, was well established and accepted and Hausa and Pidgin English languages were used as the language of solidarity as explained elsewhere by Setati (2005c). Teacher E's use of Hausa and Pidgin English to regulate and support students, encouraged the class. In line 7, Stanza 3 above, the teacher encouraged the students to talk using their mouth as she said the following words: **"Do you know my problem with this class?//.YOUR MOUTH//. THERE IS… //.DO YOU KNOW DUSA (CHAFF). A LOT OF CHAFF IN YOUR MOUTH//. You know it//. You don't want to talk//".** English language is the LoLT. The teacher and students do not share the same home language, although Hausa and Pidgin English languages which she frequently switches to are understood by most of the students. This suggests that Hausa and Pidgin English languages have potential to be used in the teaching and learning of Mathematics in multilingual classrooms. The next sections focuses on the verbal norms of practice as enacted in teacher E's classroom.

7.6 Verbal norms of practice

Below I present the verbal norms of practice sub-category of DP as featured in teacher E's class. The sub-category includes, whole-class participation, individual participation, loud talking, rewarding, justification, regulating and ridicule norms of practice.

7.6.1 Whole-class Participation norm (PW)

As shown in Stanza 4 below, whole-class participation was confined to choral answers of simple Mathematical questions (see lines 1-12, Stanza 4). The use of personal pronouns such as; **"we", "us"** and **"our"** in her language showed teacher's/students' identities as a Mathematics educator and prospective mathematician while engaging in whole-class activity.

Stanza 4

1. T What is the value of the hypotenuse?//
2. Ss 17cm
3. T 17cm//. So the hypotenuse which is 17 square. Is equal to what? We have 15 square plus x^2. Now we want to make x^2 the subject. So// (…), 17// let's subtract…//. 17 times17 will give us what?//
4. Ss 289//
5. T 289 is equal to 15 times 15//, will give us what?//
6. Ss 225//
7. T 225 plusx^2. Now let's subtract 225 to both sides//. Because we want to make x the subject//. Imum? So we have 289 minus 225 is equal to x^2//. Or x^2 Is equal to 289 minus 225//. So 289 minus 225 will give us what?//
8. Ss 64//
9. T Imum?//
10. Ss 64
11. T **Make sure you write every statement//.** Multiply both side by 2//. So here we have our z is equal to 2 times root 3//. Will give us, 2 root 3//. So that means you have the

value of this place to be what?// 2. 2 root 3 and here is 2 root 3//. Confidently you can now solved//. Now let's say…//. So we continue here//. Now we have the value of z//. So let's find the value of x//. So x what do we use?//

12. Ss Cos//

13. T Cos//. So we have Cos 60//

Instances of whole-class participation in line 11 Stanza 4 above, was when the teacher instructed the students by saying: **"Make sure you write every statement",** during the calculation of a given Mathematical task. The rehearsing of terms mathematically by the whole class was foremost. Elicitation of responses was a purposeful attempt to assist the students in memorising what she regarded as mathematically significant in her Discourses. Teachers need to encourage students to talk in class so that they can learn and comprehend the Mathematical content being taught (David, 2004). Teacher E valued her role as a Mathematics educator. The students had to follow her instructions.

7.6.2 Regulating norm (RN)

The regulating norm was used by teacher E during Discourses. As a reminder to the reader, regulating norm refers to instances of using Words/phrases/sentences such as, 'you are making noise', 'open your books please', keep quiet' 'just sit down and, 'let me check your homework'. Teacher E regulated students during the teaching process in her class. The regulating norm was used by teacher E principally for the purpose of preparing and regulating students' behaviour in class. She prepared students for the lessons, instructing them what to do. Teacher E began by directing their attention to the calculation of angle and side of right angledd triangle. In lines 1 Stanza 5 below, she said: **"Let's start from calculating the angles or sides of right angled triangles".** In line 9, Stanza 5 she demonstrated the approach for calculating the angle using both calculator and four-figure tables. She then continued in lines 10-16, Stanza 5 to focus the attention of students on a textbook example.

Stanza 5

1. T **Let's start from calculating the angles or sides of right angled triangles//.** Supposed you are given angle A or Angle B or Angle C..,//. Is left for you to know//, if is the angle …// (…). Assuming you have…//(…) a triangle like this//

2. (Teacher gesturing and sketching on the board)

3. T Let's say Ɵ//. And you are given emmu, value here//. Let's say you are given emmu, 4 here //. And here you are given 3

4. (Teacher erasing and writing the value of the angle on the sketch)

5. T Let's clean and have a value//. So that we don't have two unknown//. So when you are given//. You now look at the side given to you//. See// you are sleeping so early//

6. (Teacher pointing to a student)

7. T Yes…// So you look at the side given to you

8. (Teacher pointing to the sketch on the board)

9. T You have emmu, the opposite//. Which is…//, so Sin 30 will give us//. The opposite is 4//. While the hypotenuse is $x//$. And you want to get the value of the hypotenuse//. So you can get Sin//. By the means of your four figure table or your calculator//. You check the value of Sin 30

10. T So now we take proper examples now// (…)

11. (Teacher cleaning the board)

12. T open your book1// (…) page 4…//, page 133

13. (Teacher opening textbook)

14. T Can we see this one//. Is a WAEC question//. So now let us look at this one//. Now here is the rhombus

15. (Teacher sketching on the board)

16. T So let give it a name A, B, C, D//. So line BD is 30cm

Teacher E used the regulating norms of practice as it aims at preparing and organising students to deal with that day's task. She did that to ensure that students got the maximum from the lessons. This is also consistent with Pimm's (1987) explanations about Discourses. In most classrooms teachers always place emphasis on a quiet, controlled, conducive environment for meaningful teaching and learning of Mathematics.

7.6.3 Justification norm (JN)

Teacher E used the justification norm together with Mathematical proceduralising and Mathematical explaining practice in her class. Succeeding from previous Stanzas on the analysis of Mathematical explaining and Mathematical proceduralising, justification as a norm in teacher E's class happened mostly when she was working with the entire class.

Stanza 6

1. T **Now let's subtract 225 to both sides//. Because we want to make x the subject//.** Imum? So we have 289 minus 225 is equal to x^2//. Or x^2 is equal to 289 minus 225//. So 289 minus 225 will give us what?//

2. Ss 64//

3. T Imum?//

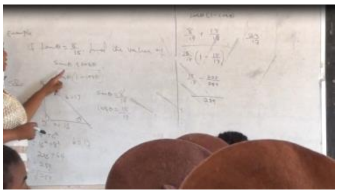
4. Ss 64//

5. (Teacher writing on the board)

6. T The square root of 64 is what?//

7. Ss 8//

8. T 8 times 2//. Let's call it line…//. Line AC//. Will give us 8cm plus 8cm//. Because, if you solved it//.

9. (Teacher pointing to the sketch) 

10. T Will still give you this is 17//. This is 15//. We say the Tan, is it this one?//So the diagonal is what? Equal to 16cm//. So we have finish with this//

11. Ss Immu//

12. T No we use Sin//. Because Sin we have opposite//. In this case you either use Tan which involve opposite or Sin// (…)//. Do you understand what I am saying?//

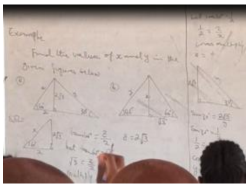
13. Ss Yes//

14. T In the acronym Tan…//. Tan and Sin, we have the opposite//. In JSS1, JSS2 you said cross multiply// (…)//. You just cross multiply//. But graduate from that//. Because in your exams SSCE or NECO//. All this small, small statement fetched you mark// (…)//. So if root 2 and the root 2 is gone//. You have y left, times 2 root 2//. Because you are multiplying root 2 to both sides. So you have y now is equal to 2 root 2//. You have the value of y//. Have I made myself clear?//

15. SS Yes//

16. T Are we together now?//

17. Ss Yes ma//

18. T Look at the board//. Which one can we use?// 

19. Ss Sin//

20. T Sin//. Ok//. We have it here//

21. (Teacher writing on the board)

22. T Sin 45 is equal to what?//. Because we have opposite//. It involve either Sin// (…) or tangent//. Right?//. But you cannot use tangent//. Because adjacent is not given//. Sin 45 will give us 3 over y//. So Sin 45 from your trig ratio is what?//

In line 1 Stanza 6 above, the teacher provided reasons for making x the subject of the formula using the following utterances: **"Now let's subtract 225 to both sides, because we want to make x the subject".** As they interaction progressed, she kept on prompting students for straightforward numerical answers. In lines 8-12, Stanza 6, she provided justification for the Mathematical task by depicting the given triangle side before working out the solution. This norm of practice was evident during the Discourses. In line 14, Stanza 6 the teacher encouraged students to give reasons for writing down supporting statements during examinations in their calculations. Her concern was to prepare students for WAEC-SSCE.

7.7 Symbolic Mathematical practice

The sub-categories of symbolic Mathematical practice are; Mathematical writing (WP), Mathematical symbolising (SP), and Mathematical Gesturing (GeP) as characterised from the data. What follows is a detailed discussion on the identified sub-categories of the Symbolic Mathematical practice.

7.7.1 Mathematical Writing practice (WP)

One of the dominantly used DP in teacher E's class was Mathematical writing practice. The teacher began a new concept on trigonometry (triangle) by explaining verbally, then writing and drawing it on the board. She continued with the Mathematical explanation. Two examples of this are presented in Stanza 7 below. Teacher E began a discussion in the class on the triangle side by first engaging the students using verbal explanations and prompting them to answer questions on the triangle side such as adjacent, hypotenuse and opposite. In lines 4-8, Stanza 7 teacher E was simultaneously writing and explaining mathematically: **"Supposed you are given angle A or Angle B or Angle C..,//. Is left for you to know//, if is the angle …// (…). Assuming you have…//(…) a triangle like this// (Teacher gesturing and sketching on the board). And you are given eeee an angle//. Let's say ϴ//. And you are given, Immu, value here// (Teacher writing the values on**

the sketch)". This is a process prompt used by teacher E, instructing students on what to do during writing mathematically at the same time drawing, throughout the lessons.

Stanza 7

1. T **Supposed you are given angle A or Angle B or Angle C..,//. Is left for you to know//, if is the angle …// (…). Assuming you have…//(…) a triangle like this//**

2. (**Teacher gesturing and sketching on the board)**

3. T **And you are given eeee an angle//. Let's say Ɵ//. And you are given, Immu, value here//**

4. (Teacher writing the values on the sketch)

5. T You are asked to find the hypotenuse//. Normally for you to know the side where the hypotenuse is//. In a lay man's way the longer side//. Or the side facing the right angled//. The side facing the right angled is what?// The hypotenuse//

6. 

7. (Teacher pointing to the side of the triangle on the board)

8. T While the side facing the angle//. Is call what?// The opposite//. When you are asked to find eeh…// (…)

9. (Teacher erasing and writing the value of the angle on the sketch)

10. T Let's clean and have a value//. So that we don't have two unknown//. So when you are given//. And you are asked to find the//.And you are asked to find line…//. So this is our midpoint which is M now//. So you are ask to find line AM

11. (Teacher writing on the board)

12. T So this angle//. Let's give it a name as y//. This is you're a//. This is your B//. This is your M//. So here we have 5cm

13. (Teacher sketched another triangle on the board)

14. 

15. T Here we have 3cm//. So automatically by Pythagoras theorem…// (…).Learning from the first example//. By Pythagoras theorem the value of y will give us what?//Without calculation//. By Pythagoras theorem what will be the value of y?

16. 

As earlier discussed in Chapter Six, Urquhart (2009) identified three kinds of writing prompts: content, process and affective prompts. Urquhart (2009) suggested in his book that like reading, teaching students Mathematics writing skill can improve their capacity to learn about themselves and others. Furthermore, Casa et al. (2016) noted that writing mathematically promotes thinking. It also helps students to think and learn effective communication in the classroom. Teacher E's way of valuing and making Mathematical writing practice relevant in the classroom suggested that she believes the practice might support and help students to understand Mathematics.

7.7.2 Mathematical Symbolising practice (SP)

Mathematical symbolising practice as used by teacher E in class and indicated in Stanza 7 was for the purpose of helping and facilitating the teaching and learning of triangles. Teacher E used symbols and notational systems to represent the concepts. In sketching the diagrams, teacher E devoted reasonable time to describe, and demonstrate as follows: **"(Teacher pointing to the side of the triangle on the board) While the side facing the angle//. Is call what?// The opposite//. When you are asked to find eeh…// (…)"** (see lines 2-4, Stanza 7). She stressed and made the significant use of several non-verbal aspects, in representing and communicating the concept of a triangle in her Mathematics class (see lines 3, 8 and 15, Stanza 7). She explained the symbolic Mathematical language in English. A study conducted by Jones (2013) focused on three uses of diagrams in the Mathematics classroom, these included diagrams in textbooks, students' problem solving diagrams and diagrams used by the teachers when teaching the subject. The results of Jones (2013) study suggested that diagrams were invaluable in the teaching and learning processes. In this study teacher E demonstrated the uses of diagrams in her Mathematics class.

The use of diagrams is important in the teaching and learning of Mathematics. Is not enough sufficient for students to use them without the teacher's direction. In stanza 7, teacher E had to draw students' attention to how the diagrams were related to the Mathematical problem under discussion.

7.7.3 Mathematical Gesturing practice (GeP)

Mathematical gesturing was apparent as indicated in Stanza 7 line 17 above. Teacher E attempted to use different kinds of Mathematical gesturing practice as mentioned in Chapter Six of the present study. The teacher used the DP in demonstrating during teaching so that students could understand the knowledge of trigonometry. The observation in teacher E's class concurred with the study conducted by Cook et al. (2016) whose findings showed that gesturing in the Mathematics classroom facilitated learning of the subject. Teacher E's Mathematical gesturing practice used in classroom was helpful and productive. I turn now to the non-verbal norms sub-category of DP as used by teacher E during her lessons.

7.8.1 Noiseless norms of practice (NN)

The noiseless norm as observed in teacher E's class was strictly obeyed. The students were aware and were used to this norm of practice. As soon as the teacher arrived in the class the students maintained silence without being reminded. It was easier for teacher E to create a safe teaching and learning environment which yielded positive results. This contributed to stability and productive teaching plus learning in the classroom. This is in harmony with Pimm (1987) who wrote that most classrooms teachers always placed emphasis on a quiet, controlled, and conducive environment for the meaningful teaching/learning of Mathematics.

7.8.2 Movement norm (MN)

This is physical change of the teacher's/students' positions in the Mathematics classroom during the teaching and learning process. It also includes wriggling the body, as well as moving and interacting with the class. Two types of movement norms were identified: mindful movement (purposeful movement) and non-mindful movement (Beaudoin & Johnston, 2011). The observation (see Stanza 7 line 6) showed that teacher E moved with purposes of in the class. She also moved to demonstrate and write some trigonometric concepts on the board. Teacher E used this norm appropriately during Discourses in the class. If students are inspired by the physically mindful movement activities of the teacher in the Mathematics classroom, it might provide an increase students' academic achievement.

7.9 Lesson description of teacher M in school A

One week has passed after December, 2017 holidays; teacher M conducted his first lesson on trigonometry. This was followed by series of two other lessons on the same topic. The textbook (New General Mathematics for Senior Secondary Schools 2) used by teacher M in his teaching was recommended and approved by the FME.

These lesson were conducted in SS2A (grade 11 equivalent in South Africa) class in school A. The lessons were part of the normal school programme. The class was multilingual. There were 34 students in average for the three lessons.

7.10. Lesson overview

This was a task involving the use of special angles (30°, 45°, and 60°) and finding the trigonometrical ratio (Cos, Sin and Tan). Teacher M gave a general description of the drawing on the board while elaborating on the sides of the right angled triangle. He then moved ahead, using an approach that students should apply involving the right angled triangle and took them through step by step strategy for solving (Adjacent, hypotenuse and opposite). Using a practical example of two friends in a real live situation, he compared and related the unknown sides. Teacher M further considered other examples. He then engaged students in the solution, elaborating on finding the unknown side and leaving answers in surd form. The teacher set homework, to be submitted during the next lesson.

In the second lesson, the teacher continued his teaching of the previous topic (trigonometry), but with a different focus. This was a practical example of trigonometrical ratio and the application of Pythagorean rule on finding the unknown side of a right angled triangle. The teacher engaged students in the solution of the problem, elaborating on the strategy required to answer the questions. This was an application of the given trigonometrical ratio ($Sin\ = \frac{3}{5}$) in finding the value of Tan. Teacher M continued with another practical example and further engaged students in describing the given problem using a sketch of a right angled triangle. He and the students worked out a solution of the problem together, elaborating on the required strategy. This was an application of the given trigonometrical ratio ($Tan\ x\ = \frac{5}{12}$) in finding the value of Cos and Sin. The teacher concluded the lesson by giving students homework which they had to submit the next day.

My third observation of teacher M's lesson focused on several practical examples. There was an example involving finding the distance of a given angle of elevation. The teacher used a sketch and illustrated with the writing posted on the classroom wall above the board. He then worked on the problem together with the students, explaining the strategy required. Secondly, he engaged students using sketches to find a bearing of a place from a certain point. The teacher elaborated on the calculation of the angle, finding the inverse using both calculator and four figure tables and the strategy for understanding the angle of the bearing. He concluded the lesson by engaging students using sketches to demonstrate a task involving the chord of a circle and finding the radius of that circle. The teacher demonstrated how to calculate the radius using the trigonometrical ratio (Sin). Teacher M gave students homework from their textbooks. The three lessons lasted for a total of 2 hours. The Table7.2 below provides an overview of categories; sub-categories and frequencies for the dominant DP identified in teacher M's class.

Table 7.2:

Categories and sub-categories of dominant DP in teacher M's classroom

Categories and sub-categories of teacher M's DP			
Categories	Sub-categories	Dominant DP	Frequencies for the DP
Language practice (verbal)	Mathematical discursive practice:	Mathematical Explaining practice (ExP)	23
		Mathematical Exemplifying practice (EP)	36
		Mathematical Reiterating practice (RP)	105
		Mathematical Code-switching, practice (CsP)	5
		Mathematical Defining, practice (DfP)	2
		Mathematical Questioning practice (QP)	156
		Mathematical Proceduralising, practice (PP)	12
		Mathematical Re-voicing practice (RvP)	43
	Verbal Norms of practice	Whole-class participation norm (PW)	17
		Justification norm (JN)	20
		Regulating norm (RN)	89
Non-language practice (non-verbal)	Symbolic Mathematical practices:	Mathematical Symbolising practice (SP)	74
		Mathematical Gesturing practice (GeP)	13
		Mathematical Writing practice (WP)	39
	Non-verbal Norms of practice	Noiseless norm (NN)	10
		Movement norm (MN)	12

Table7.2 above indicates an overview of the dominant DP categories (Mathematical discursive practice, Verbal norms of practice, Symbolic Mathematical practice: and

Non-verbal norms of practice) in teacher M’s classroom. Mathematical questioning practice (QP) was predominant in the Mathematical discursive sub-category. The regulating norm (RN) emerges as the most dominant in the sub-category of verbal norms, while the Symbolising practice was prominently featured in the Symbolic Mathematical practice sub-category. I now discuss below one by one the dominant DP featured through teacher M’s use of language/non-language categories of DP.

7.10.1 Mathematical Exemplifying practice (EP)

Teacher M’s method of the introduction of the trigonometry (triangle) was neither Mathematical explaining nor Mathematical defining practice. The students were engaged with a pre-planned example of a Mathematical task by the teacher on the concept of right angled triangle from the start of the lesson. The teacher wrote the question on the board and sketched a diagram; afterwards, he mathematically explained how to find the unknown side of a triangle. In Stanza 8 below the example that was solved involved finding the unknown sides $(x \; and \; y)$ of a given right angled triangle. The teacher was establishing how the problems on the concept of right angled triangle were supposed to be solved. This same approach was adopted by introducing all the concepts such as the practical application of trigonometrical ratio and bearing.

While teaching bearing for example, the teacher used several pre-planned examples in the class to introduce the concept. In the examples, as given in Stanza 8, lines 4-6 below the teacher engaged students using sketches to solved a Mathematical task on bearing. He elaborated on the calculation of the angle, finding inverse using both calculator and four-figure tables. The teacher said: “**We now want to take more examples on what we started yesterday//. So yesterday we do only one triangle//. But today, we will do two triangles in one// (Teacher gesturing and pointing to the sketch on the board) So we are moving forward//. Now from this diagram//. On the triangle in our calculation//. There must be one unknown and two known//. That is, one side One angle and one unknown//. So in this case for us to start solving//. To get either x or y//. Base on this diagram you have y// But let us start with this x//. (…) From this diagram now//. What is the name given to this two?//”**

Stanza 8

1. T Sit down//. And let's start the lesson//

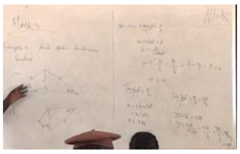
2. Ss Thank you Uncle//

3. (Teacher writing and sketching on the board)

4. T **We now want to take more examples on what we started yesterday//. So yesterday we do only one triangle//. But today, we will do two triangles in one//**

5. (Teacher gesturing and pointing to the sketch on the board)

6. T So we are moving forward//. Now from this diagram//. On the triangle in our calculation//. There must be one unknown and two known//. That is, one side One angle and one unknown//. So in this case for us to start solving//. To get either x or y//. Base on this diagram you have y// But let us start with this x//. (…) From this diagram now//. What is the name given to this two?//

7. (Teacher demonstrating and pointing to the diagram) 

8. T What is the name?//

9. Ss Adjacent//

10. T Adjacent//. What of x?//

11. Ss Hypotenuse//

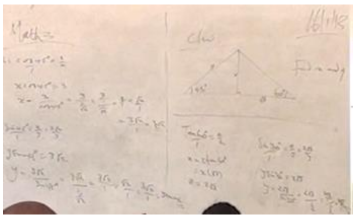
12. T What of this line?//

13. Ss Opposite//

14. T Opposite//. So now this adjacent//. This is hypotenuse//. Sin or tangent//. Which one connects adjacent and hypotenuse?//

15. Ss Sin//

16. T Ehen//. Adjacent and hypotenuse//

17. (Teacher pointing to the sketch on the board) 

18. Ss Cos//

19. T Cos//. So from this incident now//. We now write Cos 60 is equal to adjacent is what?//

20. (Teacher writing on the board)

21. Ss 2//

22. T 2//. Hypotenuse is?//

23. Ss x//

24. T x//. So from here we simplify//. So x times this, will give us…?//

25. Ss xCos 60//

26. (Teacher and students chorusing)

27. T Ehen, 1 times 2 equal to…//

28. Ss 2//

29. T All this…?// (…)

30. (Teacher writing and moving back and forth)

31. Ss Divide by Cos 60//. Divide both side by what?//

32. Ss By Cos 60//

33. T You have $x = 2$//(Cos 60)//. Form our special angles//. What is Cos 60?//

34. Ss 1/2//

35. T So x is be equal to 4, this our $x = 4$//. So we have solved for x//. Copy down this before we go on// (…). Example 6//I hope the 6 is fine//

36. Ss Yes// is 6//

37. T Copy so that we solved it//. Ok let's understand the question first//. What are they saying?// (…) Read the question//

38. Ss From a place 400meters north of x, a student walk eastwards to a place y which is 800meters from x. What is the bearing of x from y?//

39. T Ok// They said from a place 400 meters from x//. So let's joint p//. I didn't say p is the exact name of that place// You can use x// That is when you joint your new position now//, to the starting point//

40. (Teacher gesturing and pointing the directions of the sketch on the board)

41. T We are told that the distance is 800 meters//. The 800 is not here//. So what we will do is to calculate the angle here//. Let's call it Ɵ//. Umm?// So we calculate Ɵ//. When we get our Ɵ//. We will get the one outside//. I will explain how we will get the one outside later//. But let's get our Ɵ first//. Now// what is the measure to 400?// Based on Ɵ//. 400 what is the length?//

42. Ss Opposite//

43. T Opposite//. While 800 is what?//

44. Ss Hypotenuse//

45. T So Opposite, hypotenuse is what?//We are looking for Ɵ//. Ɵ will be equal to Sin invers//. There is a way we can get this answer without tears//. From our special angle//. If you observe the table of special angle//. Check the line under Sin//. Check under Sin//. What is the…?// When you check//. Now, check the line under Sin//. There is arc is on the…//

46. Ss 30//

47. T 30//. So it means that Θ will be 30//

The pre-planned examples considered in teacher M's class were workout. The students were all directed and guided toward developing the concept of triangles and establishing a particular approach for solving the problems. The teacher was enacting his identity as an expert in his subject area. He failed to pay attention on how the selected pre-planned examples were related to the students' previous knowledge of the triangle and the Mathematical language ability of the class. The selected pre-planned examples enacted in teacher M's class seemed to echo the concern raised by Watson and Mason (2006) that if teachers use examples without consciously selecting them, then rather than gain practical experience which would lead to generalisation and conceptualisation, students might end up in a drill and routine.

7.10.2 Mathematical Proceduralising practice (PP)

As visible in Stanza 8, line 38 above teacher M engaged students in solving the question: From a place 400 meters north of $\boldsymbol{x}$, a student walk eastwards to a place $\boldsymbol{y}$ which is 800meters from $\boldsymbol{x}$. What is the bearing of $\boldsymbol{x}$ from$\boldsymbol{y}$?. Then in lines 39-40, Stanza 8 the teacher delved deeper into Mathematical explaining of the procedures by interpreting how and what it means to get the answer to the unknown values ($x\ and\ y$) of the question. Following his explanations, in line 41, Stanza 8 he asked: What is the measure to 400? Based on Θ, 400 what is the length? The students responded with a short answer in line 42, Stanza 8: Opposite. The interaction continued with the questions and answers until they arrived at the value of $\theta\ =\ 30°$.

The descriptions given above as illustrated in Stanza 8 seem similar as in the case of teacher E in Stanza 1 above. It is interesting to note that Stanza 8 focus on Mathematical proceduralising practice during interactions in class. The responses of students were mostly short and choral. Mathematical proceduralising practice occurs when teachers/students use verbal Mathematical language to describe the procedures followed in solving a given task without necessarily justifying those steps. This implies that the use of discursive Mathematical language was valued in teacher M's class. The study of Pimm (1987) is of relevance here. Pimm argued that formal Mathematical language (during Procedural discourse) is often regarded as the hallmark of Mathematical practice. This suggests that the use of formal Mathematical language during the Discourse of Mathematical Proceduralising as a practice in teacher M's class was valued and made significant.

7.10.3 Mathematical Explaining practice (ExP)

Mathematical explaining as a DP in teacher M's class was carried out in combination with Mathematical proceduralising practice during the solution of an example. In Stanza 9 below, teacher M explained how to calculate the value of y (an unknown side of a right angled triangle). Following the Mathematical example of a triangle with a sketch on the board, the teacher used the given information question to engage the students in working out the answer. The teacher elaborated on the strategies required to answer the question. This was an application of trigonometrical ratios (Sin and Tan) using angles (30° and 60°) to find sides of a right angled triangle. The focal point of the Mathematical explanation was on the procedure for finding the unknown side of a triangle.

Sometimes, he mathematically explained and elaborated as in the case of tan in the stanza 9 below. In the discussion of tan the class had already considered the trigonometrical ratio of tan, so it was a new concept when the teacher asked in line 7, Stanza 9: **"What is opposite over adjacent?"** The students quickly gave the answer as tan. This approach was maintained throughout the lesson presentations. The teacher was the only one providing the Mathematical explanations that were mostly procedures for solving the given task without justification. The role of the teacher and students of Mathematics were made significant by the use of personal pronouns such as **we, I, us, you, and so forth.** The work of Rowland (2012) is closely connected here to the observation in teacher M's classroom. Rowland argued that "most times, we cannot pass on what we know and understand for ourselves ready-made and gift-wrapped" (p. 4). This was apparent in teacher M' class, he kept on struggling while explaining mathematically. He changed his communicative language approach plus the pattern of Discourse during the whole class participation or individual participation with the students in his efforts to make them understand.

7.10.4 Mathematical Questioning practice, (QP)

As indicated in table 7.2, the Mathematical questioning practice was one of the dominant DP used by teacher M. Even though Mathematical questioning appeared to be predominant, many of the questions were short and procedural. In most cases, they were funneling questions eliciting choral responses from the students. There were a few occasions where Mathematical questioning practices were focusing questions. The teacher interrogated/ probed for the students' insight on the concepts under discussion. This way of Mathematical questioning by the teacher was consistently followed throughout his teaching process in the class.

Stanza 9

1. T Ok//. As I told us//. For us to find y//. So the information have to be up to three//. And out of the three//. Two must be known and one unknown//

2. (Teacher gesturing and pointing to the board)

3. T Now that we want to find y//. We have only three information there//. So this two we cannot get y//. We must have another side that is given//. That is known//. So for us to get another side to add up to this information//. We have to calculate this line//

4. (Teacher pointing to the sketch) 

5. **T** This angle, this too, 60 and this//. Let's see if this line remains//. **Give me any letter to be used//**

6. **Ss** ***z//***

7. T z//. Like this//. So before we calculate z//. From the value of z//. We now joint this angle and then find the value of y//.So z is opposite to this is adjacent//. Finding the two are necessary//. **What is opposite over adjacent?//**

8. Ss Tan//

9. T Tan//

10. (Teacher and students chorusing)

11. T Tan 60 equal to opposite is what?//

12. Ss z//

13. (Teacher writing on the board)

14. T z, Ehen// adjacent?//

15. Ss 2//

16. T So cross multiply//. This and this//

17. Ss z//

18. T Ehen, equal to 2//. The same method//

19. Ss Tan 60//

20. T Tan 60//. But what is Tan 60 from our special angle?// Tan 60?// (…)

21. (Teacher moving back and forth)

22. Ss $\sqrt{3}$//

23. T $\sqrt{3}$//. So is the same thing as what?//

24. (Teacher writing on the board)

25. Ss $2\sqrt{3}$//

26. T So this is our z// (…)

A clear example was the case in Stanza 9 above. The class was engaged in calculating the unknown side of a triangle using the trigonometrical ratio. In lines 5-7, Stanza 9 the teacher asked a funneling question: "**Give me any letter to be used?"** The students did not waste time in chorusing the answer as **"z"**. He continued the explanation of the procedure and asked the students again: "**What is opposite over adjacent?"** The students quickly responded. This pattern of using funneling questions were typical in teacher M's class. Worthy of note in these observations is, as far as validating was a concern, to know whether the answers to the Mathematical tasks were correct or not, was only the responsibility of the teacher without the students' contributions. The teacher was the authority, an expert in his area of discipline.

7.10.5 Mathematical Defining practice (DfP)

Teacher M's approach to the solution of a task in class was not, to begin with, a Mathematical definition of terms. He first engaged the students with an explanation of the procedure to solving the problem by sketching a triangle on the board. It was only during the process of using Mathematical explaining that he saw the need to state the Mathematical definition of acute angle as indicated in line 4 of Stanza 10 below. The teacher mathematically defined acute angle as **"angles that are less than 90"**. The students were struggling to understand the difference between the two kinds of angles, when the teacher asked them: **"We draw what?//"** (see Stanza 10, lines 1 and 2). The teacher was actually giving the students a stipulated definition as this was a setting up of the meaning-relation between words and objects or the act of giving an object a name or vice-versa (Edwards & Ward, 2008). This same Mathematical defining played out in the case of chord of a circle. The original intention of the teacher was to solved a problem involving the chord of a circle. In lines 26-32, Stanza 10 the teacher struggled to sketch and demonstrating a circle with a chord as he kept on explaining mathematically. After realising that the students did not understand him, in line 33, Stanza 10, he mathematically defined a chord of a circle: **“A chord is a line that touches a circle at two points”**. In this instance teacher M gave the students a stipulated definition.

Stanza 10

1. T Let see the solution now//. Always we will draw a right-angled triangle//. **We draw what?// (…)**
2. Ss Right-angled triangle/Acute angle (mixed responses)’
3. (Teacher sketching and describing)
4. T We said that $Sin\ P$//. That is, there is…// an angle is here//. Acute angle are **angles that are less than 90**//. So this is a right-angled triangle//. These two other angles//. They are less than 90//. And each one is less than 90//
5. (Teacher moving back and forth describing and pointing to the sketch)
6. T So any angle less than 90 is an acute angle//. So this angle you are seeing here//. Just call it P//. Just call it P//. $Sin\ P$//. From this diagram now//. I have three sides//. Let me call this once x, y, z// (…)
7. Ss y, z//
8. (Teacher and student chorusing)
9. T Like this//. Base on this angle now, which side is the opposite?//
10. Ss y//
11. T y//. Because this is our opposite//. What of x?// (…)
12. Ss Hypotenuse//
13. T What of z?// (…)
14. Ss Adjacent//

15. T Now from the question//. We said that, Sin P is 3 over 5//. 3 represent what?// (…) Or let's start with the Sin//. Sin of angel//

16. (Teacher writing on the board)

17. T Sin is what over what?// (…)

18. Ss Opposite over hypotenuse//

19. T Opposite over…?//(…)

20. Ss Hypotenuse//

21. T Now from what we have here//. Sin P is 3over 5//.This 3//. The 3 represent what?//

22. Ss Opposite//

23. (Teacher moves out attending to another teacher and come into the class)

24. T **So you said 3 represent what?//**

25. Ss Opposite//

26. T You can see that this our y here is 3// (…). Example//. Examples continue before class work// (…). A chord AB of a circle whose centre is O is 10cm long, and angle AOB equal to 140. Calculate the radius of the circle//. Ehen//. The name given to that centre, is center O//

27. (Teacher reads and correct the writing on the board)

28. T So what we would do is to draw our tangent θ//. So we draw our circle//

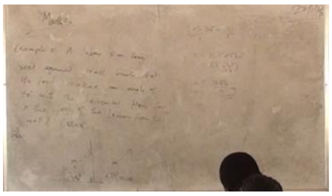
29. Ss Uncle what is this?//

30. T I am drawing a circle//

31. Ss Where is the other marker?// So this is my circle//. Or our circle//

32. (Teacher sketching on the board)

33. T Now we have a chord//. We are told that there is a chord call…//. A chord is a line that touches a circle at two points//. So now from this my drawing now//. Let's take example//. If I draw a line from here to here// eee// (…)

34. (Teacher struggling to draw on the board) 

35. Ss The marker//. Heeyee// Uncle what is this?//

36. T Let me call this one now AB//. And we have the centre of the circle//

37. (Teacher and students chorusing)

38. T We are told that the chord AB of the circle whose centre is O is 10 centimeter long//. This chord AB is 10 centimeter long//. A to B is 10centimeter long//. You didn't understand the question//. Ehen//. And WHAT AGAIN?// AND WHAT?//

39. Ss A, B, D//

40. T A what?// This is not B, is O//. AOB//. That is angle AOB//. That is angle at the centre//

The teacher was grappling in the use of Mathematical defining, a DP which he tried to highlight in his lessons. In order to address students seeming inability to understand the concepts using Mathematical defining mean that more strategies were required. One of the apparent factors is the culture of using formal Mathematical language in the classroom which is in English (LoLT), the language which the students themselves are struggling to understand. English is not their mother tongue. This factor as above needs to be dealt with by the teacher to have a communicative Mathematics classroom.

7.10.6 Mathematical Reiterating practice (RP)

Reiterating mathematically depended on the teacher. He re-uttered students' contributions. Teacher M was trying to ensure that everyone in the class was on the same page as the first person who issued the utterance. In Stanza 10 above, the teacher was solving the problem, then he use Mathematical reiterating to be quite certain that what he had said plus the students' contributions were understood by everyone in the class. Mathematical reiterating was used to sustain the students' interest and understanding during the teaching process. Stanza 10, lines 1-20 indicates, the teacher continually reiterated mathematically the contributions of students to ensure that all are following during the solution process of a task.

In line 24, Stanza 10 the teacher mathematically reiterated the statement: **"So you said 3 represent what?"** He did this to check if all were still on the same page, as there was a little distraction from another teacher outside the class at that particular moment. Teacher M used Mathematical reiterating practice to encourage students' participation and communicating mathematically in class. In doing so, the teacher valued and made important Mathematical reiterating in his lessons. Mathematical reiterating practice as a dominantly featured DP in teacher M's class was used simultaneously with Mathematical re-voicing practice. The next section discusses how Mathematical re-voicing practice was used.

7.10.7 Mathematical Re-voicing practice (RvP)

I had earlier drawn a distinction between Mathematical re-voicing and Mathematical reiterating in the previous Chapters. A reminder: Mathematical reiterating practice refers to instances that teacher/students repeatedly say something or keep on emphasising what was said/discussed in previous lesson (s) to remind them or refresh the memory of some or the whole class to enable a better understanding of their current discussion. While Mathematical re-voicing practice essentially try to repeat some or all of what has been said in a preceding tone as the basis for a shift in the interaction. It could also involve repeating what has been said using the correct Mathematical language.

Stanza 11

1. T We are looking for y//.y now will be equal to $\frac{2\sqrt{3}}{Sin\ 30}$//. But what is Sin 30?// From our special angle//. $\frac{1}{2}$//.1 over…?// (…) $\frac{1}{2}$//

2. Ss Yes $\frac{1}{2}$

3. T $\frac{1}{\frac{1}{2}}$//. **So this one can be written as** $\boldsymbol{\frac{2\sqrt{3}}{1} / \frac{1}{2}}$**//**

4. (Teacher writing on the board)

5. T Which can be written as $\frac{2\sqrt{3}}{1} \times \frac{2}{1}$//

6. (Teacher and students chorusing)

7. T Equal to what?//

8. Ss $4\sqrt{3}$//

9. T $4\sqrt{3}$ over 1//

10. Ss over 1//

11. T Which is what?//

12. Ss is the same thing as $4\sqrt{3}$//

13. T $4\sqrt{3}$//. So that is our y// (…). So we now have x now will become equal to 2 over $\frac{1}{2}$//. I told us this 2//. Can be written as 2 over 1// Then 1 over 2//

14. (Teacher writing on the board)

15. T We have division of fraction//. So we now write 2 over 1 times what?//

16. Ss 2 over 1//

17. T 2 over 1//. Ok//. **As I told us, for us to find y**, so the information have to be up to three//. And out of the three//. Two must be known and one unknown//

18. (Teacher gesturing and pointing to the board)

19. T Now that we want to find y//. We have only three information there//. So this two we cannot get y//. What do we have here?//

20. Ss $6\sqrt{2}$//

21. T They are two $\sqrt{2}$//

22. Ss $3\sqrt{4}$//

23. T $3\sqrt{4}$//. What is $\sqrt{4}$//

24. Ss 2//

25. T 2//. We have 3 time 2 equal to?//

26. (Teacher writing on the board)

27. Ss 6//

28. T But under surd//. Under surd $\sqrt{2}$ times $\sqrt{2}$//. Will give us 2//. That is, **I am just trying to give us//**

29. (Teacher gesturing)

30. T When we get to that…//. What I am saying is that//. When you have two numbers under square root//. When you multiply it//. Give you one of the numbers under the square root//. So $\sqrt{2}$ times $\sqrt{2}$ is 2//. $\sqrt{3}$ times $\sqrt{3}$ is 3//. $\sqrt{a}$ times $\sqrt{a}$ is a//. **OYAH//, USE YOUR CALCULATOR//. SHARP, SHARP//(…)**

31. Ss We don't understand (students laughing)

32. T 13 into 169 is 12//. Then times 13//. That is what it means//(…). Example, Examples continue before class work// (…). Uncle Ben // YAYA? (How?)

33. (Teacher looking at a page in textbook as another teacher peering the class by the door)

34. T Are we set for 7 now?//

35. Ss No/Yes//

The Mathematical re-voicing practice was used along with Mathematical reiterating to develop Mathematical language. As indicated in Stanza 11, line 2 above where the students wrongly represented the value of **Sin 30** during the calculation of to $\frac{2\sqrt{3}}{Sin\ 30}$ as $\frac{1}{2}$. In line 3, Stanza 11 the teacher corrected the students by mathematically re-voicing the expression as $\frac{1}{\frac{1}{2}}$//. **"So this one can be written as $\frac{2\sqrt{3}}{1}/\frac{1}{2}$//".** In most instances, the teacher used Mathematical re-voicing to correct students' wrong answers in their choral responses.

7.10.8 Mathematical Code-switching practice (CsP)

The Interactions in teacher M's classroom as indicated in Stanza 11 above were mostly in English. The teacher used the voice of authority in regulating and instructing students. As evident in line 30, Stanza 11 teacher M used Pidgin English language to give an instruction for students to use their calculator. The teacher used the expression: **"OYAH//, USE YOUR CALCULATOR SHARP, SHARP".** Teacher M expected total obedience. He was in control. Thus the utterance reveals an identity (Gee, 2005) of an instructor that ensures control over the students' participation in class.

Similar incidents occurred in his lessons while using Pidgin English language. For example in lines 17 and 28, Stanza 11 the teacher made the following statements: **"As I told us, for us to find y,** and **I am just trying to give us".** Here the teacher used Pidgin English. He used the pronoun **"I"** to exclude the students and positioned his identity (Gee, 2005) as an experienced and knowledgeable teacher, a Mathematics expert. The teacher stopped the students' active participation. I shall focus on the verbal norms of practice sub-category of DP in this study as used in teacher M's classroom.

7.11.1 Whole-class Participation norm (PW)

In stanza 12 below whole-class participation norm was used together with Mathematical questioning (See lines 1-25, Stanza 12). The teacher used Mathematical questioning to prompt the whole class to respond with short answers. The pronouns used to identify whole-class participation were; **"we", "us", and "you"** as indicated in lines 2-5, and 8 of Stanza 12. Other instances of using the whole-class participation norms occurred when the teacher asked the class to copy a task on the board. He said the words: **Did you copy?** Teacher M regarded whole-class participation norm important (Gee, 2005).

Stanza 12

1. SS Good morning uncle//

2. T How are you?//

3. Ss We are fine Uncle//

4. T Ok// Sit down everybody and listen//. We are going to take some examples on the practical application of trigonometry//

5. Ss Yes, thank you Uncle//

6. T Example 1//

7. (Teacher writing on the board)

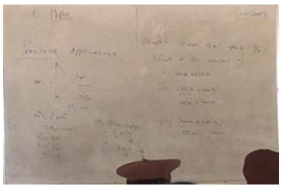
8. T **Did you copy?//(…)**

9. Ss Yes/No//. Yes sir/No// (mixed responses)

10. (Teacher moving forth and back, while students are copying work on the board)

11. T What is that?// (…) Still on?// If $Sin\ P$ is 3 over 5 and P is an acute angle, what is the value of $Tan\ P$?// (…) Solution//. Let see the solution now//. Always we will draw a right-angled triangle//. We draw what?// (…)

12. Ss Right-angled triangle/Acute angle (mixed responses)

13. (Teacher sketching and describing) 

14. T We said that $Sin\ P$//. That is, there is…// an angle is here//. So this is a right-angled triangle//. These two other angles//. They are less than 90//. And each one is less than 90//

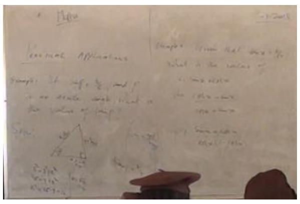
15. T From this diagram now//. I have three sides//. Now that we want to find y//. We have only three information there//. So this two we cannot get y//. We must have another side that is given//. That is known//. So for us to get another side to add up to this information//. We have to calculate this line. So we want to get y//. Just like you have a friend//. And you are looking for somebody that is related to that your friend//. For you to get that person//. You have to locate your friend//. Is your friend now that will tell you how to get to that person//. You want to see him now//. Go to so, so place you will find him//. So that is why we have…//.**That is why we said that Mathematics are things that are happing//. Things that are happing//. Just turning it to numbers and letters//.** These are things that are happing// (…). We are looking…//. Which one do we start with?// (…)

16. (Teacher gesturing and moving back and forth)

17. Ss x//

18. T Why x, why not y?//

19. Ss Because there is no number on the other side//

20. (Students gesturing and pointing to the board) 

21. T Because we must get unknown side from x//. To get the y//

22. Ss Yes//

23. T But for x//. This side//. This side//

24. (Teacher gesturing and pointing to the board)

25. T And this side are given//

26. Ss Yes//

It was evident that the purpose of whole-class participation norm in form of choral responses in teacher M's class went farther than a simple recitation of concepts. It required the recall of information the students had previously acquired. He used the whole-class participation norm for the purpose of sustaining and maintaining students' interest in a Mathematical task. It was a strategy for stimulating students' discussions in the Mathematics lessons. Unequivocally, the use of whole-class participation norm in multilingual class requires much more awareness and frequency than M allowed.

7.11.2 Regulating norm (RN)

The regulating norm was used in teacher M's classroom. It was used for the purpose of instructions in solving a problem and preparing students' behaviour in the classroom. In line 15, Stanza 12 for example, it was all about relating a real live story of a friendship between two people to the Mathematical task that was solved. Teacher M concluded by justifying the purpose of the story telling by saying: **"That is why we said that Mathematics is things that are happing, things that are happing, just turning it to numbers and letters".** The teacher used a story to regulate and sustain students' interest. This observation suggests teacher M employed contextual Discourses which are interrelated with language use to regulate and sustain students' interest. As Gee (2005) argued we are all members of multiple Discourses and so the analytical task would often be finding which of these are employed in the communication. This observation was evident in M's class.

7.11.3 Justification norm (JN)

In Stanza 12, line 15 the teacher gave a reason for calculating the unknown side of a right angled triangle. He further justified that with a real-life situation by narrating a story of friendship between two people as mentioned above. Teacher M structured his whole class discussion that, the reasons for using variables x and y in the Mathematics class were provided during an interaction (See lines 18-20, Stanza 12). In the section that follows I present the Symbolic Mathematical practice sub-category of the DP as enacted by teacher M.

7.12.1 Mathematical Writing practice (WP)

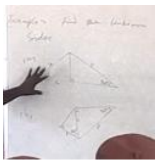
In Stanza 13 below teacher M wrote the topic (trigonometry) on the board. Afterwards, he used a sketch of a triangle on the board as an example to explain the written problem. The Mathematical task that teacher M was working on state: **"given a triangle below, find the unknown values of x and y?"** (see line 5, Stanza 13). 'A triangle' is a keyword in the above question. As the diagram on the board was a right angled triangle, it meant that the use of trigonometrical ratio was important. In line 6, Stanza 13 teacher M explained and asked the students: **"we now write cos 60 is equal to adjacent is what?"** This kind of Mathematical explanation and the questioning given by the teacher was not unexpected in a Mathematics class as it is typical of trigonometrical ratio. From the students' perspective, it would be beneficial if written Mathematical language were clearly explained and demonstrated by the teacher.

Stanza13

1. T Sit down//. And let's start the lesson//

2. Ss Thank you Uncle//

3. (Teacher writing and sketching on the board)

4. 

5. T So yesterday we do only one triangle//. But today, we will do two triangles in one//**given a triangle below, find the unknown values of x and y?//**

6. (Teacher gesturing and pointing to the sketch on the board)

7. T **We now write Cos 60 is equal to adjacent is what?//**

8. (Teacher writing on the board)

9. Ss 2//

10. T-2// Hypotenuse is?//

11. Ss x//

12. T $x//$. So from here we simplify Tan 60 equal to opposite is what?//

13. Ss z//

14. (Teacher writing on the board)

15. T z, Ehen// adjacent?//

16. Ss 2//

17. T So cross multiply//. This and this//

18. Ss z//

19. T Ehen, equal to 2//

20. (Teacher showing section of the triangle under consideration)

21. 

22. T We have cover all the sector of this triangle//. This side that is here//. So with this idea…//. Or knowledge of z here//. We can work on the other triangle//. The same method//

23. Ss Tan 60//

24. T Tan 60//. But what is Tan 60 from our special angle?//. Tan 60?// (…)

25. (Teacher moving back and forth)

26. T So this one can be written as $\frac{2\sqrt{3}}{1} / \frac{1}{2}$ //

27. (Teacher writing on the board)

28. T Which can be written as $\frac{2\sqrt{3}}{1} \times \frac{2}{1}$//

29. (Teacher and students chorusing)

30. T Equal to what?//

31. Ss $4\sqrt{3}$//

32. T $4\sqrt{3}$ over 1//.You apply the knowledge//. Ok// That is that//. Charge your brain//

33. (Teacher sketching and writing on the board)

34. 

35. Ss Find x and y//. Uncle, find x and y//

36. (Teacher moves round the classroom encouraging students)

37. S How can this be x and y?//

38. T How …?// You said what…?// (…)

39. S Uncle don't worry, I am cracking my brain (mental exercise of the brain)//

40. T please// (…) the classwork is serious//

Written Mathematical symbols often involve given procedures during calculation. These might include problem-solving or proving of a Mathematical task. As Pimm

(1987) argued written Mathematical language is most often perceived to be the indication of the subject in class. Teacher M valued and perceived writing mathematically as a valuable aspect of teaching and learning.

7.12.2 Mathematical Symbolising practice (SP)

In Stanza 13 above teacher M focused the students' attention on the Symbolic Mathematical task. Teacher M first sketched the diagram of a triangle and proceeded with mathematical explanation as he asked students short questions. These diagrams were similar to those, teacher E used in Stanza 8 in assisting students to identify the underling structure of right angled triangle. Sketching such diagrams might require Mathematical knowledge. In sketching the diagrams, teacher M translated the written Mathematical English into the Symbolic language of Mathematics. In carrying out these translations, teacher M had to perform an analysis of the problem. It is also practicable to present the task using the Symbolic language directly as indicated in Stanza 13 above.

However, one important factor which the teacher perceived was the challenge of the students' complete understanding of how the written Mathematical language is translated to the Symbolic language. In order to solved any task the students needed to understand, among other things, what these diagrams meant (Jones, 2013). This observation suggests that the teacher's intervention is significant in drawing students' attention to the relationship between written Mathematical language and Symbolic language.

7.12.3 Mathematical Gesturing practice (GeP)

Mathematical gesturing was evident in the class as indicated in Stanza 13 line 19 above. Teacher M demonstrated the use of different kinds of the Mathematical gesturing (Descriptive, emphatic, suggestive and prompting) during teaching so that the students would understand and learn. Teacher M used the Mathematical gesturing well. The observation in teacher M's class was consistent with the study conducted by Cook et al. (2016) whose findings showed that gesturing in the Mathematics classroom facilitate teaching and learning of Mathematics. Mathematical gesturing practice as used in teacher M's classroom was helpful.

7.13 Non-verbal norms of practice

The Non-verbal norms sub-category: noiseless, movement, hand-raising, and rewarding norms of practice. I present below the analysis of two (noiseless, and movement) norms as featured in teacher M's class in the following sections.

7.13.1 Noiseless norm (NN)

The noiseless norm refers to the expectation that all students must be silent or very quiet during teaching and learning. The observation in teacher M's class indicates that this norm was adhered to during the teaching and learning. Teacher M's classroom observed this norm. The students had become used to this norm. Immediately the teacher arrived in class, the students were silent without being reminded to keep quit. Teacher M created a safe teaching and learning environment which yielded positive outcome. There were instances when the class was noisy, but these episodes did not influence the lessons. This is in harmony with Pimm (1987). Pimm explained that in most classrooms teachers always place emphasis on a quiet, controlled, environment for the meaningful teaching/learning of Mathematics.

7.13.2 Movement norm (MN)

This is the changes or movement of positions of the teacher's/students' within the Mathematics classroom during teaching and learning process. There were two types of movement: mindful and non-mindful movement (Beaudoin & Johnson, 2011). Teacher M moved with purposes within the class for three different reasons. The first one was to demonstrate and show some trigonometrical concepts on the board. Secondly, to check, correct, encourage and commend students' classwork. Thirdly, teacher M moved to regulate students' behaviour. If students are motivated by the physically mindful activities of the teacher/students in the classroom, it might results in an increase in the students' academic achievements (Beaudoin & Johnston, 2011).

7.14 Discussion on school B

The observed results showed a series of dominant DP as indicated in Tables 7.1 and 7.2. These tables indicate that the teachers work across and within the two main categories of DP (language and non-language). Both teachers appear to have the same form of presentation in constructing the flow of their verbal and non-verbal talks in the classrooms using categories and sub-categories of DP. Just like School B teachers, they both used more language category (verbal communication) compared to the non-language (non-verbal) category of the DP. The teachers differed in their foci on the content coverage of the topic (trigonometry), although they both dealt with the introductory part of the topic, covering the same concepts such as angles, triangles and its types. Teacher E was more concerned with teaching the triangle using right-angled triangle and Pythagorean Theorem, while teacher M focused on the chord of a circle and finding the radius of that circle, calculation of the radius using the trigonometrical ratio (Sin)

Re-comparing the empirical results in this chapter with the kinds of literature (Chapter Two) and the Discourse practices in the multilingual Mathematics classrooms, it suggests that some of these DP in school A are similar. The Discourses in the two classes of school A focus on the interaction between students with the teacher at the centre being professional and expert. These DP occurred when the teacher was engaged in Mathematical proceduralising and giving instruction to students, rather than allowing the students to contribute their input. The teachers did most of the talking. The production of the DP was limited by the Mathematics teachers.

7.15 Conclusion

In this chapter, I have explored and analysed the identified categories and sub-categories of DP in teachers (E and M) classrooms at school A of this study. How the dominant DP in the multilingual Mathematics classrooms of teachers at school A were enacted, were examined. Suggestions were made based on the empirical evidence for the teacher(s) to consider the implications of these DP for teaching and learning of Secondary School Mathematics.

CHAPTER EIGHT: Discourses of Mathematics teachers about multilingual classrooms

8.1 Introduction

This chapter focuses on the reflective interviews of Mathematics teachers in their schools. These in-depth interviews were aimed at validating what the teachers did in their classrooms. The interviews revealed their reasons and methods for using the dominant DP. The empirical evidence shows that Mathematics teachers used home languages, but expressed their worries and disappointment with the restriction of the usage by the Nigerian language policy. The Nigerian language policy (FME, 2012) prevented teachers from using home languages in teaching and learning at Secondary Schools classrooms. The data analysis shows that some DP such as code-switching was used as support to the LoLT but this was at the teachers' discretion. This chapter clearly reveals the language challenges which have continued to bedevil the multilingual classrooms as well as the struggle of teachers to find a solution. The chapter also highlights why Mathematics teachers grapple to help students who are learning the LoLT. The purpose of the reflective interviews in this chapter is to give an account of the results for the research question: why do teachers use language (verbal and non-verbal) in their Discourse practices in multilingual Mathematics classrooms of northern Nigeria? In this chapter, four sub-categories of DP were closely examined with a particular interest in teachers' challenges of language use. Their solutions are presented in their reflective interviews data:

- Mathematical discursive practice
- Verbal norms of practice
- Symbolic Mathematical practice
- Non-verbal norms of practice

These sub-categories were corroborated by the reflective interview data (text) obtained from the Mathematics teachers and were selected based on the critical incidents as revealed by the teachers. The following questions were used to illuminate Discourse practices emerging from the reflective interviews with teachers:

1. Why do teachers use language (verbal and non-verbal) to make relevant and irrelevant their Discourse practices in the multilingual Mathematics classroom?
2. Why do teachers use language (verbal and non-verbal) to play their part (roles, positions) in multilingual Mathematics classroom?
3. Why do teachers/students use verbal or written texts to set up certain relationships to the Discourses in the multilingual Mathematics classrooms?
4. Why do teachers use language (verbal and non-verbal) to connect social goods to Discourses operative in the multilingual Mathematics classroom?
5. Why do teachers use language (verbal and non-verbal) to make relevant (irrelevant), the social languages to Discourse practices and in what ways in the multilingual Mathematics classrooms?
6. Why do teachers use language (verbal and non-verbal) in their sign systems and symbols during Discourse practices in the multilingual Mathematics classroom?

8.2 Recapitulation of the Sub-categories

To allow for a better understanding of the discussion in the Mathematics teachers reflective interviews, I start this chapter with the recapitulation of the DP sub-categories as used in this study. The sections which follow are brief discussions on the sub-categories of DP.

8.2.1 Mathematical discursive practice

Subsequent from the classroom observations, teachers in their interactions with students made meaning by emphasising, words/phrases/sentences. Teachers also used these Discourse practices in response to questions. The sub-categories for Mathematical discursive practice identified from the data included Mathematical questioning, Mathematical defining, Mathematical explaining, Mathematical exemplifying, Mathematical reiterating, Mathematical code-switching, Mathematical proceduralising, and Mathematical re-voicing practice.

8.2.2 Verbal norms of practice

As discussed in Chapter Two of this study, Discourse practices in the Mathematics class are interlinked and intertwined with the verbal norms of practice. They are the taken for granted knowledge within the Discourse practice (Gee, 2005). The norms of practice used in this study refer to the ground rules which might contribute to the stability of teaching and learning in the Mathematics classrooms. The sub-category featured in the data included; Whole-class participation, Individual participation, Loud talking, Rewarding, Justification, Regulating and Ridicule norms of practice.

8.2.3 Symbolic mathematical practice

The Symbolic Mathematical practice as discussed in the previous chapters of this study refer to gesture, graphs, pictures, and equations, which represent different ideas, knowledge, and beliefs (Gee, 2005). The Symbolic Mathematical practices are used differently depending on their own experience and personality. Teachers communicate using non-verbal Mathematical practice in their classrooms. Teachers use several non-verbal Mathematical practices to explain and highlight some concepts more than others in their teaching. Therefore category of Symbolic Mathematical practice are Mathematical writing, Mathematical symbolising and Mathematical gesturing practice as characteristics from the data.

8.2.4 Non-verbal norms of practice

The non-verbal norms of practice sub-category are Noiseless, Movement, Hand-raising and Hand-clapping norm. These norms of practice are also interlinked with the DP during action and interaction of teachers and students in the Mathematics classrooms.

8.2.5 The teachers and the use of dominant DP in the multilingual classrooms

The four teachers presented here are from different parts of Nigeria and have different home languages. Three of the teachers (teacher E, G, and M) are from north-eastern Nigeria, and all three do not share any home language, while teacher S comes from north-central Nigeria. As earlier mentioned, all four teachers understand and speak English, Hausa and Pidgin English. These Mathematics teachers can also understand and speak some of the home languages of the students. Dominant Discourse practices featured in the Mathematics classrooms elicited the reflective interviews conducted with the Mathematics teachers. The analysis of the videoed classroom lessons indicated the identified dominant Discourse practices and their usage. In the reflective interviews, teachers justified their reasons for these dominant

DP and recounted their challenges in the use of home languages in teaching. Stanza1 below clearly shows some of the instances during my interview at school A with teacher E.

This interview with teacher E was video recorded during a long break for the students. I interviewed the teacher in the school's Mathematics staffroom. The interview was pre-arranged.

Stanza1

1. R What are the most important challenges in the teaching of Mathematics at SS2 in your school?//

2. T **Actually, theeee, the task, there is the students' themselves//. After teaching, no time for them, they don't have that time for them to sit down and practices//. Maths needs time to practise every day//.** Every day you have to practise and after teaching, they will tell you IMUM OOOOOH//. Ok we understood everything, when you ask them a question// (…). Maybe, after two or three days, when you go back to ask them question on that particular topic you treated with them, you will find out as if you did not teach them//. Because they did not go back to practise, they need to sit down//. After each lesson they need to sit down and work over what they were taught on that topic//. So they don't have that discipline to go back and practise//. So that is a challenge// is a problem//.

3. R Why do you think that this practice is so important?//

4. T The practice of going back to study…//

5. R Exactly//

6. T That is good//. **Because, if they go, if they practise it, it will become part of them//, it will be easier for them and any time you meet with them, they might ask questions even in exams or tests/**/. It will be part of them, they may grow with it//. Because practice makes perfect as long as they did not practise it, it will, it seems, it will be difficult for them//. **Maths is not like other subjects that you can just read a story//, you need to sit down, use your hands, write, practise it//. Not reading like reading a novel//. Maths is not like reading a novel, it is not like history or other subjects//. It needs you concentrating, to study, to practise/**/. So that it becomes part of you, even if they don't use it now later in life they can use it//.

In line 2 Stanza1 above, the teacher's words during the interview, indicate one of the challenges faced during Discourses in her teaching: **"Actually, the…, the task, there is the students' themselves, after teaching, no time for them, they don't have that time for them to sit down and practices. Maths need time to practise every day".** The significant words are **"time"** and **"practice"**. For her, the social goods (knowledge of Mathematics) during Discourses were dependent on those keywords (time and practice). Teacher E as above justifies her use of Mathematical reiterating practice as observed during lesson presentation. Recall that while giving her lessons, she appeared to reiterate mathematically the social goods (knowledge of Mathematics content) in the classroom. Teacher E thought reiterating mathematically could refresh and remind students what had been taught earlier.

Teacher E supported her Mathematical reiterating by stating: **"because, if they practice it will become part of them, it will be easier for them and any time you meet with them, they may ask questions even in exams or test".** The teacher Mathematically exemplified during her talks in line 6 of Stanza 1 as she gave explanation with juxtaposition on how to study Mathematics using the following words: **"Maths is not like other subjects that you can just read a story//, you need to sit down, use your hands, write, practise it//. Not reading like reading a novel//. Maths is not like reading a novel, it is not like history or other subjects//."** The teacher felt when students overcame this challenge; it might offer an opportunity for the effective and productive teaching and learning of Mathematics. The teacher's reasoning was that communicative Discourses will only occur when students have a better knowledge of what was previously taught. Her identity was that of a responsible and professional Mathematics teacher who wished that her students had time to practise what they had been taught. Planas and Morera (2011) argued for a multi-dimensional view on how Mathematics classroom should be organised daily in order to answer questions on teachers' practice. From the arguments above it is clear that Mathematics teachers need to engage students in their Discourse practices using verbal discourse for effective teaching and learning in the multilingual classrooms.

The next Stanza 2 represents the description of more daunting challenges faced by teacher E as she gave an account of her position. The teacher linked the challenge of students' poor foundation (background knowledge) to their inability of speaking correct LoLT and fear of the subject (Mathematics).

Stanza2

1. R What, for you are the problems (E.g. cultural, language) of teaching Mathematics at SS2?

2. T The problem here is right from the foundation, the foundation is not built properly, like this is a federal school, is been expected that the, the girls, this is a girl school, at least they have a good foundation. Some of them are coming from eeeee, L. E. A. primary school that is local Ehen. Where basically they are been taught with Hausa or other tribes. So coming to a federal school, a federal school is supposed to be a STANDARD SCHOOL, where any child that is coming should have a good foundation, if the foundation is not laid properly, the building on it will shake. So that is what is affecting us. Some of them, EVEN THOSE IN SS2 SOMEBODY CANNOT SPEAK VERY WELL, and because is a federal school is been eeeeemm, we don't use Hausa excerpt if it is Hausa lesson, we don't use Hausa to teach Mathematics. It is sole English, but if there will be, if maybe federal government will say use maybe any language to teach, then we would cooperate. BECAUSE SOME OF THE FOUNDATION HONESTLY IS BAD

3. R To you, the problem of the foundation, is it attributed to the language or the content of the subject?

4. T By foundation I mean, when a child is not, we are talking of Mathematics, that eem fear in you eeeem, how will I call it, fear of Mathematics, HEARING THE NAME MATHEMATICS, it's scared them, you know scared them, I remember in our Secondary School during Mathematics, you will see students will be running out of the class, because that fear is the fear of Mathematics is difficult, Mathematics. So if you see a Maths teacher you will start, in fact you will hate the teacher or you will be running away. There is fear, there is lack of foundation. Proper up bringing in Mathematics, because the fear, even now you have to be talking to them, Mathematics is not difficult. Like example, I use myself, this is a girl school, so I use myself as an example, I say to them, if I will study Mathematics up to this level then you don't have anything to fear. So I tell them remove fear, Mathematics is very simple; if only you will concentrate, and study and develop interest. Some is lack of

interest, when you see Maths teacher, (teacher heist) oooooooh, this man is coming again, or this woman is coming again, so interest is not there. So they need to get interest, remove fear, then they can understand (…)//. And Language also contributes, and so like this our terrain, when they are not vast in English, they don't want to study English, and now you are bringing eeeeeeee, Mathematics in English, and language itself is not well, is not eeeee,is not strong enough, so it bring problem.

5. R What is it in the language that is a problem?

6. T **You know this language is a borrowed language. The English itself is not our indigenous language, is a language that we captured it (teacher gesturing by raising hands up), and we need to make use of it. So you find out that a child, we are still going back to foundation, a child brought up in Hausa, or maybe Jukun at home, everywhere around the child is Hausa and the child find his or herself in a school where there is no Hausa. So the child tries to grab (teacher gestures with hand), by all means, I have to speak English (…). So, but they, the knowhow of that language is not in the child. I capture it in the afternoon, so I must use it,** but if a child, in a home where you know they communicate in English, the child is conversant with it, they communicate in English, even though their traditional language is there, but the child is use to those small, small English. So when it comes to Mathematics s/he just applied it, what I know already, so you know we are going back to foundation Ehen//

7. R How have you been trying to overcome these challenges in your teaching?

8. T **You know the eee, in Mathematics we don't use this big, big grammar like English. So since we are not allowed to use Hausa to teach, personally, I try to explain in such a way that they will understand. I try to use the language as simple as they will understand. I give so many examples. I explain, if it is one example, I try to explain for them to understand**. I will ask them do you have problem, they will say no, then I go to the next one, I go to the next example.

9. R What for you are the practices which worked well? Can you describe briefly what you do and why you do it?

10. T I give, in Mathematics after teaching, it is expected you give assignment. When you give assignments and students know that you are the type that insists on them to bring it for you to mark, they will do it, even though some of them, they will copy. Do you understand? But few once will sit down and do the assignment them self, while others will come and say just give let me copy, but if one or two can sit down and do it// (…) faithfully, they can do it

> themselves. And another thing is I try to remove the fear in them, that Mathematics is simple, simpler than any other subject. I tell them to practise it that is my day to day. Make sure you practices Maths every day. Even if is five minutes of your time, make sure you practice that Maths. Don't allow a day to pass without you siting down and practicing it. So with that some of them picked up, some of them can bring it and to say ma or aunty, solved this and this, I have problem with it//. when teaching using English, because of the problem of language, some seems not to understand very well, but if eeeee the, eeee the teaching will, maybe slow down to Hausa, since Hausa is the general language around this place, if the teaching will be slow down to maybe Hausa, then some of them may understand it better, better. Like I was studying eeeee , like, I did my project in mother tongue in teaching Mathematics.

In line 4 Stanza 2 above, the teacher said: "Language also contribute, and so like this our terrain, when they are not vast in English, they don't want to study English, and now you are bringing eee, Mathematics in English, and language itself is not well, is not eee,is not strong enough, so it bring problem." The words show the strong feelings and worries of the teacher on language challenges. The teacher implied that the students understood and speak home languages rather than LoLT. In line 6 Stanza 2 teacher E says … **"You know this language is a borrowed language. The English itself is not our indigenous language, is a language that we captured it (teacher gesturing by raising hands up), and we need to make use of it. So you find out that a child, we are still going back to foundation, a child brought up in Hausa language, or maybe Jukun language at home, everywhere around the child is Hausa and the child find his or herself in a school where there is no Hausa. So the child tries to grab (teacher gesture with hand), by all means, I have to speak English (…). So, but they, the knowhow of that language is not in the child. I capture it in the afternoon, so I must use it"**. This reinforces description as teacher E's grave concern on language challenges that she grappled with in the Mathematics classroom. Of the several Discourses which the talks of teacher E in Stanza 2 above suggested, such as Mathematical explaining, Mathematical exemplifying and Mathematical gesturing practice, she linked the language challenges to the foundation, fears of Mathematics and lack of interest.

This data analysis of teacher E suggests she recognised the challenges in her Mathematics classroom but struggled to arrive at a solution. In line 8 Stanza 2, for example, the teacher proffers a solution to the problem using the following words: "**You know the eee, in Mathematics we don't use this big, big grammar like English. So since we are not allowed to use Hausa to teach, personally, I try to explain in such a way that they will understand. I try to use the language as simple as they will understand. I give so many examples. I explain if it is one example, I try to explain for them to understand."** These words as above were made by teacher E in response to a question that concerns the solution to the language challenges which occurred in her classroom. In Stanza 3 below teacher E tried to justify her reasons for using particular DP in the Mathematics classroom.

Stanza3

1. R Why do you think these mentioned problems deserve special attention?

2. T Mathematics in general deserves special attention because is a subject where people imum in quote (teacher gesturing with her two hands) think does in the Mathematics has two heads imumm, but this is not so. Mathematics is just like any other subject, just like any other subject, so Mathematics need right from home, from the parent, needs to, parents needs to encourage their children. That is why in school, Mathematics is very important, because like in this school, if you don't pass Mathematics, you are not going anywhere. You need to sit up to read, to study it, not reading, to practise it. You use your hands to practise and know it. Not for exam seek, you just cramp balabalabala, you go and pour it that is all, is off, you cramp, you off, off your brain. You practise; you know it, so that it will be part of you. So Mathematics in general need special, if you, I don't know how to quantify it, very special attention.

3. R You mention a couple of things, particularly the use of home language. To you personally, how do you look at the use of home language in teaching Mathematics?

4. T The using, personally, **personally, because I have done the research in it, I know that the using apart from English, using their local language to teach Maths, they will understand better, they will understand, in fact, they will move along with you by, because it is in their own dialect. So they will move along with you, their attention will not be divided, they will go with you. If it is like, some of them will not even understand. But if it is their dialect they will understand aummum. You know, I told**

> **you SIFILI, I didn't know that zero is SIFILI in Hausa, is the students that said ma SIFILI, zero is SIFILI. SIFILI NE IYI, and so I also learn that zero is SIFILI. So anything that involve zero, they know eeeeh this one is SIFILI**. We live it simple and easier.

The purpose of that question was to find out why the teacher used particular Discourse practice during teaching and learning in the Mathematics classroom. To reiterate, some of the challenges facing students as teacher E mentioned in the reflective interview were: fluency in the LoLT, foundation, fear of Mathematics (Mathematics phobia) and lack of interest in Mathematics. The teacher in Stanza 3 above clearly pointed out the importance of confronting the challenges bedeviling the teaching and learning of Mathematics. In line 4 Stanza 3, she uttered the following words: **"…personally, because I have done the research in it, I know that the using apart from English, using their local language to teach maths, they will understand better, they will understand, in fact, they will move along with you by, because it is in their own dialect. So they will move along with you, their attention will not be divided, they will go with you. If it is like, some of them will not even understand. But if it is their dialect they will understand aummum. You know, I told you SIFILI, I didn't know that zero is SIFILI in Hausa, is the students that said ma SIFILI, zero is SIFILI. SIFILI NE IYI, and so I also learn that zero is SIFILI. So anything that involve zero, they know eeeeh this one is SIFILI."** Here, the teacher did not just give a reason for the use of code-switching, but she switched from LoLT to Hausa, exemplifying mathematically and narrated her experience of doing that while teaching. In a study in Malaysia, Then and Ting (2011) found out that code-switching helped students to understand terms and concepts in Mathematics they would not have understood these if the teacher had used only the LoLT. So code-switching was vital. Stanza 4 below focuses on the reflective interviews with teacher M. In the interview the teacher also explained the language challenges which existed in his classroom during teaching and learning of Mathematics.

The interview with teacher M was also conducted during a long break for the students. I interviewed the teacher at the e-library of school A. The interview was pre-arranged three weeks.

Stanza 4

1. R What are some challenges for you in teaching Mathematics at SS2?

2. T Some of the challenges, you know this our students, eeeeeee, problems with some of the subject, at that level. You know students, some of the students, their, their foundation at the primary level, in truly addressing the teaching of Mathematics in SS2, because some of them, **the problem of foundation is that, some of the students don't know it, because they did not finish the Primary School. Some of them left Primary School, at Primary four, Primary five, some of the ideas they supposed to have gotten before reaching the Federal School, those ideas are also yet be address in the learning of Mathematics, even at SS2 level. Some of the ideas are very important, once you don't get them, they will continue to affect you except if you make eeeee greater effort to cover all those aspects, if not they will continue to affect you. The foundation counts a lot, so apart from the foundation aspect some students lack of concentration or some of them, apart from concentration already they have gotten idea that Mathematics is a difficult subject, so they find it difficult to meet up, so that idea is still in them.** So anything you are teaching is difficult to them. Is already inbuilt in them because of the mentality some people have given to them right from the beginning or along the line at that level.

3. R Can you give example of some of the difficulties you face in the class?

4. T An example, like example, let's say this issue of, maybe you ask, maybe you came to a particular aspect you say 5 times 7 and students they don't response to it immediately, some of them will go back and be looking at their multiplication table which they supposed to have learnt since Primary school. That is why I said that it is affecting the teaching of the subject, **so it takes them time to give an answer to 5 times 7 is 35. Some of them will have to go to their multiplication table, some of them will go to a calculator to go and press before the will give 35. You can see that it is delaying, it's a kind of go slow to the teaching of the subject** because they, you will not cover much, because of this kind of a thing.

5. R Apart from these two or three issues, you have mentioned as challenges, do you also look at culture or language as one of the challenges?

6. T Actually is also one of the things, there are some students eeeeeeee, we have different, maybe the short coming in the area of language is, maybe there are some of the students that they are used to this Hausa, Hausa, maybe you try to tell them some things in Hausa, they will understand it better than when you are using English language, so there is one thing that there is a situation, you know that they are not all Hausa students, they are, some are Hausa, some that are Yoruba or Igbo, but some in the some in the area of Hausa, there are some if you take it in their own language, they will understand it, and some will prefer English. So there are some like that, so if you say that you will concentrate on Hausa, they are some of them that they don't understand Hausa, so there will be problem again. **Actually, some of them when you take it to their own language, their culture, EHEN//, they understand it better, there are some who they have the way of timising (multiplying) numbers, if you take them to that direction, the will get it better,** you understand. The problem now is that not all that can follow that pattern, so if you want to follow that aspect only, it will affect others.

7. R Can you give an example of a situation which needed explanations in their own local language?

8. T In like, maybe like the area of number base, if you look at number base, number base is a way of a counting, you discover, these our people, even the students, when the get home, at times they will sit down and be playing either, there are some games that they use stones to play, so they have some numbers of stones they have to put inside the hole or apart from that their parent, or most at times their parent will tell them, in those days, if you want to count maybe you count five and put it in one place, any group that you see, you see it means that it is five, so by the time you want to know this is the total, you count how many number of group you have, from there you will be able to get the total, there are some their parents will begin to tell them that in those days, the way we instituted counting is that they put it in group of tens, put ten here put ten here put ten there. If they want to know the number, the total, just count, begin to add three of the groups, you know that is thirty. So the number base is also number form that is why we have taken that base ten numbers. We also have base nine, base seven, base five, base two and base eleven, EHEN//,. So those ideas also help, EHEN//, those are the ideas that I use, so putting those ideas across to the students.

It is evident in Stanza 4 above that the teacher's words indicated great challenges the students' struggle to perform simple mathematical tasks. Teacher M's challenges in his Mathematics classroom are similar to that of teacher E. For example, teacher M attributed one of these challenges to students' poor foundation (background knowledge) which he noted that it continued to slow down the pace of teaching and learning of Mathematics. In Stanza 4 lines 2 and 4 The teacher said the following words: **"…the problem of foundation is that, some of the students don't know it, because they did not finish the Primary school… so apart from the foundation aspect some students lack of concentration or some of them, apart from concentration already they have gotten idea that Mathematics is a difficult subject,… so it takes them time to give an answer to 5 times 7 is 35. Some of them will have to go to their multiplication table, some of them will go to calculator to go and press before the will give 35. You can see that it is delaying, it's a kind of go slow to the teaching of the subject…"** Through these words of the reflective interview, teacher M revealed the challenges. He believes that students lack basic knowledge of Mathematics. It was within the views of teacher M that the use of home language could be solution of the challenges. He captured this in some of his comments in the interview: **"Actually, some of them when you take it to their own language, their culture, Ehen//, they understand it better, there are some who they have the way of timesing (multiplying) numbers, if you take them to that direction, the will get it better".**, This claim was further supported by the data presented below in Stanza 5.

Stanza 5

1. R Ok, now what are some of these language-related issues you always encounter in the class? And how do you manage those terminologies such as cube, cuboid and prism in the class?

2. T Imum, those terminologies, they are always there, the only thing is that you in order to make them understand, you make use of or I give them some local, local examples, that is from practical examples of those things like cuboid, show them a box of chalk, then by the time, or something like cube, and then cuboid, cube and then cuboid, that is the combination that is you try in short. This issue of cuboid, by the time you use, or you demonstrate, you use something like cuboid, **the students will capture it faster Ehen//,** even if you find it difficult to pronounce it, but when you know that there is something that the uncle has called it in class, they will try to master it, because they are trying to relate it to what you show

them and even how you pronounce it or you mention it. So they will begin to get use to some of the things and the aspect that will bring confusion, to the different types of shapes.

3. R Can you remember a classroom episode which illustrates the issue of using local language or home language, so that the students can be able to understand?

4. T I can, we have, let me take, let me think// (…), that is one thing, we use language to demonstrate something eeeeeeeeee, I want eee to use eeee, let say eee matches, although it is still in relation to cuboid, I tell them is ASHANA, ASHANA, EHEN//, the ASHANA you are seeing, if you are using to light the stove and this and that. The box, that box, that ASHANA box EHEN//. If you are using their language the ASHANA box, the box, that AKWATI of the ASHANA EHEN//. That one is the same thing as cuboid, is an example of the cuboid EHEN//. So you can see that, I am using ASHANA, using the Hausa language EHEN//. They know that ASHANA is the stick of the matches inside in the cuboid EHEN//. So if you want to demonstrate sphere, you can take them to KWAI, you want to teach a sphere is like, if you want to take an object in language side of it KWAI, KWAI, as you can see the shape of it EHEN//,, the shape of it is a sphere EHEN//, because is different from eeee, something that is round like a ball, a ball actually is partly a sphere too, but there are some balls that are not totally spheres but all the same, I want to say that KWAI as a language. Apart from using Hausa, you can use others, to have an idea about other languages, you can still bring in , you can asked some of the students, ok egg, how do they call egg in your language? Then by the time they mention it you now use it too, to tell them that, that thing you mention is an example of this, like that so that other, other languages will have a share of that knowledge, so that they don't complain, because it is not only one tribe that is in the class, EHEN//. So you try to diversify (teacher laughs), so you are using a term now, so as to let others know that you value their language too EHEN//,, because we are in Hausa area, it highly concentrated of Hausa, because like this one, you know that this is a federal school, there are many people from different parts of the country, so you have to teach with caution.

5. R You said "I am speaking Mathematics English", may I know why you use Pidgin English during lessons?

6. T That is, they that is the pattern, that is what I mean is, you know I said consecutive number. So now, these numbers, I said they are numbers that follow each other//, like that after this one, this one, this one, Ehen//, because there are some numbers are not consecutive. If I write 1,2,3,4, now if I pick 3 here and then pick 7 in front there, the numbers, the numbers and maybe, I pick 7 and pick 2 here these numbers are not following each other, based on the ones that I picked. That is, let's write 1, 2, 3, up to let's say 8. So, if

I pick 3, let's indicate 3, now 3 is a number now, if I take 7, I now come and take 2, but my intention is on the base is 3. So picking 7 and 2 here, these numbers are not following each other, but this 2 is here, while 7 is at the other side. The number that follow each other base on my 3 here is 1, 2, these once, they are following each other in this pattern like these. So when numbers like these 2 and 7, 7 is on the other side, so base on the 3 that I picked initially here, these numbers are not following each other EHEN//,, So they are not consecutive. The one that follows, let say after this 1, you move to 2, you move to 3, they are following each other, they are consecutive. I am trying to eeeee, I am trying to bring it down, I am trying to explain, so that they understand the CONSECUTIVENESS

7. R Now as a result of coming to their level you use a mixture of Pidgin English so that they will understand, am I correct here?

8. T I, I cannot say no to this

9. R Why do think these issues we have just discussed, foundation, talking about using a bit of Hausa, why do you think they deserve attention?

10. T Imum, there is a need for addressing as you rise. Mathematics is a subject that is very importance to the society now, because Mathematics is a subject that is needed everywhere. Whether you are a mathematician or not, you need it and apart from that this period of time, because of the importance in the society and for them to move forward to the higher level they still need it. And there is a need up in terms of, they still get this ideas of necessity for Mathematics, because without Mathematics they can't go anywhere, even if they have so many passes, they still need the Mathematics, even there are some students like those in arts class, they don't need Mathematics, but because of the system now whether you are from Maths or not, whether commercial or arts or science, you still need Mathematics. So because of necessity in that field of that subject, there is a need to address this area. So that we will not have students left behind after they have study up to the secondary level. Because there are lot of people now that are at home now because of this Mathematics we are talking about. They might have other subject hundred credits, distention in other subjects but once they fail Mathematics, they are not going anywhere. That is why you see a lot of people are roaming about, sometime not that they didn't pass very well, but because of this Mathematics, they are nowhere. You know there is a lot of competition now on Admission, this and that even jobs at times when the see that the number of people are too high for that, they now go into another area, they know that, if they go to that side a lot of people will be drop. So they can use Mathematics as a point for those who, so that there will, those who have probably ordinary pass in Mathematics, they drop their own aside. So is a way of screening, you know the grade in English is even better, but in Mathematics people know

that, they have problem with Maths. So when you need Admission, they look at that area very well to reduce students, even job at times, when they see that the going is too tough, the competition is too keen, they go into that aspect. So Mathematics is very important and because of it important you have to address these issues, is a most.

Subsequent from the texts in Stanzas 4 and 5, the common features as uttered by teacher M showed that students understood and learned Mathematics better if the teacher presented used both LoLT and home languages. In line 2 Stanza 5 the teacher says **"the students will capture it faster".** In a way, the teacher suggested that students understand better when home languages are used together with LoLT during class. The views of teacher M seem similar to the studies conducted by Akinoso (2014) and Ogundele et al. (2014) on the causes and remedies of students' poor performance in Mathematics in Nigeria. The result indicated that students who passed both English and their home languages performed better at Mathematics. Teacher M also switched between Hausa, Pidgin English and LoLT during the reflective interview to mathematically exemplify the teaching of some concepts (see lines 4-6, Stanza 5). He suggested that code-switching is a resource to be harness in multilingual classrooms. The next Stanzas below represent the description of the other two Mathematics teachers in school B, who also gave similar accounts of their challenges while teaching in multilingual classrooms.

The reflective interview with teacher S was conducted during a free period for him in the school. The venue for the interview was the Chemistry laboratory of school B. This interview was pre-planned four weeks earlier.

Stanza 6

1. R What are the most significant challenges you face in teaching Mathematics at SS2?

2. T We have challenges//, challenges like…// challenges we face, challenges I faced in teaching Mathematics are the overcrowding of students, and the students not understanding Mathematics, mathematical languages, like mathematical concepts// (teacher gestures). **At times, before students move to…//, before students will enter into SS2, there are specific languages, the language of Mathematics that they supposed to got understood//, which at time they don't normally understand the concepts, when they**

come into SS2//. So, instead of you to build on what they have learned in their previous classes//. You now move back again to cover those topics//. This is also the challenge// (teacher gesturing and nodding). And the challenges of emm…// though this one is just a minor one sha//, is the movement of students to classes//. This one occur at times, due to the overcrowdings' of the students in a class, because at times we teach almost 100 students in a class//(teacher gesturing). Which is at least is a big, is big problem and how to control the students in the class is also a problem (teacher gesturing by describing hand).

3. R Let us talk about language. You mentioned mathematical language, what do mean by that?

4. T Mathematical language//, there are some concepts in Mathematics that at least an SS2 student needs to understand, or got them understood before moving them into SS2//(teacher gesturing and nodding). Like if you are discussing shapes//. When I said geometrical shapes, or a triangular, shape, or a shapes that are found under trigonometry, like that, so a child can find it difficult to differentiate between this is trigonometric and this is a geometrical shape, so these are languages that a child needs to understand this before even going into SS2, in fact, even SS class not only even SS2. So you can, you…// so at times me, I discover them as a problem//. You understand//. The difference between one shape to another or one topic to another//, which will help a child at least to understand the current topic to be taught (teacher gesturing, nodding and pointing his finger on the desk).]

5. R When I said language, I am referring to the languages that you and the students also understand. What challenges do you encounter in that aspect?

6. T Yes, we have official language for teaching which is English//. That one is generally accepted as English, for us to use English to teach, but at times, as I said, one you have to go back to your local language//. The language that students understand, because as a teacher, you have a stated objective// (teacher gesturing, nodding and pointing his finger on the desk). If you say, you will build upon what it is the official as a language for you to deliver your lesson//, your, your lesson, you may not achieve those objectives. So at least you have to deviate // (teacher gesturing). By deviating, I mean you need to go, you leave that official language and then go to another language that you teach and the students will understand you//. If a teacher is…// If I am teaching at times, I use to leave English language and go to Hausa, explain the concepts properly in Hausa before coming back to English//. So at that, at that junction, you will understand that the child will understand what that particular concept is, is all about.

7. R I also observed you, using a little bit of Hausa. Are saying when you don't use a mixture of the two, the students will not understand?

8. T Yes, I tried that, I tried that// There was a time I taught a concepts fluently using English, and then I assessed them, definitely…//. And I tried the, the, the two, I used English for whole concept, when I introduce a concepts. Started to, I started that concept with English, and ended that concept with English and I assessed them// (Teacher gesturing), and I kept the record aside//. And I mixed the two languages, and I explained, the same topic, I assessed them, and compared the two results. When I look at the result of when I used the two languages: English and Hausa, students performed better than when I used English alone//. That is why I prefer using both languages. At times I teach Hausa in my teaching, to get them understand

Teacher S explained the challenges he faced during teaching and justified his used of some dominant Discourse practices. Among the challenges mentioned: overcrowded classes, poor understanding of Mathematical language and lack of basic knowledge of the subject (see Stanza 6 line 2). Thus teaching and learning of Mathematics was very problematic. It is obvious from Stanza 6 lines 2 and 6 above that teacher S was seriously concerned about these challenges which affect productive teaching and learning. In line 2 stanza 6, the teacher captured his frustration during teaching and learning using the following words: **"At times, before students move to…//, before students will enter into SS2, there are specific languages, language of Mathematics that they supposed to understand//, which at time they don't normally understand the concepts, when they come into SS2//. So, instead of you to build on what they have learned in their previous classes, you now move back again to cover those topics//, this is also the challenges// (teacher gesturing and nodding)."** It is clear from the verbal talks of teacher S above that he was worried about the challenges confronting students and so to enable productive teaching and learning he went back and forth, explaining and reiterating the background knowledge of the concepts which the class needed, before engaging the students on the new topic. In his effort to solved the challenges, teacher S employed the use of several languages. In Stanza 7 below teacher S illustrated why he use two or more languages during teaching and learning in the Mathematics class.

Stanza 7

1. R What for you are the practices which work well, when you are using one, or two or three languages?

2. T Yes, if I am using the two, if I am using the two languages, though I will not be//, the Hausa will not be consider as…//, as eee a medium for communication between I and the students, but at times, as I said I deviate a little bit Ehen//. I teach Hausa into my …//, into my classroom lesson note, not throughout//.

3. R So what are the practices which work well for you when you encounter these challenges and you want overcome them?

4. T Is during explanations, during explanations//. You give them a little note, at times you find it difficult to understand what the note is all about// (teacher gesturing). So at times I do leave that aspect, I do use Hausa to explain that concepts, before going on to examples.

5. R **Why do you think Mathematical explaining in other languages works well for you?**

6. T **Is for me to understand what has been stated as my objectives and to achieve my objectives.**

7. R Can you exemplify some of these challenges which needed a switch to another language? Or is it all?

8. T Not all, it can't be all//. No matter how, there is at least a little part of what you think the child will understand, because teaching is all about building, build upon what the child has learned previously//. Example, if you want to teach a geometrical shape like, like a cone//. You know a child had been used to how to measure, how to measure Garri//, or something like that//. Also all these round books, like that//. If you now mention a…// If you introduce a, a concept and I put it on the board cone. They will not understand, no matter how I explain, they will even see the structure been drawn on the board//. Do you understand//, now if I deviate now//. Do you know how to measure Garri in the market? They will now say yes//. Now, can you differentiate between from the mouth, mouth level of the Garri and the one on top? They will say yes//. Now take the one on top, that is what is refer to as cone//(teacher gesturing, nodding and pointing his finger on the desk). Have you ever seen the hooks around wood? Yes//. Have you ever seen the cover, roofing? They say

Ehen//. That roofing is what is refer to as a cone//. Now, I will now use Hausa to explain those things, now before coming back to English to teach.

In lines 3 to 6 Stanza 7 above teacher S mentions that Mathematical explaining practice seems to work well which switches from one language to another. When asked: **"Why do you think Mathematical explaining in other languages works well for you?"** In line 6 Stanza 6 above the teacher provided justification as to why using other language was necessary for him by saying the following words: **"Is for me to understand what has been stated as my objectives and to achieve my objectives"**. Here there are three keywords **'me', 'my' and 'objective'**. The uses of the keywords are evidence of his identity as professional Mathematics educator. It is the concern of every teacher to ensure his students achieve or perform well after lessons. In Stanza 8 below teacher S elaborated and provided justification for the use of symbols and representations in his Mathematics classroom.

Stanza 8

1. R What of symbols, using symbols, because I observe you always draw triangles and when you are talking you point at the sketch, why do you think this is important?

2. T Is very important, those symbols are very important to differentiate between one angles to another. They can be…//, they can be represented, I mean, replaced by any other symbols too, or by any other sign or letter//. Is very, very important oh, because it will give the image of what to, what you have in mind to teach

3. R Are you saying that in the textbook you are using or in any material you are using, they have those sketches?

4. T Not all

5. R Then **why do you always sketch?**

6. T **For the students understanding, yes, because they understand well, if we, we begin with the information I mean, and also the representation//, with two you will get the information (teacher gesturing, nodding and pointing).Yes the students understands, yes, very, very important.**

As indicated in Stanza 8 above my interview with teacher S showed his strong conviction about the use of symbols in the teaching and learning of Mathematics. In line 2 Stanza 8 the teacher valued and stressed the use of symbols. In lines 5 and 6 when asked: **"why do you always sketch?"** He justified the need for the use of symbols isaying: **"For the students understanding, yes, because they understand well, if we, we begin with the information I mean, and also the representation//, with two you will get the information (teacher gesturing, nodding and pointing).Yes the students understands, yes, very, very important"**. The way the teacher answered the questions using gestures and body movement indicated how significant he considered the use of Mathematical gesturing and Mathematical symbolising practice in his teaching. As earlier indicated in Chapter Seven of this study, the norms of practice were also observed in teacher S' classroom. Stanza 9 below focuses on the interview questions on the norms of practice with teacher S

Stanza 9

1. R **I observed you always move round the class why?**

2. T **I do move round the class, if not as I said the class is somehow congested, I used to move from behind to the front like that// (Teacher gesturing). But if you observe I don't normally go in between the students, because there is no space for the teacher to move, due to the condition of the school. That is why I can't move. At times I can observe those that are writing and those that don't write//Ehen. And If they are not writing at times I ask why//. And if they write I check if there is a mistake. At times what the teacher will write on the board will be different with what the students will write their books//. So I move round to correct students writing in their books.**

3. R Now another thing I observed in your lesson is when you write a particular question or example you read it again, over and over. Is it that the students can't read or why?

4. T No//, they know how to read, not that they don't know how to read//. I did that because I want them to understand the question//. To understand the question and before I move into the solution//, I did that only for them to understand the question and those that don't get the write up very well, so that they will be able to get it. If there is any spelling error, they will now effect it in there notes.

5. R So can you itemise some of the rules and regulatings in your class?

6. T My rules, that is, these are…// At times I call them my principles. You know I don't normally allow students to…//. This one is constant; I don't normally allow students to write, if I am solving a problem on the board. I don't allow them. If I am explaining, they don't write, if I am writing they don't write (Teacher gesturing). I give them time for them to copy// Imum. And why do I do this such, kind of thing, because, you cannot tell me that if I am explaining, you are writing, you will be understanding what I …//, you may end up copying what, what, what you don't know, Imum//. This is the main reason why I give them time to copying, after explaining, and while you are copying I will still be explaining while they are copying//. And for the first time I have stop them. I stop them, let them understand before they write, so that if they are reading it at home they will understand, they will get the image very well//. They will now be remembering, thinking all this what the teacher said in the class, and so on, and so forth//. So if you allow them like that//, you are explaining and the child is busy//, where will he put his attention? Is it on the explanation or on the writing?// That is number one. And I don't allow movement in the class//. I don't know, I don't know//, but umm//, I don't allow movement in the class//. But umm// I have said it before, because of the overcrowding//. At time, if you are…//, a child will just come and say excuse, excuse, excuse, like that// (teacher waving his hand). So when I don't…// It reached to a stage whereby that movement principle, I put it aside, I said now if you want to come inside just come in without saying excuse, the same thing if you want to go out just go out without saying any excuse, so that you don't disturb the teacher and the rest of other students. So you are free to go out quietly and also come in. so if you say an excuse, when you are outside, you will not then come in because you have distracted the attention of the whole class and the lesson. So this are some of my principles//.

7. R These issues you have mentioned; the practices and the norms, why do you think they deserve attention?

8. T Yes, they deserve attention because emm, these are the, these…//, those issues I mentioned, I think they are the once that if the teacher did not properly handle them, he may end the teaching without achieving his objectives. Yes you may end up, you, you may I mean you may teach thinking that, the students yes, they understood what you mean, but at the end, they may not.

9. R What is your advice to the policy makers or the government?

10. T (He laugh) The advice are, one // one, among…// they are many sha. But let me just concentrate on one. The policy makers and the government should restrict the numbers of students they are admitting into schools. For so, teacher will at least…//, the work load of

teacher will be at least a little bit reduced. Sheey you witness the number of students we have?// Ehen, and deem defiantly, like emm, the government , a school cannot do this thing ooh//. The one I am about to mention like emm Mathematics laboratories if you look at, most schools don't even have Mathematics laboratories like the concept I taught on trigonometry , do I even need to write them on the board? I don't, I am supposed to just go and look for at least if it is an aid, you know, that will attract students' attention, so that if you are teaching, your attention will now be there at least, at time they can be using the locally one, locally made once//.But emm if the one that government can provide, so that to even show an effort that, to even show any attention that they will do so that I mean so that the school will build upon what the government did, is ok like that. But the government should not be leaving the work to the school. Of which the school management cannot afford to do that, at the end they will now ask the teacher to go and improvise.

In Stanza 9 lines 1 and 2 above, teacher S makes it clear that the discussion was shifted to the norms of practice in the Mathematics classroom. The interviewed discussions actually shifted to his expectations of his students' behaviour in the Mathematics classroom. These were about the rules and regulatings or what the teacher calls the **"principles"** guiding the behaviour and conduct classroom. When asked in the reflective interview: **I observed you always move round the class why?** The teacher responded using the following words: **I do move round the class, if not as I said the class is somehow congested, I used to move from behind to the front like that// (Teacher gesturing). But if you observe I don't normally go in between the students, because there is no space for the teacher to move, due to the condition of the school. That is why I can't move. At times I can observe those that are writing and those that don't write//Ehen. And If they are not writing at times I ask why//. And if they write I check if there is a mistake. At times what the teacher will write on the board will be different with what the students will write their books//. So I move round to correct students writing in their books**. It is clear from the talks above that teacher S used the movement norm to check, evaluate and correct the students' work to be sure what they were writing in their note books was mathematically correct. Teacher S' remarks reveal that he was concerned that they copied the work written on the board correctly. Incidences Such as this provide opportunities for the teacher to correct and initiate discussion of what constitutes acceptable mathematical writing practice. In line 10 of Stanza 9 teacher S further expressed a strong opinion and advice that the authorities' concerned should provide good teaching and learning environment as well as restricting the number of students admitted to schools to solved the problem of overcrowded classroom. This is because overcrowding was very problematic.

The Stanza 10 below is a representation of texts from transcripts of the reflective interviews conducted with teacher G which shows how he differs in his opinion on issues of language challenges and further provided justifications for the usage of particular Discourse practices in the Mathematics classroom. The reflective interview with teacher G was pre-arranged two weeks in advance and was video recorded at the chemistry laboratory of school B during a long break for the students.

Stanza 10

1. R What are the most challenging tasks for teaching Mathematics at SS2?

2. T eeeeeee one, they are many: 1) I had the problem of **most of the students don't have textbooks.** 2) eeeeee even **those that have the text book don't even read**. 3) Problem of eeeee let's see// the work load is just too much. 4) I called it Mathematical phobia; because the students, they are already// they felt that Mathematics is difficult and other things

3. R Can you give an example of Mathematics phobia?

4. T Mathematics phobia means fear// fear of// fear that cannot even be explained, and so they are afraid of the subject right even before they came to secondary school. They have been telling them stories of this subject from their eeeeeeee brothers that were not even serious, that Mathematics is extremely difficult. So they feel discourage. So they are even discouraged before the learning.

5. R Do you think these issues deserve attention?

6. T I//. I really, I'm really, in fact, let's say, I'm trying before every lesson, I have to take my time in explaining to them, that this things you are doing is not all that difficult. If you can put in your little effort you will surely succeed, and Mathematics is not just for people that are special. If you can do Mathematics, I tell them this that Mathematics is not

just for those that have brilliant heads, but for those that are serious, those that can do it with perseverance.

As indicated in line 2 Stanza 10 textbooks played a significant role. In the teacher's talks during the interview, he felt that reading textbooks was an important aspect of teaching and learning Mathematics. This could be inferred from his use of words: **"most of the students don't have textbooks"** and **"those that have the text book don't even read."**. Teacher G values the use of textbooks. The teacher also highlighted two challenges in the Mathematics classroom: (1) improper allocation of a stressful workload for teachers and (2) students phobias about Mathematics. This phobia about Mathematics was echoed by teacher E in school A. Prior to this interview with teacher G, in an informal discussion after observing a lesson, he told me that over twenty classes had been allocated to him. The teacher views this allocation as too much large and he felt it was counterproductive. In line 4 Stanza 10, teacher G pointed out that the challenge of "Mathematics phobia" emanated from the influence of parents, relations, or friends of the students. Teacher G, showed an identity of a professional and responsible Mathematics teacher who really wants his students to learn the subject.

The discussion above suggested that the teacher view the use of the textbooks in the teaching and learning of Mathematics as significant. Teacher G was worried about the improper allocation of workload. Students' phobia for Mathematics was also made significant as one of the challenges that the teacher has to deal with while teaching. As the reader can see in the Stanza 11 below, teacher G enumerated language challenges confronting him while teaching Mathematics in the classroom.

Stanza 11

1. R Do you have language challenges?

2. T Seriously yeah

3. R Can you exemplify?

4. T I want to say something about **language barrier**. As I sit in the school today, they have put a law that speaking vernacular is prohibited. And so I, I on my own side, **I have to**

break the law, because sometimes a student, you see a student that is brilliant, but because of the language barrier, s/he cannot speak the English, they cannot ask question, they cannot even answer. That was what I do if I teach, sometimes I have to go down to their level, is not only Hausa, I even go down to the use of a local dialect so that students can understand. Now once I am able to explain what I'm to teach, then I go back to English. Let me give you one instance, there was one student of mine, his name is Bashir. As I am speaking to you now the boy is in ABU, he wanted to read medicine, but could not get in, he is reading micro biology now. When I met that boy, that boy could not even speak one English word. He is always in the class. It was a question of if I stage to speaking in English. So that is what I do, I decided to come down to his level; I discovered that the boy was good at Mathematics, but could not ask question because he could not speak English. I now gave him room (leeway). I said Bashir, if you have a problem; just ask me, in fact even in Hausa. So when I said that people where just laughing. From that day hence forth, whenever he had a problem he would come and ask me in Hausa, then I now used Hausa to explain to him, and then go back to use English to explain again. That was when I saw the best in him. In fact before he finished his Secondary School and went to ABU, he became one of the best students at the school, and represented the school in one of the national competitions in Mathematics. Now tell me if said I had stage to the use of English only, that boy would have ended up been a failure, that is why I use Hausa in my teaching

5. R What are some of the specific language problems in the uses of symbolism, and objects?

6. T You have to use something similar to it. For instance, you see linear equation, $2a + 5 = 0$. If you are to explain coefficients to the students, how do you do this? Eeem, you will only say coefficient is a number attached with a variable. How do you do it? How do you give example, for say ok, for you to separate the number and the variable, you have to divide it. I now use, let me give an example; a child and the father and the wife. So you can easily separate the man and his wife. Why because, that number will just climb, eeeeee, just cross over that equal sign and become minus, ok, now if a woman marry and she is divorced, so and if she goes back to her father. She become minus because she is a divorcee. But if you have a child with the father, there is no way you can separate them, only death. That is why, if you have $2a = 5$, for you to separate a and 5, you will multiply both side by this. So that is what I use. I don't even need to use any symbols. I use vernacular to explain to them. I use English, and then I will use Hausa, the general language that everybody understands. In fact, not only that, I will even practicalise it, let them see, yes

7. R How have you handled the issue of many languages?

8. T I can’t understand what you are looking at. Unless you are looking at the youth corps members who are serving around here, even those who have, once you are here, you can understand Hausa very well. That is what I mean, and sometime, there are some terms that you don’t know their meaning in other languages but they are in Hausa. So what I do, if I eeee, what I do is that, I now bring somebody that can speak that language of that students to explain to the student who cannot understand the language I use. I want to give you an instance, there was a time I was teaching statistics. One of the girls said I don’t understand. The topic was eeeee, median. You know median is a number in the middle when you arrange set of numbers in either descending or ascending order. So I have to call one girl, I said please explain to this girl in your language what I am teaching. She now explained it to her, even me I didn’t understand what she was saying to the girl, but I saw the girl nodding her head. After that, I now asked her to explain it to me and she correctly explains it to me. I now asked her again to use another language to explain to other students, even me I don’t understand.

In the reflective interview language problems were most significant in the teaching and learning of Mathematics. This could be inferred from the words: **“language barrier”** uttered by teacher G as indicated in line 4 Stanza 11. G valued effective communication in the teaching and learning of Mathematics. Stanza 11 showed how the teacher made significant the use of mathematical code-switching. This is evident from the words of teacher G in lines 4-8 Stanza 11: **“I have to break the law, because sometimes a student, you see a student that is brilliant, but because of the language barrier, s/he cannot speak the English, they cannot ask question, they cannot even answer. That was what I do if I teach, sometimes I have to go down to their level, is not only Hausa, I even go down to the use of local dialect so that students can understand”.** The teacher assumed the identity of a person in authority. He took the initiative in dealing with the challenge of language in the Mathematics classroom, by switching from English to the students’ home languages to clarify concepts. The teacher found the use of home languages such as Hausa in complementing LoLT as vital. In the stanza 12 below teacher G gave more justification for switching to other home languages during teaching and learning.

Stanza 12

1. R Why do you break the law by using home languages in class?

2. T See the end justify the means. I am doing that for students to understand what I am teaching. So I just have to use that my method. That I am using Hausa or vernacular doesn't mean I will use Hausa throughout, no, I use English, but at that instance, I have to go down their level, so once they are able to understand me, I just go back again to use English. In fact, even eee, I have been saying this that even those people that have enact those laws, they have been using Hausa in their office and in their teaching. Go to their office, you will meet those speaking Hausa in their offices. Why are they saying that we should not use Hausa? I can use Hausa and English or any language to teach my students if they can understand me.

3. R You used these words: "do this assignment sharp, sharp or solved this problem sharp, sharp" in one of your lessons. What do you mean by 'sharp, sharp'?

4. T That word sharp, sharp, innaaaaaa, this is the type or one of the term we use when we speak Pidgin English. If I said sharp, sharp; then it means fast, immediately, let it be fast, that is **sharp, sharp.**

5. R It means that; you also make use of Pidgin English?

6. T Yes

7. R Why?

8. T I want to teach, some, some of the students there in my class, they can speak Pidgin English. Yes that is what I am doing. I want to also say something familiar to them. So, if I just say please clean this board with immediate effect and finish now, now, now. They will feel as if I bring these words from somewhere, but if I say sharp, sharp. They will clean it fast and say, so this maths that we do at home is what we are doing in the class. So I want to fill the gap.

9. R In one of the lessons you used the words: "WALLAHI I will not forgive you when I am marking". The word 'WALLAHI' is a Hausa or Arabic word?

10. T Is an Arabic word

11. R Ok an Arabic word, so why do you switch between the two languages?

12. T Generally, I said earlier, if you can observe, this '**WALLAHI**' I use the word that are locally spoken out there, that is what we speak. Most of these our Muslim friends use the

word when they want to show you that they are very serious; that is why I use the word 'WALLAHI'. Now observe my words, for example this test I gave them last week, once you make use of the word '**WALLAHI**', you are now preparing their mind to be serious.

13. R And I also observe when you are writing, is like you use both two hands, in writing, why do you do it that way?

14. T eeee, one I will tell you , one is, one is my nature of using both right and left in writing. And the second reason is that, some time I will write and this right hand will be tired and I have to change to use the left hand. And another reason is you know the class is congested, when I stand like this, I am writing, I hear students say 'sir you are blocking me'. I will take that advantage of using the other hand. These are the reasons why I use two hands in writing.

15. R Why do you think these language challenges are very important issues to be considered?

16. T It is very important because, you understand what I mean is not just about Mathematics that matters, this is even eeee toward our own communication. The most important thing in life is concepts, concepts. If I am communicating with you, so like, I want you to// the concept I have in me should be what you have, if not there is going to be misconception. If I just come and teach without the students understanding. What are they giving me here, if I just come and just teach this eeeee, this problem, bala, bala, bala. I will just be speaking English, like to me eeee, is not the **beauty** of the language that matters to me, but the **concepts** I have in me. How do I teach it to them, to me these issues should be addressed in every general way possible. Please I am just pleading; as far as I am concerned I will not stop using eeee, local languages to teach. That is why when I teach I will speak English and switch to local languages, if not my students will not understand.

Teacher G made significant the uses of languages such as Pidgin English, and Arabic in the teaching and learning of Mathematics. This is suggested from the use of words like **"sharp, sharp" and "WALLAHI".** This resembles the earlier talks in stanza 11 above where the teacher valued and made significant effective communication in the teaching and learning of Mathematics, by dealing with the challenges of language barriers. In stanza 12 lines 9-12 teacher G uttered the following words: **"WALLAHI I WILL NOT FORGIVE YOU"** to express or show his seriousness. The teacher assumed the identity of a person in authority. He took the initiative in dealing with the language challenge in the Mathematics classroom, by supplementing the use of English with both Pidgin English, and Arabic language. The text in the Stanzas above shows that, the teacher perceived the switching between languages such as Pidgin English, and Arabic language to supplement English as appropriate Discourse practice of a multilingual classroom.

8.3 Summary of Findings from Teachers' Reflective interviews

The teachers stressed the importance of using text books, and also the use of home language in multilingual Mathematics classrooms. The observed lessons and the reflective interviews were in English however, the teachers frequently code-switched between Arabic, English, Hausa, Pidgin English, and other home languages.

Some of the challenges in teaching Mathematics raised by teachers, at the SS2 level were (1) student's lack of foundations, (2) students having phobia about the subject. The teachers were worried and showed their concern on how to deal with these challenges and enable students to develop questioning, and investigative attitudes towards Mathematics. It is very clear that teachers face many challenges in their teaching. These challenges were directly related to Mathematics and languages in the schools. The teachers spoke of difficulties working with the diversities in student's background knowledge and ability. They did not have the time to deal with the poor foundations (background knowledge) of the students. In school B poor motivation was a serious factor which hindered better teaching and learning. The teachers justified some of the particular Discourse practices such as Mathematical reiterating, Mathematical symbolising and Mathematical explaining practice they used in coping with these challenges. Despite their different practices in the schools and classrooms, all the teachers spoke in different ways about increasing in teacher-student's interaction as a way of dealing with the problems and challenges.

One point of interest was the similarities in most teachers' descriptions of their lessons. There were differences on how whole-class interaction was structured during a given tasks. The teachers' understanding of the problems and challenges were linked to their school context plus their knowledge of teaching and learning

Mathematics. They all stressed foundations as a great challenge. They were confronted as well by students who were victims of Boko Haram terrorism and were experiencing trauma. The teachers faced the challenge of students having significant gaps in their requisite knowledge. These challenges had a major influence on the issues of the languages they had to use in their teaching. Nonetheless, language and non-language practices were the main focus of teachers' presentation of lessons and interviews. The findings from the views of the teachers are summarised below:

a. The four teachers expressed the view that teachers-student interaction was a good thing.
b. They all found that speaking in English only was not nearly sufficient. The teachers felt that Mathematical code-switching practice was vital.
c. This research has shed light on how teachers regard the use of Discourse practices such as Mathematical code-switching, Mathematical explaining, Mathematical reiterating and so on in the multilingual classrooms as a vital resource to harness.
d. The study has shown that the uses of the identified dominant Discourse practices are severely limited by the language policy.
e. This research has shown that teachers predominantly used English in teaching Mathematics in the classrooms. Occasionally teachers had to switch to home languages.

The empirical results show that all the Mathematics teachers have the same opinion on home language usage in the multilingual classrooms. However, they differed in how it was used during teaching and learning Mathematics.

The analysis suggests that the teachers view the use of text books in teaching Mathematics as a good practice. One teacher, G had an enormous work load. Students' Mathematics phobia was also a significant factor. They all constructed an identity of a responsible and authoritative teacher.

CHAPTER NINE: The implications of the dominant DP, Recommendations, Contributions, Limitations, and Conclusion

9.1 Introduction

In Chapters Six, Seven and Eight of this study, I have presented in detail the empirical results of the analysis of the two categories (language and non-language) Discourse practices identified in two schools of the teachers' multilingual Mathematics classrooms. I focused more fully on the dominant Discourse practices. This chapter aims to synthesise the implications of the dominant DP in the multilingual classrooms and propose some recommendations. In this chapter I also discuss the theoretical/methodological contributions of this study and the limitations of the framework. The motivation for the focus of this study as indicated in Chapter One was driven by the challenges teachers grapple with while teaching Mathematics in a language which students are struggling to understand (Adler, 2001; Essien, 2013; Moschkovich, 2007a; Setati & Barwell, 2006). The focus was further powered by the kinds of literature of other researchers on the teaching and learning of Mathematics in multilingual classrooms. The Gee (2005) Discourse analysis theory and method was used in this study to identify and explore the Discourse practices Mathematics teachers used in their use of verbal and non-verbal discussions with students in the multilingual Mathematics classrooms in northern Nigerian Secondary Schools. The empirical results have shown that while there is a range of Discourse practices some of the DP were meant to strengthen or support the dominant DP identified in the data.

The empirical results of this study have also established that the Mathematics teachers that I observed are not adequately prepared to teach in the multilingual classrooms. Hence the teachers might not be adequately qualified to confront the challenges. To fill this gap, code-switching was used by the teachers for the purpose of supporting communication of information. The Mathematics teachers acknowledged that the students needed to be helped in expressing their ideas in classrooms by using their home languages. I also observed that Mathematics teachers allowed students to code-switch in their classroom interaction to help them verbalise their thinking as the majority of them were not proficient in the LoLT.

It is not the intent of my study to evaluate the language policy in Nigeria, but this research has revealed some disconnection between the language policy in schools and the Nigerian language policy document. As earlier discussed in Chapter One of this study, none of the home languages in Nigeria (e.g. Hausa, Igbo and Yoruba) has been accepted as a unifying medium of instruction in schools (FME, 2012). The nation's language policy (FME, 2012) documents, and the 1999 amended constitution of Nigeria allow for the use of Hausa, Igbo and Yoruba languages with English at some official public functions. Accordingly, these three languages have been accorded national language status and are learned in the nation's schools, in addition to English (Akinnaso, 1993; FME, 2012). The home language in any region is the Language of Learning and Teaching (LoLT) in the first three years (that is lower Basic 1-3) of Nigerian primary schools, and during this period, the English language is also offered as a subject. In the fourth year, English replaces the home language as the LoLT. Students are also offered the choice of one home languages and one foreign language (FME, 2012) which they learn until their final year in Secondary School as summarised in Table 9.1 below.

Table 9.1:

Nigerian national language policy on education

Levels of classrooms in schools		LoLT	Elective
1	Lower Basic 1-3	Home language	English languages
2	Upper Basic 4-9	English language	One from (Hausa, Igbo and Yoruba languages). One from (Arabic, and French; languages)
3	Senior Secondary (SS) 1-3	English language	One from (Hausa, Igbo and Yoruba languages). One from (Arabic, and French languages)

Table 9.1 above illustrates the language policy disconnect which exists between lower Basic Education, and the Senior Secondary Education. According to the policy, the teachers are not allowed to use either the home languages (Hausa, Igbo and Yoruba) or the foreign languages (Arabic and French) in teaching and learning at Upper Basic 4-9 and Senior Secondary Education (SS) 1-3 classrooms. This was observed in the schools and classrooms during the conduct of this study.

All the four Mathematics teachers who participated in the conduct of this study used English throughout their teaching and learning. All the teachers explained to me during the reflective interviews that home languages were only used for some specific terms and concepts, not the whole lesson. The findings of this study suggest that, the Mathematics teachers placed the responsibility of the existing gap in the use of language in classrooms on the language policy and school managements. The Mathematics teachers did not commit themselves fully to the use of home languages because of the language policy at the Secondary Education level. The questions which really need to be answered are: (1) what roles do Mathematics teachers play in the implementation of language policy? (2) How can the language policy be implemented, if Mathematics teachers do not use it in their teaching?

The empirical result of this study has shown that the English language is dominantly used and well accepted in Secondary School Mathematics classrooms. At present, Mathematics teachers teach and demonstrate everything using the English language, all Mathematics textbooks used by the teachers are in English. The teachers write their lesson plans in English. The findings suggest that unless there is a modification in the language policy, the use of English in Secondary School Mathematics classrooms will continue, even though (in reality) teachers/students will code-switch to home languages at some point. Given the gap that exists between Lower Basic and Secondary Education levels, it follows that the implementation of the language policy needs to be modified.

9.2 The dominant DP in Secondary Schools Mathematics classrooms

Two categories of Discourse practices (language and non-language) commonly used in the Secondary Schools Mathematics classrooms were observed. (i) Language practices in this study refer to the use of verbal (oral) talks by teachers/students in a spoken discursive actions and interaction in a multilingual Mathematics classroom to make particular Discourse practices important or valuable. The term discursive in this study would refer to the whole process of shared social interactions between two or more individuals, which includes language (spoken) words (Chitera, 2009). In elaborating on the categories of language practices in this study, as identified from the data included Mathematical explaining, Mathematical exemplifying, Mathematical reiterating, Mathematical code-switching, Mathematical defining, Mathematical questioning, Mathematical proceduralising, and Mathematical re-voicing. (ii) The non-language practices refers to gestures, graphs, pictures, and equations, which represent different ideas, knowledge, and beliefs (Gee, 2005). They are Mathematical writing, Mathematical symbolising, and Mathematical Gesturing practice as characteristics from the collected data.

The analysis of Discourse practices as presented in Chapters Six, Seven and Eight in this study centered on the dominant DP such as Mathematical explaining, Mathematical reiterating, Mathematical exemplifying, Mathematical questioning, Mathematical defining, mathematical symbolising, Mathematical re-voicing Mathematical writing, Mathematical Gesturing and Mathematical proceduralising. Teachers' approach for the calculation in classrooms was similar to what Setati (2005a) explained Mathematical procedural Discourse practice is where the emphasis in teaching Mathematics is aimed at establishing the steps which should be taken to calculate certain Mathematical problems with no development of the concepts. This kind of Discourse practice would only introduce students to accept procedures. Even though solving Mathematics requires a knowledge of algorithms, this must be backed-up with a good deal of conceptual understanding so that students would know why and how the steps are undertaken in calculating problems.

The analysis of the data also featured dominant Discourse practices such as Mathematical reiterating, and Mathematical re-voicing as mentioned above. Reiterating mathematically was used by all the teachers to remind students or refresh the memories of some or the whole class to enable a better understanding of their current discussion. While Mathematical re-voicing practice was done in what has been said in a preceding tone as the basis for a shift in the interaction (Enyedy et al., 2008). One of the conclusions to be drawn from the data analysis of this study is that, re-voicing and/or reiterating mathematically reflected the challenge in the Mathematics classroom where teacher really struggle to teach students who themselves are also learning to read and write in English language.

To a large extent, the Discourse practices used by Mathematics teachers in the multilingual classrooms all showed limited student participation during lessons. It was obvious that the limited participation of the students in class was caused by the way and manner in which Mathematics teachers conducted the lessons in their various classrooms, by not really allowing the students to actively contribute their own ideas. For example, students were given instruction to limit answering questions to a “yes or no”. Consequently, I concur with the argument of Clarke et al. (2013) that, teachers especially those teaching in the Mathematics classrooms need to move beyond short and simple focusing Mathematical questioning which elicit choral answers. They should use the type of Mathematical questioning which combine both focusing and funneling to foster logical reasoning in students’ thinking and communicating in the Mathematics class. By so doing students could be helped to improve their Mathematical language communication skills. Students were also instructed to follow the procedures the teachers have given as a Mathematical exemplifying on the chalk board. The empirical results of this study also showed that there was a projection of the high status of the identity of the Mathematics teachers. Indeed there were instances that suggested a heavily an authoritarian identity by the Mathematics teachers. To that end, most classrooms were authoritative and controlled such that students were given clear directives to obey and follow the commands of the Mathematics teachers.

9.3 Recommendations

In the light of the emergent issues in this study, I will elaborate on recommendations to better the positions of the Secondary School Mathematics teachers in northern Nigeria. The implication of this study for the Secondary School Mathematics teachers and indeed the recommendation for the Nigerian Federal Ministry of

Education are the need to address the disconnect between the language policy in Lower Basic Education and the language policy in the Secondary School Education programmes. I strongly suggest that the development of a course on methods of teaching language and Mathematics in our tertiary institutions of education together with in-service training/workshops for the Mathematics teachers could be of help. As discussed in the previous chapters of this study, a language policy which allows the use of home languages in schools would give Mathematics teachers in classrooms more flexibility to enhance students' understanding. The flexibility of the language policy could also help improve the quality of classroom interactions between teachers and students. As shown in this study, Mathematics teachers were not supposed to code-switch in their classrooms because the language policy did not permit this.

In the Nigerian context, many courses have been developed and are currently taught in the teachers' training colleges and Universities on teaching and learning methods, classroom management, lessons plan, schemes, and records of work and so on. Little or nothing has been done in the areas of language and Mathematics teaching, which is one of the very important areas to be considered, particularly now that most classrooms have students with diverse language backgrounds. To reiterate, I strongly recommend that a course of study be introduced in the teacher training programmes of colleges of education and faculties of education in our Universities. This is now the practice in other institutions of higher learning such as the University of the Witwatersrand in the Republic of South Africa, Nigeria could borrow this. The purpose of developing the language and Mathematics course should be for the teachers' appreciation and understanding of the language issues and the challenges which might arise in the multilingual Mathematics classrooms. Concepts or topics to be covered would include the challenges Mathematics teachers encounter during teaching, language awareness and the language of Mathematics. In so doing, Mathematics teachers might be encouraged to examine their own language challenges as a way of understanding how best to teach multilingual classes.

The empirical results of this study show that Mathematics teachers know some of the problems and challenges in multilingual Mathematics classrooms. The findings also show that Mathematics teachers are not well prepared with strategies to help the students in the multilingual classrooms. Workshops and in-service training for the Mathematics teachers would be of inestimable help. This training would enrich the teachers. They would be able to make enlightened decisions and then adopt the appropriate teaching possibilities for students in multilingual classrooms.

9.4 Direction for further study

I suggest there should be more research on teachers' Discourse practices and teacher education programmes on language and Mathematics in order to get more insight into the findings in this study. It is necessary to conduct such a study to initiate policy action from the empirical shreds of evidence. This research has shed light on how Mathematics teachers regard the use of Discourse practices such as Mathematical code-switching in the multilingual classrooms as way of solution to the challenge of language use in the multilingual classrooms instead of a resource to harness. The study has also shown that the uses of the identified Discourse practices in the multilingual Mathematics classrooms are limited by the language policy.

A study with pre-service teachers is also necessary. The focus of the study would be to uncover the views of the pre-service teachers about language and Mathematics which they have studied in colleges of education and Universities. The study would permit the research to find out the recommendations given by the pre-service teachers as to what should be done in the colleges of education and Universities that would assist them for productive teaching in the multilingual Mathematics classrooms.

Finally, this research has shown that teachers predominantly used English in teaching Mathematics in the multilingual classrooms. But occasionally teachers switch to home languages. It would be exciting to examine further as to what happens to the Discourse practices in Mathematics classrooms when teachers use home languages.

9.5 Theoretical/Methodological Contributions, Limitations and Conclusion

Secondary School teachers' Mathematics classroom observed with the lens of Gee's Discourse analysis theory and method enabled me to examine and understand the challenges of teachers. The Discourse practice main categories (language and non-language) enabled me to identify and understand what kinds of Discourse practices existed in these multilingual Mathematics classrooms. This confirmed the studies (Ogundele et al., 2014; Oluwole, 2008; WAEC, 2011, 2012, 2014) conducted over the years regarding students who are not proficient in the LoLT in Nigeria.

These challenges faced by Mathematics teachers in teaching students who themselves are grappling to understand the LoLT was the source of inspiration to conduct this study. As discussed in Chapter One of this study that there was limited literature in the Nigerian context on the detailed descriptions and analysis of the language challenges that existed in multilingual Mathematics classroom (Jegede, 2011). Let me give a brief recap. Of the one hundred and twenty three articles published in ABACUS, the leading journal in Mathematics education in Nigeria and the journals of the Mathematics education panel, published by the science teachers association of Nigeria from 2005 to 2014, only three articles focused on the language problems in multilingual Mathematics classrooms. These three articles (Akinoso, 2014; Kolawole & Oginni, 2010; Odetula & Salman, 2014) focused on the southern part of Nigeria and none focused on the north. The dearth of previous studies of the language challenges that existed in multilingual Mathematics classrooms in the northern Nigerian context suggested that it was crucial to conduct a study of the practices that were possibly used by teachers in multilingual Mathematics classrooms.

This study focused specifically on the dominant Discourse practices of Mathematics teachers in multilingual classrooms of Secondary Schools. The main purpose of this study was to understand teachers' Discourse practices used in multilingual Mathematics classrooms in northern Nigeria Secondary Schools. One method to deal with this challenge as discussed included an exploration of how teachers' Discourse practices were used in the context of teaching Mathematics where students were multilingual and still learning in the LoLT. The main research question is: What Discourse practices were used by teachers as plainly evinced in their language (verbal and non-verbal) in northern Nigeria multilingual Mathematics classrooms? To answer this research question, I used these sub-questions:

a. How do teachers use language (verbal and non-verbal) to enact practices as reflected in their Discourses in the teaching and learning of Mathematics in multilingual class-rooms in northern Nigeria?
b. Why do teachers use language (verbal and non-verbal) in their Discourse practices in multilingual Mathematics classrooms of northern Nigeria?

Together, these research questions enabled me to see the pattern of actions and interactions of the use of language and non-language symbols in teachers' Discourse practices in northern Nigerian multilingual classrooms. The questions also enabled me understand why and how teachers did what they did and exhibited their identities as reflected in their particular Discourse practices during teaching and learning of Mathematics in a multilingual classroom. This study explored these questions from the notion of Discourse as expounded by Gee (2005).

I modified and adapted 15 analysis questions out of the 26 questions proposed by Gee (2005, pp. 110-113) based on the context and the focus of my study to gain insight on the emerging themes in the data. The empirical results from the study and their implications for Mathematics teachers' Discourse practices in the Nigerian context was discussed in Chapters Six, Seven, Eight and the previous sections of this chapter. I needed to focus more fully on the weakness (limitations) and the strength of this study, as well as the methodological and theoretical perspective developed and applied. The methodological and theoretical perspective is an empirical and original contribution of this study for use in conducting further studies.

In developing the analytical framework for this study, I, therefore, divided the main construct from Gee's theory [Discourse practices (DP)] into two categories namely language practices (verbal) and non-language practices (non-verbal) as shown in

Figure 9.1 below. These categories represent teachers' verbal and non-verbal talks during interaction with students.

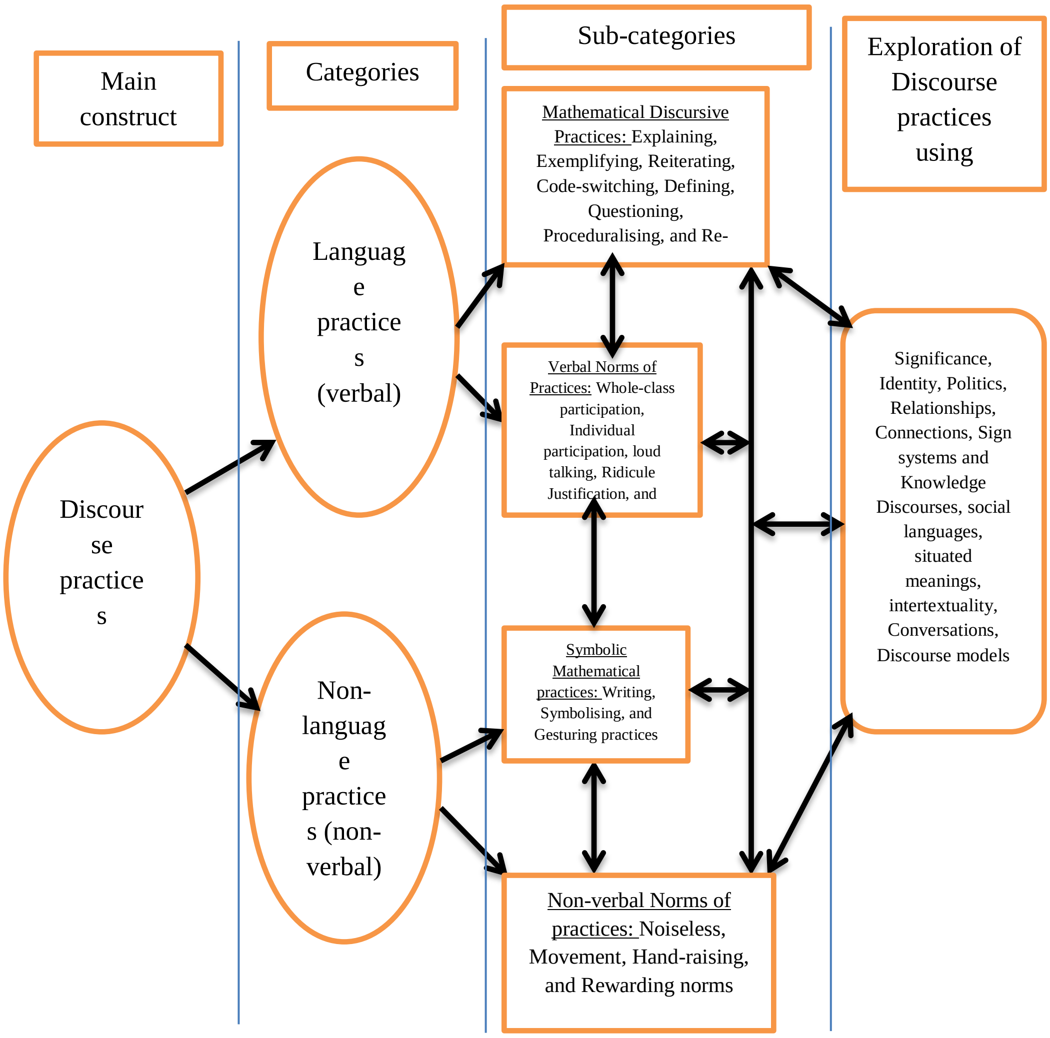


Figure 9.1: A Framework for identification and exploration of Discourse practices

The diagram above shows the global view of the analytical framework in this study with the categories and sub-categories from Gee's Discourse analysis perspective, collected data and the kinds of literature reviewed in Chapter Two of this study. The lines and arrows on the diagram indicate the flow of directions and interlinking of the analysis process.

In the attempted framework above, I developed codes, code indicators and their examples for all the sub-categories. I looked through the unique language and non-lingusitic characteristics of the codes based on their indicators. It was important for me at this stage to constantly refine these sub-categories as I continually moved back and forth between the codes to set clear boundaries between them. The analytical framework as elaborated above identified and explored Discourse practices during teachers'/students' actions and interactions in the multilingual Mathematics classrooms. The framework was developed to comprehensively capture all the characteristics of the two categories of DP which all stem from Gee's theoretical perspective. I used codes for each of the sub-categories and indicators on how to identify each code. The analytical tasks for language and non-language practices categories explored and explained the different Discourse practices.

In using the methodological perspective to analyse the collected data for this study, the challenge I had was the analysis of each category (language and non-language) of the Discourse practices as distinct units. In order to have an in-depth analysis, I followed the pattern of actions and interactions of each Mathematics teacher during the class discussion and simultaneously explored their dominant Discourse practices. For instance, the differences between their Mathematics teachers' classrooms became explicit during the exploration of the pattern of actions and interactions of each teacher's lessons, and not during the identification of the Discourse practices. Mathematical exemplifying as a Discourse practice in one class of this study dealt more with pre-planned illustrations of a concept or an idea, while in another class; it was more emphasis on solving a mathematical problem, using spontaneous examples so that students could gain knowledge and applied that in similar examples. In these instances as above, the Discourse practices were all shaped by the pattern of actions and interactions of the Mathematics teachers' uses of the two categories (language and non-language). Both language and non-language practices categories analysed in this study enabled me to identify and explore in depth the dominant Discourse practices.

As noted in the previous chapters, Gee's theory is a sociocultural and sociolinguistic theory, hence the difficulty in my using Gee's theory as both theoretical and analytical framework was to develop an analytical framework that could capture all the categories and sub-categories of Discourse practices in multilingual Mathematics classrooms. Gee's Discourse analysis perspective was limited in terms of providing all the necessary tools for gaining an entry into the multilingual Mathematics classrooms. The theoretical contribution this study has made lies in the extension of Gee's theory to include Discourse practices in multilingual Mathematics classrooms of the Nigerian context. To fill these gaps and overcome the challenges, I drew on some concepts from the kinds of literature reviewed (Chapter Two) relating to Discourse practices in the multilingual Mathematics classrooms, and then using Gee's Discourse analysis perspective in this study, to attempt the development of a methodological approach which would meaningfully capture the Discourse practices in the multilingual Mathematics classrooms of this study.

Although both the theoretical and methodological perspective as discussed was a good starting point for considering the use of language and non-language practices by teachers during Discourses in multilingual Mathematics classrooms, this perspective however, had limitation. The limitation lay in the distinctive nature and the context of this study. The study was conducted in two Senior Secondary Schools, involving four Mathematics teachers with particular focus only on the multilingual classrooms. It is important to extend further research using Discourse analysis, to more classrooms and teachers.

It is important to conclude this chapter with a retrospective reflection on the journey which led to my choice of Gee's theory because it was not subconsciously selected. My journey to select a theoretical and methodological framework as lens did not start with Gee's theory. The initial idea for my study was on exploration of the challenges Mathematics teachers faced while code-switching between the LoLT and the home languages in multilingual classrooms. My aim was to find solutions, to find answers and then recommend what could improve the situation. I used a deductive approach i.e., a grounded theory as my theoretical framework. In a very short time I became fully aware that my study is not about the development of a new theory. I needed to explore the Discourse practices teachers used in their multilingual Mathematics classrooms while teaching students who were also learning to understand the LoLT. I soon change my theoretical framework to the socio-cultural theory of Vygotsky (1978), and the social practice theory of Lave and Wenger (1991). I used these to provide the theoretical lens to examine the topic. I quickly realised that my work was not about learning in a community of practice as advocated in Lave and Wenger (1991), neither is it about the use of language in cognitive development as emphasised by Vygotsky (1978). At the time for the submission of my PhD proposal for external examination, I had change to an Onto-Semiotic Approach (OSA) which is classified under the socio-cultural constructivist philosophy (Godino, Batanero, & Font, 2007). Drawing on the OSA theoretical framework, was to provide the theoretical lens for examining Mathematics teachers' discursive practices in multilingual Mathematics classrooms (Godino et al., 2007). My reason for drawing on OSA was that, the framework focused primarily on practices relating to how language and other semiotic devices are used in the negotiation of mathematical meaning in the classrooms, and how social interactions between teachers/students influence cognitive development. After the release of my external examination report it became clear that I needed a better and more robust theoretical and analytical framework to identify and explore teachers' discourses in multilingual Mathematics classrooms. I finally selected Gee's Discourse analysis Theory and method (Gee, 2005) as a lens to frame my work. My reason for doing that, as noted in the previous Chapters, is because this study ssought to explore, identify, and understand what Discourses exist in the multilingual Mathematics classrooms, as well as why and how they are used by teachers. Hence the need to look for a theory that would help me understand teachers' Discourse practices. Discourse practices in this research refers to regular ways of using language, other symbolic expressions, and objects of thinking, feeling, believing, valuing and acting in the Mathematics classrooms either by a teacher or shared by teacher and students in their activities (Gee, 2005). Thus the selected theory should enable the analysis of not only written or verbal talk, but also non-language symbols and other objects of thinking used by teachers and students in their practices within the Mathematics classrooms. The theoretical perspective should be able to help me categorise different topics or themes that emerged from the data. From the foregoing that I needed to explore teachers' talk and actions and to identify the Discourse practices that are used by the teachers and consequently understand why and how they used them in teaching and learning of Mathematics, for me this implied an approach from a Discourse perspective. Gee's Discourse analysis: Theory and method (Gee, 2005) was used to analyse teachers' Discourse practices within the Mathematics classroom. In these entire searches for a suitable framework, it has had corresponding changes to the focus of my research work.

In conclusion, this study has contributed personally to my professional development regarding how I would approach my teaching and research work. As a Mathematics educator, I have the privilege of developing and helping both pre and in-service teachers who are teaching Secondary School students. The Discourse practices (mathematical explaining, mathematical code-switching practice etc.) identified in this study will have an impact. I will direct my attention to this in the training of pre service teachers as well as those teachers who have already qualified and are toiling on the front line.

APPENDIX A: Examples of interview (semi-structured) questions

Teachers' use of language (verbal and non-verbal) in their teaching in Schools/classrooms

1 What are the challenges for teaching Mathematics at SS2 in your school?

2 Why are these challenges most important and how?

3 Can you exemplify or illustrate these points?

5 What is it in the language that is a problem?

6 How have you been trying to overcome these challenges?

7 What Discourse practices have you use to handle these language challenges?

8 Why do you think giving them assignment will overcome the challenges?

9 During your lesson presentation you said 3 will go into??? Why?

10 When you encounter problems in class, do you share with other teachers?

11 Do you think using local language will help?

12 What, for you are the problems of teaching Mathematics at SS2?

13 What do you find to be language related issues that arise in your teaching?

14 Why do you use the phrase sharp, sharp?

15 What about the use of the Arabic word 'WALLAHI'?

16 Do these issues described above by you deserve attention?

17. Can you remember a classroom episode which illustrates the issue of using home language, so that the students can be able to understand?

18. You mentioned mathematical language, what do mean by that?

19. Are saying when you don't use a mixture of the two, the students will not understand?

20. Why do you always sketch?

21. Can you itemise some of the rules and regulating's in your class?

APPENDIX B: Ethics clearance, letters, and consent forms

Wits School of Education

UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

27 St Andrews Road, Parktown, Johannesburg, 2193 Private Bag 3, Wits 2050, South Africa. Tel: +27 11 717-3064 Fax: +27 11 717-3100 E-mail: enquiries@educ.wits.ac.za Website: www.wits.ac.za

11 December 2015

Protocol Number: 2015ECE019D

Student number: 1106415

Dear Alexander Michael

Application for ethics clearance: Doctor of Philosophy

Thank you very much for your ethics application. The Ethics Committee in Education of the Faculty of Humanities, acting on behalf of the Senate, has considered your application for ethics clearance for your proposal entitled:

Discursive practices in multilingual mathematics classroom in Nigerian secondary schools

The committee recently met and I am pleased to inform you that clearance was granted.

Please use the above protocol number in all correspondence to the relevant research parties (schools, parents, learners etc.) and include it in your research report or project on the title page.

The Protocol Number above should be submitted to the Graduate Studies in Education Committee upon submission of your final research report.

All the best with your research project.

Yours sincerely,

MMabeta

Wits School of Education

011 717-3416

Cc Supervisor: Dr Anthony Essien and Dr Patrick Barmby

PERMISSION FROM POST PRIMARY SCHOOLS MANAGEMENT BOARD

University of the Witwatersrand, Private Bag 3, WITS 2050, Johannesburg

Tel: (011) 717-3086

E-mail: alexmichael73@gmail.com

Cell phone: +27834371100

1 September, 2015.

The Executive Chair,

Taraba State Post Primary Schools

Management Board, Jalingo

Dear Sir/Madam,

My name is Alexander Michael. I am a PhD Student in the School of Education at the University of the Witwatersrand, Johannesburg, South Africa.

I am doing research on Discourse practices in multilingual mathematics classrooms in Nigerian secondary schools, and would like to invite secondary schools to participate in this study.

Data collection for my study will be in two phases; in the first phase, two mathematics teachers, one each from two schools of the study area, will be involved in teaching students in SSS2 classrooms. The second phase will have six participants. There will be an interview for a maximum of 15 minutes or less to select mathematics teachers willing to participate in the study, and signing of the written consent to participate in the study from each mathematics teacher. It will involve observing teachers in SSS2 classrooms, thus written consent from each of the students and parents of those students that are below 18 years of age will also be needed. The condition for a student's participation in the study is voluntary and subject to signing the consent letter. Those that do not sign the consent letter will be excluded systematically from the video and audio recordings process. The video and audio recordings are for the purpose of data analysis, and the processed data will be for academic teaching and conference purposes only. I will give feedback at the end of my study to all participants.

The teaching presentation will be video and audio tape recorded from the beginning to the end of each lesson. Observation for each of the participants will be for a period of five different lesson presentations. These lessons will be part of the normal school timetable. There will be no extraordinary planning of lessons, and the videoed lessons will be part of the normal teaching programmes of the participating schools. There is also going to be a semi structured in-depth interview with each of the participants.

The reason why I have chosen your schools is because of the location in the state capital. It will provide a good place to study multilingualism in the mathematics classroom and your schools has experienced teachers. I am inviting your schools to participate in this research because it will benefit the schools and teachers, so that most problems associated with teachers' discursive practices in a multilingual mathematics classroom will be identified and the study will give suggestions for a new approach. The research participants will not be advantaged or disadvantaged in any way. They will be reassured that they can withdraw their permission to participate at any time during this project without any penalty. There are no foreseeable risks in participating in this study. The participants will not be paid for this study. The names of the research participants and identity of the schools will be kept confidential at all times and in all academic writing about the study. Your individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-4 years after the completion of the project.

Please let me know if you require any further information. I look forward to your response as soon as is convenient.

Yours sincerely,

Alexander Michael.

School consent to collect data in SS2 classes for a PhD research

Following your letter requesting to collect data in SS2 classes for your PhD research, I the Principal of the above school, hereby grant you permission to collect data within the school. Your letter indicated the focus of your research on teachers' Discourse practices in multilingual Mathematics classrooms. Based on your letter, I have also given permission to the following:

- To conduct a semi-structured interview with the Mathematics teachers.
- To video-record the Mathematics teachers as they teach during their normal period on the school timetable as agreed-upon between you and the teachers involved.
- You are free to collect some lesson notes/plans from the teachers if it could be of help to gain better understanding into how multilingualism is attended to by the teachers in the Mathematics classrooms.
- You are also permitted to use the data for publications and other research purposes such as conference presentations and seminars.

Yours sincerely,

Signature: …………………………..Date…………………………

Permission from the Principal

My name is MICHAEL Alexander. I am a PhD Student in the School of Education at the University of the Witwatersrand, Johannesburg, South Africa.

I am doing research on Discourse practices in multilingual Mathematics classroom in Nigerian secondary schools and would like to invite your school to participate in this study.

The first phase will focus on classroom observations of six teachers. The duration of each lesson will depend on school timings. These lessons will be part of the normal school timetable. The uses of the video recordings are important in order to capture exactly and accurately the Mathematics teachers' Discourse practices in multilingual classrooms.

In the second phase of data collection, I anticipate working with the same six Mathematics teachers. This phase will focus specifically on important practice emerging from the first phase of the study. There will be a semi structured in-depth interview with each of the six teachers. The interview with each teacher will be for a maximum of 30 minutes. The condition for a student's participation in the study is voluntary and subject to signing the consent letter. Those that do not sign the consent letter will be excluded systematically from the video and audio recordings process. The video and audio recordings are for the purpose of data analysis, and the processed data will be for academic teaching and conference purposes only. I will give feedback at the end of my study to all participants.

The teaching presentation will be video and audio tape recorded from the beginning to the end of each lesson. Observation of each of the participants will be for a period of five different lesson presentations. These lessons will be in the normal school timetable. There will be no extraordinary planning of lessons, and the videoed lessons will be part of the normal teaching programmes of the participants in your school. There is going to be a semi structured in-depth interview with each of the participants.

The reason why I have chosen your school is because of the location in the state capital. It will provide a good place to study multilingualism in the Mathematics classroom and your school has experienced teachers.

I am inviting your school to participate in this research because it will benefit the school and teachers, so that problems associated with Discourse practices in multilingual Mathematics classrooms can be identified and we can give suggestions for a new approach.

The research participants will not be disadvantaged in any way. They will be reassured that they can withdraw their permission at any time during this project without any penalty. There are no foreseeable risks in participating in this study. The participants will not be paid for this study.

The names of the research participants and the identity of the school will be kept confidential at all times and in all academic writing about the study. Your individual privacy will be maintained in all published and written data resulting from the study.

All research data will be destroyed between 3-4 years after completion of the project.

Please let me know if you require any further information. I look forward to your response as soon as is convenient.

Yours sincerely,

Alexander Michael

Email: alexmichael73@gmail.com

Cellphones: +27834371100, +2347060971090

LETTER OF CONSENT: STUDENT PARTICIPATION

My name is MICHAEL Alexander. I am a PhD Student in the School of Education at the University of the Witwatersrand, Johannesburg, South Africa.

I am carrying out research on teachers' Discourse practices in multilingual Mathematics classroom in Nigerian secondary schools

My investigations involve a written consent to participate in the study from each student and the parents of those students that are in SSS2. The condition for a student's participation in the study is voluntary and subject to signing the consent letter. It is my responsibility to give feedback at the end of my study to all participants. I will observe teachers' Discourse practices n multilingual Mathematics classrooms. The teaching process will be video and audio recorded from the beginning to the end of each lesson.

I am asking whether you will mind participating during classroom observation which will be videotaped? Remember, this is not a test, it is not for marks and it is voluntary, which means that you don't have to do it. Also, if you decide halfway through that you would prefer to stop, this is completely your choice and will not affect you negatively in any way.

I will not be using your real name in my research, but I will make one up so that no one can identify you. All information about you will be kept confidential in all my writing about the study. I plan to store the data in a password protected hard drive and locked away in a locker at my office in Wits School of Education and will be destroyed between 3-5 years after I have completed my project.

Your parents have also been given an information sheet and consent form, but at the end of the day, it is your decision to join us in the study.

I look forward to working with you

Please feel free to contact me if you have any questions.

Thank you

Alexander Michael

Email: alexmichael73@gmail.com

Cellphones: +27834371100, +2347060971090

Student Consent Form

Please fill in the reply slip below if you agree to participate in my study called: Discourse practices in multilingual Mathematics classroom in Nigerian secondary schools

My name is: ________________________

Circle one

Permission to observe you in class

I agree to be observed in class. YES/NO

Permission to be videotaped

I agree to be videotaped in class. YES/NO

I know that the videotapes will be used for this project only YES/NO

Informed Consent

I understand that: My name and information will be kept confidential and safe and that my name and the name of my school will not be revealed. I do not have to answer every question and can withdraw from the study at any time. I can ask not to be audiotaped, and/or videotaped. All the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_____________________________Date___________________________

LETTER OF CONSENT: INFORMATION TO PARENTS

My name is MICHAEL Alexander. I am a PhD Student in the School of Education at the University of the Witwatersrand Johannesburg, South Africa. I am doing research on teacher's Discourse practices in multilingual Mathematics classroom in Nigerian secondary schools.

My research will involve observing teachers in classrooms. Therefore written consent from the parents of each student that are below 18 years of age is requested. The condition for a student's participation in the study is voluntary and subject to signing the consent letter. It is my responsibility to give feedback at the end of my study to all participants. I will observe teachers' Discourse practices in multilingual Mathematics classrooms. The teaching presentations will be video and audio recorded from the beginning to the end of each lesson. The reason why I have chosen your child's class is because my study will be conducted in second year senior secondary schools (SSS2) multilingual classrooms. I was wondering whether you would mind if your child or children is/are observed, audio and videotape recorded during Mathematics lessons. Your child will not be disadvantaged in any way. S/he will be reassured that s/he can withdraw her/his permission at any time during this project without any penalty. There are no foreseeable risks in participating and your child will not be paid for this study. Your child's name and identity will be kept confidential at all times and in all academic writing about the study. His/her individual privacy will be maintained in all published and written data resulting from the study. I plan to store the data in a password protected hard drive and locked away in a cupboard at my office in Wits School of Education
All research data will be destroyed between 3-5 years after completion of the project.
Please let me know if you require any further information.
Thank you very much for your help.
Yours sincerely,
Alexander Michael Email: alexmichael73@gmail.com Cellphones:+2347060971090

PARENT'S CONSENT FORM

Please fill in and return the reply slip below indicating your willingness to allow your child to participate in the research project called: Discourse practices in multilingual Mathematics classroom in Nigerian secondary schools

I, ________________________ the parent of ______________________

Circle one

Permission to observe my child in class

I agree that my child may be observed in class. YES/NO

Permission to be videotaped

I agree my child may be videotaped in class. YES/NO

I know that the videotapes will be used for this project only. YES/NO

Informed Consent

I understand that:

- My child's name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- He/she does not have to answer every question and can withdraw from the study at any time.
- he/she can ask not to be audiotaped, and/or videotape
- All the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_____________________________ Date___________________________

LETTER OF CONSENT: TEACHERS PARTICIPATION

My name is MICHAEL Alexander. I am a PhD Student in the School of Education at the University of the Witwatersrand, Johannesburg, South Africa.

I am doing research on Discourse practices in multilingual Mathematics classrooms in Nigerian secondary schools. My data collection will involve a pre-interview for the selection of Mathematics teachers willing to participate in the study. A written consent to participate in the study from each Mathematics teacher will be needed. It is my responsibility to give feedback at the end of my study to all participants.

There will be classroom observations of teachers' Discourse practices in the multilingual Mathematics classrooms. The teaching presentations will be video and audio tape recorded from the beginning to the end of each lesson. Observation for each of the participants will be for a period of five different lesson presentations. These lessons will be on the normal school timetable. There will be no extraordinary planning of lessons, and the videoed lessons will be part of the normal teaching programme of the participating schools. There is going to be a semi structured in-depth interview with each of the participant teachers. Issues arising from the classroom observations will form part of the interview questions.

The reason why I have chosen your school is because of the location in the state capital. It will provide a good place to research multilingualism in the Mathematics classroom and experienced teachers are in your school.

I was wondering whether you would mind participating in the research?

Your real name and identity will be kept confidential at all times and in all academic writing about the study. Your individual privacy will be maintained in all published and written data resulting from the study. I plan to store the data in a password protected hard drive and locked away in a cupboard at my office in Wits School of Education.

All research data will be destroyed between 3-5 years after completion of the project. You will not be advantaged or disadvantaged in any way. Your participation is voluntary, so you can withdraw your permission at any time during this project without any penalty. There are no foreseeable risks in participating and you will not be paid for this study.

Please let me know if you require any further information.

Thank you very much for your help.

Yours sincerely,

Alexander Michael

Email: alexmichael73@gmail.com

Cellphones: +2347060971090

TEACHER'S CONSENT FORM

Please fill in and return the reply slip below indicating your willingness to be a participant in my voluntary research project called: Discourse practices in multilingual Mathematics classroom in Nigerian secondary schools

I, ________________________ give my consent for the following:

Circle one

Permission to observe you in class

I agree to be observed in class. YES/NO

Permission to be audiotaped

I agree to be audiotaped during the interview or observation lesson YES/NO

I know that the audiotapes will be used for this project only YES/NO

Permission to be interviewed

I would like to be interviewed for this study. YES/NO

I know that I can stop the interview at any time and don't have to answer all the questions asked. YES/NO

Permission to be videotaped

I agree to be videotaped in class. YES/NO

I know that the videotapes will be used for this project only.YES/NO

Informed Consent

I understand that:

- My name and information will be kept confidential and safe and that my name and the name of my school will not be revealed.
- I do not have to answer every question and can withdraw from the study at any time.
- I can ask not to be audiotaped, and/or videotape
- All the data collected during this study will be destroyed within 3-5 years after completion of my project.

Sign_____________________________Date___________________________

APPENDIX C: Adjusted Timeline for the Study

Adjusted timeline for my PhD research work

Year	Period	Proposed Research activities
2015	March-April	Literature study and developing ideas
	May	Initial idea presentation
	May-September	Research proposal writing
	October	Formal presentation and submission of research proposal
	November-December	Ethics clearance from the University
2016	January-April	Correction and re-submission of research proposal
	May-June	Negotiating access to research sites, and Pre-data collection interviews
	July-December	Data collections for pilot study, and Refining the instruments for the data collections
2017	January-May	Data transcription/analysis for pilot study and presentation, Theoretical framing
	May-October	Theoretical/Methodological framework
2017-2018	November 2017-February, 2018	Further collection of Data (lessons observations and face to face reflective teachers' interviews), Data Transcription, coding and Paper presentation of preliminary findings at SAARMSTE conference of January, 2018
2018	March-August,	Data analysis, presentation of findings at PhD research degree weekend and Writing chapters of my thesis
	September-December, 2018	Writing chapters, and Submission of the first draft of my PhD thesis to supervisors
2019	January-March	Correction, editing and submission of thesis for examination.

APPENDIX D: Examples of the lessons observed

Teacher E (17/01/2018)

1. Ss Good morning Aunty
2. T Good morning students//. And sit down//. Our topic for today is trigonometry//. Let’s start from calculating the angles or sides of right angle triangles//. Supposed you are given angle A or Angle B or Angle C..,// Is left for you to know//, if is the angle …// (…). Assuming you have…//(…) a triangle like this// (Teacher gesturing and sketching on the board). And you are given eeee an angle//. Let’s say Ɵ//. And you are given emmu, value here//. Let’s say you are given emmum, 4 here//. And here you are given 3// (Teacher writing the values on the sketch). You are asked to find the hypotenuse//. Normally for you to know the side where the hypotenuse is//. In a lay man’s way the longer side//. Or the side facing the right angle//. The side facing the right angle is what?// The hypotenuse// (Teacher pointing to the side of the triangle on the board). While the side facing the angle//. Is call what?// The opposite//. When you are asked to find eeh…// (…) (Teacher erasing and writing the value of the angle on the sketch). Let’s clean and have a value//. So that we don’t have two unknown//. So when you are given//. And you are asked to find the hypotenuse?// You know what to use by what?// Means of a SOHCAHTOA//. You now look at the side given to you//. What and what the properties given to you//. What and what do you have?// (…) See// you are sleeping so early// (Teacher pointing to a student). Yes…// So you look at the side given to you//. (Teacher pointing to the sketch on the board)//. You have emmum, the opposite//. Which is…//, so Sin 30 will give us//. The opposite is 4//. While the hypotenuse is x//. And you want to get the value of the hypotenuse//. So you can get Sin//. By the means of your four figure table or your calculator//.You check the value of Sin 30//. You get the value of Sin 30// (Teacher gesturing with her fingers). Just to touch your brain small//. But to, today we are going to Pythagoras theorem//. So can we start with Pythagoras theorem?// A Pythagoras theorem is not a new topic//. We started it from your JSS classes// (Teacher gesturing). Imum?// Pythagoras theorem//. So who will tell me the rule of

Pythagoras theorem?// Pythagoras theorem says what?// Is a scientist//(Teacher gesturing and moving). The Pythagoras is somebody//. Is like they say Esther's rule//. Is a scientist that came up with a rule//. So who will tell me what Pythagoras said?// (Teacher cleaning the board and drawing a sketch). Pythagoras theorem says// (…), a sum of the square of the two sides is equal to the square of the hypotenuse//.We have this//. This is the hypotenuse// (Teacher pointing to the sketch). We have…//, I said we are going to build on what you know already// Imum?// There is nothing new//. Just to add to what you know//. We have…//, this is the hypotenuse//. We said the square of the two other sides// (…) (Teacher writing and pointing to the sketch). $a^2 + b^2$ will give us c^2//. I hope you have remember?…//

3. Ss Yes//

4. T You have remember//. Is a letter//. So if we have …//. Let me give an instance//. We have here to be 3cm//. And we have 4cm and you are asked to find the hypotenuse (Teacher sketching another triangle on the board). They are A, B, C//. So from Pythagoras rule// (Teacher writing on the board). We said x^2i.e. the square of the hypotenuse is equal to x^2//.we have… emm 3^2+ 4^2//.So 3^2 Will give us what?// 3^2Means 3 times 3// 3 times 3 will give us?//

5. Ss 9

6. T 9 Plus

7. Ss 16

8. T 16//. So 9 +16 will give us what?//

9. Ss 25

10. T 25//. So we havex^2=25//. That means…//, but what we want is x//. The value of the hypotenuse//. Not x^2, what do you do?// We get the square root//. The square root of 25//. So we have x… //, will give us the square root of 25 is what?//

11. Ss 5

12. T That means when you square the two…// (Teacher pointing to the sketch on the board). The sum of the squares of the two other sides will give you the value of…?// Will give you the square of 25 (Teacher pointing to the sketch and gesturing). The previous number//. So the rule of Pythagoras

theorem is//. When you have…//. And another way is when you take the square, you have…//. Now you want to prove it//. Here you have emmm…//. (Teacher sketching a triangle with square boxes on each side on the board)// Here we have three//. That means the square of three//. Imum?// The square of 3 we have// (…). And here you have four//. You have four, four into four places// (…). And here you have five//. Five, five into five places// (…). So when you count these boxes//. Here you have four//. Here you have three//. Here you have five//. So the five the square here will give you 25//. That means when you count this plus this should give you this// (Teacher pointing and showing students the sketch)// So here when we count//. We have what here?// We have nine, 1, 2, 3, 4, 5, 6, 7, 8, 9// (Teacher counting the sketched square boxes on the board). Here we have 16, 10//. This is 9// (Teacher counting the sketched square boxes on the board)// 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25//. Yes//.So when you count this//. You will get 25//. That means the rule is saying when you square 3 will give you 9//. Plus if you square 16 should give you the value of the hypotenuse//. That is it, I rest my case//. Did I recall your brain?, so now we take proper examples. Now open your book1to page, page 143, now let's see this one, is a WAEC question (teacher writing an example on the board as her cell rang and distracted the class. She then answered the call outside the class using Hausa, one of the home languages). So now let us look at this one, sorry. Now they said, the sides of a rhombus are 17cm long, if one diagonal is 30cm long what is the length of the other diagonal (teacher read the written question aloud) now here is the rhombus (teacher sketching a rhombus on the board). 17cm this is one diagonal, this is another diagonal imum? The diagonal is the line that divides the shape into two parts. So one side is 17, and one of the diagonal is 30. So this is, so let give it a name A, B, C, D. so line BD is 30cm, so if it is 30cm and is divided into two equal parts what cm do we have?

13. Ss 15

14. T so this sides is 15cm, you have a right angled and this side is also 15cm and you are ask to find so this side is 17, equally here will be 17

imum? Here too will be 17cm and you are asked to find the length of the other diagonal. This is line AC is the other diagonal. We have line BD as diagonal which is 30cm we have line AC, the value of AC we don't know, so we have to look for the value of line AC imum? So here let's give it a name as what x. If you look at this we have a right angled so let me bring out one, we have this. So here is 17cm and we have here too as 17cm, the base, we don't know the values, so by the help of Pythagoras theorem. So what does the rule said? So which side is our right? What is the value of our right angled? The hypotenuse, what is the value of the hypotenuse?

15. Ss 17cm
16. T 17cm very good//. So the hypotenuse which is 17 square is equal to what? We have 15 square plus x^2. Now we want to make x^2.the subject, so let's subtract, 17 times17 will give us what?
17. Ss 289
18. T Is equal to 15 times 15 will give us what?
19. Ss 225
20. T 225 plus x^2. Now let's subtract 225 to both sides because we want to make x the subject imum? So we have 289 minus 225 is equal to x^2 or x^2 is equal to 289 minus 225, so 289 minus 225 will give us what?// imum?//
21. Ss 64
22. T Now you take the square root of both side, now we have our x equal to the square root of 64, so your x will give us what
23. St 8. Now if here is 8cm, here is 8cm and this diagonal is divided into two equal part, so the line the diagonal AC will give us, let call it line, line AC will give us what?// 8 times 2 imum?//
24. Ss 16
25. T 8times 2, so the diagonal, the other diagonal will give us, let call it line, line AC will give us 8cm plus 8cm because, if you solved it will still give you this is 17. This is 15. So here will give us 8. So the diagonal is what? Equal to 16cm. so we have finish with this, if you have question, you ask, if you don't understand, let me explain it again. Who is not clear? (Teacher looking at a page in the text book) Finish and let's do question two.

Who is not clear? Hurry up, you don't have time. Let me write question 2 here (Teacher writing example 2 on the board). So we have example 2, ABC is an isosceles triangle in which line AB is equal to line AC equal to 5cm and line BC equal to 6cm. calculate line AM where M is the midpoint of line BC (Teacher reading question 2 aloud). Can I clean this side? Who will tell me what you understand by an isosceles triangle? Tell me the properties of an isosceles triangle (Teacher moving forth and back in the classroom).

26. Ss 2 sides are equal, 2sides are alike.

27. T 2 sides are a like how? 2 sides are equal. Even from the question you can see that two sides are equal imum? The two sides are equal. We have this (Teacher sketching a triangle on the board) lines AB and AC are equal and we have what? 5cm so this side too is 5cm. now the idpiont of line BC. That means line BC is been divided into two. Bisect it from A down to B. so line, line BC will have 6cm, so 6cm is divided into two will give us how many cm each?

28. Ss 3cm

29. T equal to 3cm each so here we have 3cmand here is 3cm. This is 6cm and you are asked to find line, so this is our midpoint which is M now, so you are ask to find line AM. So this angle let's give it a name as y, this is you're a, this is your B this is your M. so here we have 5cm, here we have 3cm. To solved this by Pythagoras theorem, by Pythagoras theorem the value of y will give us what? By Pythagoras theorem what will be the value of y? What will be the value of y? Talk, talk, talk What will be the value of y?or who will talk to get the value of y? We need somebody to try get us the value of y, Deborah, yes. Who will give it a trial? (Teacher call on a student to solved the problem on the board). So what is the value of the hypotenuse? Is only y^2

30. T ask your mate

31. Ss 25-9

32. T What is happening 25-9

33. Ss 16 square root of 16 is equal to 4

34. T So the value of y, is 4cm. you have done it now in the first example, the first illustration, the first illustration. So you have amum the isosceles triangle line AB is equal to line AC and you have line BC equal to 6cm and line BC is divided into two. So we have each part is 3cm and you are asked to find the midpoint which AM line AM. Now line AM, you have the hypotenuse to be 5. So when you square 5, you have 25 equal to 3^2 is 9 plus y^2 remember we said the square, the sum of the square of the two sides is equal to the square of the hypotenuse. So you have 25 minus 9 will give us 16, when you take the square root of 16 will give us 4cm, that means the midpoint. Line AM is what line AM is equal to 4cm. Let me add one a similar thing. So some in this class can solved this one (Teacher read aloud the question from a text book and write it on the board). PQR is an isosceles triangle in which line PQ is equal to line PR, if line QR is equal to 16cm and height line PM is equal to 15cm calculate line PQ. Calculate line PQ (another teacher entered the classroom to check his period on the time table).Example3 we will turn it to class, homework, do it and submit it on Friday. Example 3 should be homework. Book1 exercises 11b add number 2 and 4 to it. Assignment to be submitted on Friday Class monitories submit it unfailingly on Friday.

Teacher E (19/01/2018)

1. Ss Good morning aunty//
2. T Good morning, how are you?//
3. Ss We are fine//
4. T Sit down and let's start
5. Ss Thank you ma//
6. T (Teacher writing the topic and an example on the board) If Tan θ is equal to 8 over 15, find the value of Sin θ plus Cos θ all over Cos θ into bracket one minus Cos θ. Now let's see this, since you did something similar (Teacher read the written question aloud and she laugh) is it open the light or switch on the light?
7. Ss Switch on the light

8. T Aright so let’s see the sketch we have θ, they said Tan is what opposite over adjacent opposite over adjacent, so we use, use the Pythagoras theorem to get the hypotenuse imum? Let’s give it a name A, B, C, imum, so this is small b, so we have hypotenuse we have b square plus, plus. B square is equal to a squared plus c squared imum? B squared will give us our a squared is 15 squared plus c is what? 8squared, so 15squared is what? 15 times 15

9. Ss 225

10. T 225, 225 and 8 squared will give us what? Give us what?

11. Ss 289

12. T 289, so if you find the square root of 289will give us what?// imum? The square root, your cal// or four figure table//

13. Ss 17,

14. T So we have, so our b is 17, now the question said you should find, so you have the hypotenuse now (Teacher’s cell phone rang and interrupted the lesson) so Sin θ, Sin θ will give us what from our sketch, Sin θ is what? Look at the sketch now Sin θ will give us what? (Teacher pointing the sketch) Sin is what? Don’t be doing as if nobody knows not thing, what is happing? So opposite is what?

15. Ss 8

16. T And the hypotenuse is what?

17. Ss 17

18. T So we have opposite is 8 over hypotenuse is 17. What of Cos θ Cos is what? Adjacent

19. Ss Over hypotenuse

20. T Each the adjacent side is 15 over 17// right?// I think am going to clean that side. So the question is Sin Ѳ to be 8 over 17 plus 15 over 17 all over all over what? All over we have Cos is what 17 over 17 into 1 minus 15 over 17. Now let’s see let’s eeam simplify numerator, see the same base, just add, 8 plus 15 will give us what?

21. Ss 23

22. T 23 plus 17 and then now let’s simplify this imum? We have ammu 15 times 1 will give us 15 over 17 minus 15 times 15 will give us what?

23. Ss 225

24. T 225, 17 times 17 will give us

25. Ss 289

26. T 289 koo?// 289 so now let’s take the LCM, the Lcm will give us 289 because 17 can go into imum?//, 17 into this will give us 17, 17 times 15, press your cal// quickly, do you see all we doing here we want to simplify this. Do you understand what we are doing?

27. Ss Yes

28. T the class is quiet, now listen, this is what we are ask to simplify from, from this value. Tan we have opposite over adjacent right?

29. Ss Yes

30. T And you are expected to find Cos θ and Sin θ, so from this using your Pythagoras theorem we got the value of the hypotenuse to be 17. So our Sin, Sin θ will give us our 8 over 17 then Cos θ will give us adjacent over hypotenuse which is 15 over 17, you have a value now slot it into the expression given to you, your Sin θ which is 8 over 17 plus your Cos θ which is 15 over 17. So they have the same denominator, so you add, so we have 8 plus 15, will give us 23 over 17, I said keep it a side, now let’s simplify this so I open the bracket, remember your BODMAS, Bracket of x … like that. So you open, you remove the bracket, use the number outside to multiply everything inside the bracket. So we have 15 over 17 times 1 will give you 15 over 17 is here. Next step now 15 over 17 times//. So 15 times this, 15 times 15 will give us

31. Ss 225

32. T Then 17 times 17, already we have 289 which is this, now here you find the LCM. So if you take 289, 17 can go in imum?

33. Ss Yes

34. T So I said 17 into 289 is what?

35. Ss 17 times

36. T 17 times, so 17 times 15, are we together now/

37. Ss Yes

38. T So 17 times 15 will give us what?

39. Ss 255

40. T We have 255 minus 289 into 289 will give us one times 225, so we now subtract 255 minus 225 will give us what?

41. Ss 30

42. T 30 Koo?//

43. Ss Imm//

44. T So we have 30 over 289, now back to our equation now divide by, remember is division, so divide by 30 over289. Now the next step is to reciprocal imum?// You revise it so we have 23 over 17 times 289 over 30 imum?//

45. Ss Yes

46. T Automatically 17 here is one, 17 here will give us what?

47. Ss 17

48. T 17, so 23 times 17 will give us what?

49. Ss 391

50. T 391 over 30, so if you like you keep your answer or you further simplify it, so 30 into 391 will give us what?

51. Ss 13.03

52. T 13 times 30 will give us what? It seems only one person that has cal in this class SS2

53. Ss 390

54. T 390, so we have 131/30 KOO? Punch it well because I didn’t check it, punch it well 13 times 30 will give us what?

55. Ss 390

56. T 390 plus one, so the expression that they asked us to find the value of, this, so the value of the 390 over 30 or 131/30. Let’s consider something isn’t it you are going into it tomorrow, angle of elevation, can I clean the board?

57. Ss No ma

58. T (Teacher waiting for students to copy the work on the board)//, Imum? You said what? (Teacher cleaning and writing another example on the board) From a point P on the level ground//. The angle of elevation of the top of a tree id 60 degrees, if the tree is 39 meters high how far is the base from P? Now let's look at this one, angle of elevation, who will explain to me, what you understand by angle of elevation, angle of elevation, angle of elevation, any idea? Imum? //Imum? Any idea that of the JSS2 learn from it just small idea of angle of elevation. Imum?// Yes tell us, ok. Alright, look at the statement they said from point, from the point P on level ground, from the point P on level ground that means you are close to a tree imum? We have a tree there, so when you stand, some of you that you are used to plugging that mango tree you stand and you want to plug, if you stand angle of elevation, you look up, to see which one is ripe isn't it, so your face and the tree forms, this is a tree and you are here, you are looking up imum? Looking at the ripe mango which one to be plug So angle of elevation, you were standing down and looking up, the angle depression is what? You are standing on top of something and looking down simple illustration. Elevation you are standing and looking up your face and the thing will form an angle, while if you are standing up on top of something maybe on top of a building and maybe you are piping something and you looking down so that is angle of depression. Elevation, you want to lift something, to lift , so you are looking up, so a person is standing here look here this is the tree imum?, so the angle form here will be your angle of elevation, so when you are looking up the angle will be somewhere here. Do you understand?

59. Ss Yes

60. T Just to start from the scratch//. So we have this is your H, this is her level ground and maybe imum this is the base to form an angle of 90 degrees from the ground and this is her point and this is a student or person standing here and this is the height which is in between, 39 meters high and the question is what? How far is the base, the base, so let's live this one to be x and the angle is here to be, if here is 60 here will give us what?// 30 degrees, so if you add the two it will give us you, your 90 and you are ask to find the

base, so who will try this, who will try this to get the value of x imum? Imum?// So Tan, Tan30 will give us what? Tan30 will give us what? Tan30 will give us what? Do you know my problem with this class, your mouth, there is, do you know DUSA (chafe), a lot of chafes in your mouth, you know it, you don't want to talk. Tan30 in your trig ratio is what?

61. Ss 1 all over root 2

62. T And Tan30 will give us our opposite which is $x$over adjacent is what? What is your adjacent?

63. Ss x

64. T So we have Tan, Tan30 degrees will give us 1 over root3. So here we have 1 over root3 is equal to what? x over 39, so we want to take the base with x the subject, so when you cross multiply or multiply 39 to both side, over x will give us 39 over root3, 39 over root3, so the base is 39, now root, root3 is what? Now cal//, divide 39 by the value of root3.root3 will give us what?

65. Ss 1.7

66. T Imum?//

67. Ss 1.7

68. T So we have 39 divide by 1.7 will give us what?

69. Ss 22.9

70. T So we have x is equal to 39 over 1.7, so our x will give us 22.9 meters or 23 if round it up. Now let's see if we use ammu for depression what do we have?

71. Ss 60

72. T if we use Tan60, Tan will give us what?// Emmu opposite over adjacent and our Tan is what? Imum?

73. Ss Root3

74. T Root3 is equal to 39 over x, make x the subject, so what do we do? Imum? Imum?

75. Ss multiply both side//

76. T Imum?//

77. Ss multiply both side by 39//

78. T Multiply both sides by

79. Ss 39

80. T Multiply both sides, just look at if you multiply both sides by 39, so are you not adding to the problem?

81. Ss by x

82. T By x, the unknown//. Great mathematicians//' Imum?

83. Ss Cross multiply

84. T (She laughs) I don't want this cross multiply or you want to make$x$ the subject of the formula and you don't want to use cross multiply, what do you do? Or now let use your cross multiply, so we have x root3 is equal to 39, so divide both side by? Divide both sides by what?

85. Ss Root3

86. T Imum

87. Ss Root3

88. T So your x will give us 39 over root3is till the same thing. If you have question ask. Let me add one more or ask you to do it. Ok we have a similar thing, they said if x is and acute angle and Tan x is equal to 3over4. Evaluate Cos x minus Sin x all over Cos x plus Sin x. This one is simple.(Teacher read the question aloud) finish it now and exchange you're not book for marking

Teacher E (23/01/2018)

1. Ss Good morning aunty//

2. T Good morning, how are you?//

3. Ss We are fine//

4. T Sit down and let's start

5. Ss Thank you ma//

6. T Sin, Sin45, we have amm opposite over hypotenuse is what? y so Sin45, what is the value for Sin 45? Sin45 is what? We have 1 over root2 is equal to 2 over y so when you cross multiply you have ammu, you have y over root2 is equal to 2, imum so you will be left with 2 to multiply to both

side, so that you make y the subject, when you multiply with 2 to both side we want to make$y$ the subject, so we have y times root2 over root2 is equal to 2 root2 you are multiplying so this and this will go, so your y will give us 2root2 imum? We have the value of the y which is 2root2, Ok, let's find the value of x now the adjacent, so the adjacent, what do we use imum? Tan45, will give us opposite, the opposite is 2 over the adjacent is what? The class is too quit imum? Any problem?// You are too tensed, what is the problem? If you have problem ask what is it? (Teacher laugh, and move near a student) feel free, what is the problem? Where is it that you didn't understand? Imum?

7.	Ss	Aunty
8.	T	Yes
9.	S	Is there no other question?
10.	T	(She laugh) any other question for?
11.	S	For the looking for y and x
12.	T	We want to use Pythagoras, simple easy way to deduct. This is different from the Pythagoras. Pythagoras is just part of the trig for you to understand the hypotenuse, the opposite, and the adjacent. Now let me explain, listen, to have, instead of you to find using your four figure table to find the values of Sin 45, imum?// For you to find the value of Sin 45, they want you to use the trig ratio, the trigonometry ratio they want you to use instead of you going to your four figure table, at times in an exams, they will say solved without using table, so that means you will not use four figure table to find the value, you will solved without using table, so for you to solved without using table, you have to know the value of using the trig ratio , now listen you have to know the value of Sin45, imum? Tan45, so from the initial ee sketch I did on the board, you will be able to get from, your right, where is your right-angled triangle? The sketch is given, so the hypotenuse here is 2 from the calculation, we found out that the hypotenuse is equal to 2, the square root of 2. Ordinarily you find out, you say ok let me check for the square root of 2, inside my four figure tale, then in this case live the square root in your answer, live the square root, so knowing the trig ratio, tan45,

tan, tan θwill give us what? Tan θ we said is the opposite over the adjacent, using your SOHCAHTOA, imum? The acronym SOHCAHTOA, so Tan45 will give us the opposite over the adjacent, Sin45 will give us, Sin you know that is what? Opposite over hypotenuse, so where you have, where the angle is facing, is your opposite, where the right-angled is facing is your hypotenuse and the remaining part is the adjacent which is the lower line, is your adjacent. Now for instance, let me use this, you are given eee the opposite to be 2, the hypotenuse is not given, the adjacent is not given. And you are ask to find the value of the hypotenuse and the adjacent, so is left for you to know am given the opposite, opposite is 2, hypotenuse is not given, adjacent is not given, so is left for you to use from the acronym the SOHCAHTOA, what would I use to get either get the value of the hypotenuse or the value of the adjacent. So here we decide to use what? Tan Imum? Tan, we say the Tan is it this one. No we use Sin, because Sin we have opposite, in this case you either use Tan which involve opposite or Sin, do you understand what I am saying? In the acronym Tan, Tan and, and Sin we have opposite so in this case now you either use your Sin, Sin45 since you have the opposite or Tan45 you have the opposite given but if you say ok no I want to use eee I want use Cos, Cos45 will give you what? Cos is adjacent over hypotenuse, with two unknown you cannot solved it, you cannot solved it, so use the one that you have the value given and one unknown, in this case you either use Tan 45, Tan45 is equal to opposite over adjacent, imum? Or your Sin 45, you have your opposite over your hypotenuse which is y, so we decide to use Sin, sin45 to get the hypotenuse, so Sin 45 we said the opposite over our hypotenuse which is y, that is exactly their now we said but Sin 45 is what? 1root2, Sin is here which is 1over root2 is equal to our opposite over the hypotenuse y imum? So if you cross multiply, so what I did there, I cross multiply, y times 1 will give us y over root2 is equal to 2 but we want get the value of y, so what do we do? In JSS2, JSS2 you said cross multiply imum? You just cross multiply, but graduate from that, cross multiply you just multiply root2 times 2 but here we said multiply root2 to both sides, because in your exams SSCE or NECO all this small, small statement Fichte you mark. Divide this by this, multiply this by this, subtract this by this it Fichte you marks, so learn to write it. Graduate from cross multiplying, you multiply, multiply both side by so if multiply both side you have Y times root2, definitely this root2 is going, is equal to 2 times root2 that is if you cross multiplying, imum?, so if root2 and the root2 is gone, you have y next times 2 root2 because you are multiplying root2 to both sides so you have y now is equal to 2 root2, you have the value of Y. Have I made myself clear?

13. Ss Yes
14. T Are we together now?
15. Ss Yes
16. T Now we have the value of y, the next thing is for us to find the value of x, so you have your hypotenuse now imum? You have your hypotenuse, you have the opposite, you are left with the adjacent, so now you can use the one that involve adjacent so the one that involve adjacent is what? Is Cos and Tan, and we pick Tan//. You can use Cos and still get your answer, so we have Tan45 is equal to what? Opposite over the adjacent, the adjacent is x and opposite is, but we know the value of Tan45 to be what? Tan 45 is what?
17. Ss 1
18. T Tan 45 is what? The value of Tan 45
19. Ss 1
20. T we have that, so we now have 1 is equal to 2 over x, imum so multiply both side by x, right multiply both side by x, so you have$x$ is equal to what? 2, if you multiply both sides by x, junior class cross multiply, so we have the value of amm x to be 2, the opposite is also 2, then// the hypotenuse is 2 root2, any other question? Any other question Ok, you don't have question, since we still have time I will give one class work let me, let me add Tan 60. Can I clean this//
21. Ss No all
22. T Imum?//
23. Ss clean this side

24. T So I believe in exams if you see question involving eemm Sin 45, angle 45 you will be able to solved it imum? The one we solved involve angle 45, now we are going to angle 60 and 30, Finish it and give me your attention. You are done? Finish?

25. Ss Yes

26. T (Teacher writing and sketching angle 60 and 30 on the board) can I go down imum?

27. Ss Yes

28. T Here is 2, 2 and 2 equilateral, so let’s find the altitude to line AD. So now let’s find AD using your Pythagoras theorem, let me bring it out, imum? We want to get line AD using the Pythagoras theorem BD sorry, BC is divided into 2, we said is an equilateral triangle that means all the sides are 2,2 unit each. But BC is divided into 2 because of the altitude, so you have BD is 1 unit and BC is another unit, so we pick this potion, so your AB by Pythagoras, A, line AB is equal to line BD squared plus line AD squared. Your AB is 2 square is equal to BD is what? 1 squared plus Y squared imum, Ok. So we have amm, we want to make ee Y the subject. So we have Y square is equal to what? 2 times 2 will give us 4, here is 4 is equal to 1 plus Y squared, so they have minus 1, imum? So your Y square will give us what? 3 and Y will give us what? We are going to take the square root of both sides, Y will give us root3. So your altitude is root3 imum?// That means you have this, this is angle 60, this 30 this 90, here is root3, here is 2 and here is 1. Now, now let’s look at tan60, tan60 will give us what? Tan is opposite over hypotenuse, the opposite of 60 here we have root3, we have root3 opposite over adjacent 1so that means tan, tan60 degrees is root3. Are we together? Tan 60 is root3, now what of cos 60 degrees. Cos is what? Cos is what?

29. Ss adjacent over hypotenuse

30. T The adjacent is what? Adjacent is what? Adjacent here is what?

31. Ss (mixed answer some say 1 while others root3)

32. T What is the adjacent? I am talking about 60 now, angle 60 the angle 60 which one is the adjacent?

33. Ss 1

34. T 1// Why are you saying root3? Root3 is what?

35. Ss The opposite//

36. T And 2 is what?

37. Ss Hypotenuse

38. T So here we have 1, Tan is adjacent over hypotenuse, so Cos 60 is 1 over 2 imum? Now Sin 60, sin is what? Opposite over hypotenuse, so the opposite is root3, the hypotenuse is 2. So Tan 60 is root3, Cos 60 is 1 over 2, Sin 60 is root3 over2, the subsequent, now let's pick the one for Sin 30, since they are together, Sin30 will give us what? Sin is opposite, Sin is opposite over hypotenuse, the Sin 30 is 1 over 2, then what of Cos 30 Cos is, we are taking this imum? So Cos is adjacent the adjacent root3 over the hypotenuse root2, now what of tan30, tan30 is opposite over adjacent so the opposite is 1 over the adjacent is root3//. Maybe tomorrow we will give examples using this. Let me give you a home work so that you can submit. Excises, page 142, excises 11 d, class Rep//.

Teacher M (16/01/2018)

1. Ss Good morning uncle//
2. T Good morning students//. And how are you?//
3. Ss We are Fine//
4. T Sit down//. And let's start the lesson//
5. Ss Thank you Uncle//
6. T (Teacher writing and sketching on the board), we want to take more examples on what we started yesterday. So yesterday we do only one triangle, but today we will do two triangles in one. So we are moving forward now from this diagram, on the triangle in our calculation there must be one unknown and two known, i.e. one side, one angle and one unknown, so in this case for us to start solving to get either x or y base on this diagram you have y here, you have 30. Ie the angle 30 is given, there is no…., there is no additional information or maybe to be 3 like one. So in this case we have

to start with this angle first to find our x, after getting x for us to get y we must get an information from all this line, no number out of all this line throughout without…. So we are going to do some additional work to get y, but let's start with the x. From this diagram now what is the boundary between this to this two? What is the name?

7. Ss Adjacent
8. T Adjacent, what of x
9. Ss Hypotenuse
10. T What of this line?
11. Ss Opposite
12. T Opposite, so now this adjacent, this is hypotenuse Sin or tangent which one connects adjacent and hypotenuse?
13. Ss Sin
14. T Ehen adjacent and hypotenuse//
15. Ss Cos
16. T Cos, so from this incident now, we now write Cos 60 is equal to adjacent is what?
17. Ss 2
18. T 2, hypotenuse is?
19. Ss x
20. T x form … x can be used to give us xCos60 equal to 2//. All this?//
21. Ss Divide by Cos60//
22. T You have $x =$ 2//(Cos 60)// .Form our special angles, what is Cos 60?
23. Ss $\frac{1}{2}$
24. T eeee?//
25. Ss $\frac{1}{2}$
26. T Thank you, so we now have x, now will become equal to 2 over $\frac{1}{2}$. I told us this 2 can be written as 2 over 1, then $\frac{1}{2}$. We have the issue of fraction. So we now write 2 over 1 times what?
27. Ss 2 over 1

28. T 2 times 2

29. Ss 4

30. T 1 times1

31. Ss 1

32. T Equal to

33. Ss 4

34. T So x is be equal to 4, this our $x = 4$, so we have solved for x, copy down this before we go on. Are you all through?

35. Ss Yes sir//

36. T Ok, as I told us, for us to find y, so the information have to be up to three and out of the three, two must be known and one unknown. Now that we want to find y, we have only three information's there. So this two we cannot get y, we must have another side that is given that is known. So for us to get another side to add up to this information, we have to calculate this line, this angle, this 2, 60 and this. Let's see if this line remains. Give me any letter to be used

37. SS z

38. T z, like this, so before we calculate z, from the value of z, we now joint this angle and then find the value of y, so z is opposite to this adjacent, finding the two are necessary because y is opposite over adjacent Tan, Tan 60 equal to opposite is what?

39. Ss z

40. T z, eeee… eee adjacent?//

41. Ss 2

42. T So cross multiply this and this

43. Ss z//

44. T eeee, equal to 2 Tan 60//. But what is Tan 60 from our special angle?

45. Ss $\sqrt{3}$

46. T $\sqrt{3}$, so is the same thing as what?

47. Ss $2\sqrt{3}$

48. T But the z now, we would marge it to, at the side to get our y. So, let's take. z is now opposite, based on this triangle we have cover all the sector of

this one, this side is here or knowledge of z here, we can work on the other triangle, so based on the other triangle, this is opposite, this is what?

49. Ss Hypotenuse

50. T Ehen, so opposite and hypotenuse what do we have?

51. Ss Sin//

52. T We have Sin, Sin what now?

53. Ss 30

54. T 30, equal to z what is our z?//

55. Ss 2√3

56. T z/y, because z is 2√3 over y. Cross multiply this times this, $Sin\ 30 = 2\sqrt{3}$. $(y\ Sin 30)/(\ Sin\ 30) = \ (2\sqrt{3})/(Sin\ 30)$, but what is Sin 30? In our special angle, you are still looking at your new book?

57. Ss No sir//, $\frac{1}{2}$

58. T $\frac{1}{2}$?//

59. Ss Yes $\frac{1}{2}$

60. T 1/(1/2). But this one can be written as (2√3)/1/1/2, which can be written as (2√3)/1 × 2/1,equal to what?

61. Ss 4√3,

62. T 4√3 over 1 which is what?//

63. Ss Is the same thing as 4√3.

64. T So that is our y. So we want to get y, because just like you have a friend, and you are looking for somebody that is related to that your friend, for you to get that person, you have to locate your friend, is your friend now that will tell you how to get to that person, you want to see him now go to so, so place you will find him. So that is why we said that mathematics are things that are happing things that are happing. Just turning it to numbers and letters, that is for a) you copy, so that we take the b) part yes, copy the a) so that we take the b) part. Are you through

65. Ss Yes

66. T Ok, should I clean all the writing on the board?//

67. Ss No//

68. T Somebody is still coping?

69. Ss Clean the a) part

70. T Ok let's take the b) part, that second diagram, we have two triangles one is on this side, one is on the other side we are looking, which one do we start with?

71. Ss x

72. T Why x why not y?

73. Ss Because there is no number on the other side

74. T Because we must get unknown side from x, to get the y

75. Ss Yes

76. T But for x, this side, this side and this side are given.

77. Ss Yes

78. T So now based on this triangle now, which side is adjacent?

79. Ss 3

80. T And which side is hypotenuse?//

81. Ss That x

82. T So then adjacent and hypotenuse, what do we have

83. Ss Cos

84. T Now Cos 45 equal to what over what?//

85. Ss 3

86. T Over?//

87. Ss x

88. T Cross multiply, this side and this

89. Ss Is x

90. T x Cos Ehen… what next?

91. Ss Divide both side by Cos 45

92. T Ehen what do you have?

93. Ss 3 divide by Cos 45

94. T What is Cos 45 from our special angle

95. Ss 1/(√2),

96. T 1/(√2), 1/(√2) , but this one can be written as 3/1 ÷ 1/(√2)= 3/1 × 1/(√2)

97. Ss 3/1 × (√2)/1

98. T Multiply

99. Ss (3√2)/1

100. T Which is what?

101. Ss 3√2

102. T (Teacher waiting for students to copy) are you through? How far? We want to find what side?

103. Ss y

104. T But we are going to find y not in relation to this triangle. So you will now base on y, x and angle 45 side//. Now based on the other triangle, what is the name given to x

105. Ss Opposite

106. T What is the name?

107. Ss Opposite

108. T What of y?

109. Ss Adjacent

110. T How do you know that y is adjacent?

111. Ss Because is the longest side

112. T Longest side, apart from the longest side, how do you know?

113. Ss Is facing the right angle

114. T Adjacent facing the right angle?// opposite the right angle? Now x is opposite, y is adjacent what did you joint, what is the relationship between the eeee opposite and hypotenuse?

115. Ss Sin,

116. T Sin, so now Sin what now?

117. Ss Sin 45

118. T Sin 45 equal to opposite is what?

119. Ss x

120. T x over y, but what is the x?

121. Ss 3√2

122. T (3√2)/y . So y times this

123. Ss $y\,Sin\,45$

124. T qual to $3\sqrt{2}, So\ y = 3\sqrt{2}\ Sin\ 45$. But what is Sin 45?

125. Ss 1/(√2)

126. T So 3√2 ×(√2)/1 , what do you have here?

127. Ss 6√2

128. T They are two √2

129. Ss 3√2

130. T 3√4 what is √4,

131. Ss 2

132. T We have 3 time 2 equal to?

133. Ss 6

134. T But under surd, under surd √2 times √2 will give us 2 i.e. I am just trying to give us, when we get to that what I am saying is that when you have two numbers under square root, when you multiply it give you one of the numbers under the square root. So √2 times √2 is 2 , √3 times √3 is 3, √a times √a is a √Gloria eeee times √Gloria is what?

135. Ss Gloria

136. T (He laughs and repeated after the students)

137. Ss (Students chatting freely with the teacher)

138. T (Teacher waiting for students to copy the work on the board) Ok when you are through I will give you class work. At least we have some minutes to try something (Teacher trying to clean the board)

139. Ss NO// don't clean the board

140. T When you are through you just do this. Just start the work, class work. You apply the knowledge. Charge your brain. (Teacher writing question on the board for the students to solved, then he moves round the classroom encouraging them to take the classwork serious) Ok our time is up we meet in the next lesson please.

Teacher M (18/01/2018)

1. Ss Good morning uncle//
2. T How are you?//

3. Ss We are fine Uncle//

4. T Ok// Sit down everybody and listen//. We are going to take some examples on the practical application of trigonometry//

5. Ss Yes, thank you Uncle//

6. T Example 1, (Teacher writing the topic and the example on the board), did you copy?//

7. Ss (mixed responses, some say yes and others no)

8. T (Teacher moving in between Students), still on?// If Sin P is 3 over 5 and P is an acute angle, what is the value of Tan P? (Teacher read the question of the example) solution, let see the solution now, always we will draw a right-angled triangle. We draw what?

9. Ss Right-angled triangle

10. T (Teacher sketching right-angled triangle on the board) we said that Sin P, that is an angle here, acute angle are angles that are less than 90, so this is the right-angled triangle, these two other angles, they are less than 90 and each one is less than 80, so any angle less than 90 is an acute angle, so this angle you are seeing here just call it P, just call it P. Sin P, from this diagram now I have three sides, let me call this once x, y, z like this. Length of this angle now, which side is the opposite

11. Ss y

12. T y, because this is our opposite, what of x?//

13. Ss Hypotenuse

14. T What of z?

15. Ss Adjacent//.

16. T Now from the question, we are saying that Sin P is 3 over 5, 3 represent what? Or let's start with the Sin; Sin of angel, Sin is what over what?

17. Ss Opposite over hypotenuse

18. T Opposite over

19. Ss Hypotenuse

20. T Now from what we have here Sin P is 3over 5, the 3 represent what?

21. Ss Opposite

22. T So you said 3 represent what?

23. Ss Opposite

24. T You can see that this is our y here is 3//. What of the 5?

25. Ss Hypotenuse is 5

26. T So the hypotenuse is 5. Sin now is 3 that is opposite over hypotenuse that is why you have this. We are asked to find Tan P. Tan is the same thing as what? What is the value of Tan?

27. Ss Opposite over adjacent

28. T Opposite over

29. Ss Adjacent

30. T But we don't know the adjacent, so we have to calculate it before we get the value. How do calculate it. We are taught that if you are given a right-angled triangle, if two sides are given, the third side can be obtained using Pythagoras rule, if two sides are given the third side can be obtained through Pythagoras rule. So, now for us to get as we said, we have to use Pythagoras rule. From our Pythagoras rule how do we start?

31. Ss 5 square

32. T Ehen, 5 square, 5square equal to what?

33. Ss 3square

34. T 3square plus

35. Ss Plus z square

36. T 5 square

37. Ss Is 25

38. T 3 square

39. Ss 9

40. T z square, what do you do?

41. Ss Now z square

42. T Ehen, z square//. Ehen, equal to

43. Ss 25 minus 9

44. T Ehen equal to, 25 minus 9

45. Ss 16

46. T-16, we are looking for z only//. Ehen z is what?

47. Ss 4

48. T How do you get 4?

49. Ss Square root of 16

50. T So you can see that our z is adjacent is 4, so tan now, tan P will be what over what?

51. Ss Opposite

52. T Opposite over adjacent is what?

53. Ss 3 over

54. T 3 over 4, so that is the answer, so tan P is 3 over 4//. That is for example 1(Teacher writing example 2 question on the board as the students copy the solution of example1 in their note books) when you have finish, please copy example 2, (two students entering the class lately). From where, why are you coming now? See// Come here// From where?//

55. Ss We went to the school clinic

56. T The school what?

57. Ss Clinic

58. T Are you through?

59. Ss No

60. T Be fast please, yes, (Teacher cleaning the board) so to set it up given that tan x is 5 over 12, what is the value of Sin x plus Cos x, Cos x minus Sin x over Cos x plus Sin x and Sin x plus Cos x over Cos x into 1 minus Cos x. To set it up, let me draw any right-angled triangle. This is our right-angled triangle. Now you have, we are using x now. This is our x. if this x (Teacher pointing the sketch on the board), this side will be what?

61. Ss Opposite

62. T Opposite Ehen//

63. Ss Adjacent

64. T Hypotenuse, now we are given that Tan x is 5 over 12. Where are we supposed to write our 5?

65. Ss Opposite

66. T The Sin is there//. Ehen 12 is what?

67. Ss Adjacent

68. T So that is what we have, we have to calculate that using the same what?

69. Ss Pythagoras theorem

70. T Pythagoras theorem, so by Pythagoras theorem, let's call this side, let's say m, so what is m square

71. Ss m square equal to 5 square plus 12 square//

72. T 5square?//

73. Ss 25

74. T 12 square

75. Ss 144

76. T 144, add the two

77. Ss 169

78. T 169, this m square, but we are looking for m, m will be what?

79. Ss square root of 169

80. T Square root of 169 equal to what?

81. Ss 13

82. T 13, that is m, m is 13, our m now is 13, our problem now is time, use these numbers to get the answer. What is the value of sin x plus cos x? We are taking a) now. Sin x plus Cos x. what is the value of sin x from the diagram now?

83. Ss 5 over 13

84. T 5over what?

85. Ss 13

86. T So this one become 5 over 13, Cos x is what?

87. Ss 5 over 13

88. T 5 over 13 again?//

89. Ss 12 over 13

90. T 12 over 13, so we have this two, what do we do? Find the LCM

91. Ss 13

92. T 13 divide by 13 is 1times 5

93. Ss 5

94. T Ehen, the same thing 1 times 12

95. Ss 12

96. T 5 plus 12

97. Ss 17

98. T Over 13, so Sin x plus Cos x is 17 over 13, that will answer, use the same method. Just substitution when you bring out the numbers, what you do is just in the case of x write it, Sin x write it, multiply Cos x by x, substitute the numbers do the addition, the division, get the answer. The same thing with c) the same method, substitute Sin x, substitute Cos x, turn round Cos x, just substitution, and you will still divide get your answer. So the b and c is for you please you submit tomorrow

99. Ss Now $2c$ sir

100. T Just substitution//, or yes. $2c$?

101. Ss Yes

102. T I taught is over. Now let take it fast, fast. I can clean this side

103. Ss Yes

104. T See the board

105. Ss Sin x plus Cos x all over Cos x into bracket 1 minus Cos x

106. T Now, already we have gotten Sin x plus Cos x, so there is no struggle, you use what we have. Already Sin x plus Cos x you have 17 over 13. So, you can still recopy Sin x is what?

107. Ss 5 over 13

108. T 5 over 13 plus 12 over 13 all over Cos x, Cos x is what?//

109. Ss 12 over 13

110. T 12 over 13times 1 minus what?//

111. Ss 12 over 13

112. T 12 over 13, from what we have this one is already 17 over 13 so what do we do? You can expand or you solved the one inside the bracket. So let's open the bracket. We have 12 over 13 times 1 is 12 over 13. 12 times 12

113. Ss 144

114. T 144, 13 times 13

115. Ss 169

116. T So by the sin, now 17 over 13, let’s do sin … 12 over 13 plus 144 over 169, what will be the LCM. 169, this one is 1 time 12.

117. Ss Uncle is 13 times12

118. T Ok that is good, that is good God bless you eem13 times 12, eem use your calculator sharp, sharp there is still 12 here then times 13

119. Ss 156

120. T Eeee//, 156//. Ehen this and this is 1, this and this is 144, so subtract it

121. Ss 12

122. T So 12over 169, division of fraction what do we have?

123. Ss 17 over 13 times 169over12

124. T You can simplify 13 can go here 1, 13 can go here

125. Ss 13

126. T Now 17 times 13 divide by 12

127. Ss Is 34

128. T Oooohya// multiply let’s see//

129. Ss 221

130. T 221 divide

131. Ss Divide by 12, 18

132. T Ehen 18 whole number

133. Ss 18.416

134. T Ehen 18,416 that is all, that is the easy way to solved. Try and do that one and submit it tomorrow.

Teacher M (22/01/2018)

1. Ss Good morning Uncle//
2. T How are you today?//
3. Ss We are fine Uncle//
4. T Sit down and let’s begin//
5. Ss Thank you Uncle//
6. T (Teacher writes a question on the board and allows students to copy) are you through?
7. Ss Yes//

8. T Write example 5, what is that? Example five, (Teacher cleans and write example 5 on the board). Example 5: A ladder 5m long rest against wall such that its foot makes an angle of 70 degrees with the horizontal. How far is the foot of the ladder from the wall? (Teacher move in between students in the classroom). Are you through with the example 5?

9. Ss No

10. T Imum?//

11. Ss Yes

12. T Are you still copying?

13. Ss (mixed respond, some say no and others yes)

14. T No, yes, no, just hurry up//, let's read the question. It said what? What happened?

15. Ss A ladder 5m long rest against wall such that its foot makes an angle of 70 degrees with the horizontal. How far is the foot of the ladder from the wall?

16. T So, just like a wall like this, you put a ladder on it, for example somebody that wrote this thing, if is somebody like me that my hand cannot reach there, he will need a ladder to clamp up and write that thing. The what? Imum? The what? Read what is up there

17. Ss Be eloquent and rule the world

18. T Ehen, so for a person like me to write that thing up there, he have to put a ladder, then clamp up and write. So, now assuming this is the wall, this wall now, I want to clamp up and write, be eloquent, so what I will do is to put my ladder as I draw like this, so that I am going to clamp up to write whatever that I want to write. So the wall is vertical, so where it touches the ground or the floor, it makes an angle of 90 there. Now we are told that the ladder. From the question, a ladder 5m long. That is from here to here is 5meter// Ehen//, is lent against a vertical wall. This is the horizontal, this the vertical, so this ladder make an angle of what?

19. Ss 70 degree

20. T This is the horizontal, that number, this ladder to this line. The angle form there is 30 degree, now because we write or we draw this, we now have

our right angled triangle 90, 5, 30. So we have to calculate what? How far is what?

21. Ss The ladder from the wall

22. T From the wall//. This is the wall; this is the ladder laying here. That is from the bottom of the ladder here to wall, that is what we are asked to calculate. Very serious then, now give me any letter that we can use.

23. Ss x

24. T x why not y, why not x, anyone//. What do you decide to find is fine? Now we connect x and 5.x is what? What is x?

25. Ss Adjacent

26. T What of 5?

27. Ss Hypotenuse

28. T What do we use?

29. Ss Cos

30. T Cos, so now my Cos 30 equal to adjacent is what?

31. Ss x over

32. T x over 5 cross multiply, we have our x equal to 5 over Cos30. From our special angle what is Cos 30? Don't tell any aa// You have seen it, is what?

33. Ss Root3 over 2

34. T Root3 over 2, so we have root3 over 2, multiply 5 root3 over 2. In surd form or in form of this, so like this, that is the answer is pass in three words from the foot of the wall.

35. Ss Uncle,

36. T Yes

37. Ss Why is it that 22 is not use?

38. T Is the 22 was not special, if you observe from our special angle, you will see that 22 is not part of it, we have 0, Ehen, what are the special angles

39. Ss 0, 30, 45, 60, and 90

40. T You can see that 22 is not part of that angles

41. Ss Okay

42. T We want to still write example 6, we want to take this type of the example. You need to see questions not just to ask, this teacher they don't teach us……… write example 6, we shall soon write example 6. Yes (Teacher writing example 6 on the board) example 6: From a place 400m north of x, a student walk eastwards to a places y which is 800m from x. what is the bearing of x from y? Yes, this is f from a place. Example 6, I hope the 6 is well written. Ok I think we can go on to solved. Is anyone still copying?

43. Ss Yes

44. T Let me see you//

45. S Me?//

46. T Ok let's understand the question first, what are they saying. Read the question

47. Ss From a place 400m worth of x, a student walk eastwards to a places y which is 800m from x. what is the bearing of x from y?

48. T Ok I thought that there is a place north of x. I thought that there is a point, call point x. let's call point x, so we are talking about north, east, south and west. So every point has these four directions. Has north, has east, west and south. Now this is the x. I told you that from a place 400m north of x, now this the pole on x that is going toward the north direction this is north up, moving up like this, 400 meters from x there is a place, they did not tell us the name of the place, you can just name the place. Help us give the name

49. Ss C

50. T C// Ehen, or you can use P as the name of place, so that you can remember easily. Ehen, C is not bad; I am just trying to reform it so that we can remember easily, they said from a place 400 meters from x so let's joint P, I did say P is the exact name of that place, you can use x, you can use any letter provided the working are in other. So now 400 meters north of x, that is the first sentence, then the second a student walk eastwards, at this same place like this, we still have the same direction like this, this is our south, this is east, this north, this is north, this west. We are told that this is a student, assuming you are the one. A student walks eastward. That is from this place

he still follow the east direction that is followed eastward, toward the direction of east like this to a place call y. So this is y now, so but is a distance, what is the distance?

51. Ss which is 800m

52. T Hello, the 800 is not for this place, you didn't understand the question. So let come from. Now we were told that, if you didn't understand the question, there will be a problem, now he didn't go east of the place y. this is the place, the student is now there, as if he is now there. That which is 800 this place where you are now, at this very place the place is 800 meters away from x. that is when you joint your true position now to the starting point, we are told that the distance is 800 meters. The 800 is not here, is here. Your new position now, from that place to the starting point where we started in this solution, the 800 meters. Now, what happen, what next, what next? What is the bearing of x from y? How do we get there? Let me explain, now, the bearing of x from y, from this diagram, what is the last letter or the place for deliberation.

53. Ss y

54. T y so what is it that is equal to y, you go to where?

55. Ss y

56. T y this is our north, now once you get to y, you locate the north direction. This our north, you start from here, just move round until you get to the line that is going to x. so this angle that you are seeing here is the bearing of x from y. when the say from y, you go to that y and start from north line you move now clock wise, that is clock is going like this. you don't have clock here, better buy one (he laugh) so, clock wise direction, you turn like this, when you get to the line that is joining with x so this angle is what they are looking for, but without this one inside you will not get the one outside. So what we will do is to calculate the angle here. Let's call it θ imum so we calculate θ, when we get our θ we will get the one outside, by the time we get our θ. Let's get our θ first. Imum, now how do we get the θ. Let's redraw this thing to be the right-angled triangle, this is Θ now, this one

is 800, this one is 400 like this. Now what is the measure to 400, based on θ 400 what is the length?

57. Ss Opposite

58. T Opposite, while 800 is what?

59. Ss Hypotenuse

60. T So Opposite, hypotenuse is what?

61. Ss Sin

62. T Is Sin, so you now write Sin θ//Ehen//, Sin θ equal to what?// Ehen //what over what?

63. Ss 400

64. T 400 over 800, you can simplify, zero and zero will go, this one go 4 over 8, Ehen// what again?

65. Ss 1 over 2

66. T 1 over 2, which is what?// 0.5, Sin θ is 0.5, we are looking for θ, which means is going to be Sin invers. There is way we can get this answer without tears. From our special angle if you observe the table of special angle check the line under Sin, check under Sin, what is the, when you check now, check the line under Sin there is arc is on the…

67. Ss 30

68. T Imum

69. Ss 30

70. T 30, so it means that θ will be 30. But let's follow the normal procedure we now said Sin invers of 0.5 you check the calculator or four figure table Sin invers of 0.5 is 30. So θ is 30. Now θ is not the answer, what they are looking for is the one outside. Now how do we get the one outside? Let's check, this place, from this north line to this line what is the total angle here

71. Ss 90

72. T 90, what of this one here?//

73. Ss 90

74. T Making up what now?//

75. Ss 180

76. T 180, from here to here too is another 90 plus 180, 180 plus 90

77. Ss 270

78. T But the one that is, this are the whole thing from this one to this place is 270, but the one inside is 30 so to get the one outside what? So the bearing, write the bearing of x from y is 270 minus 30. Ehen, 270 minus 30

79. Ss 240

80. T 240 degrees//. That is our answer, final answer 240. Any question, any question// Ehen// before we go no knowing .what to do? 270 , Ok,90 plus 90 plus 90, is just we speak, this what we have, we have, this is 90 the whole of this angle is 90, so 90 plus 90 plus 90 will give us 270. But there was a line here like this; this angle can be measured without, so we are removing 30 from the whole of this. That is why, it is 270 minus 30, it will give us the one, how we can get here, it gives us the 30, but the whole thing was here is 270. The one outside, the angle that is outside there, 270 minus 30 is 240 please, that is all for example 6, we would take 7 then I will give you class work. This eee just the matters of understanding the question, once you are given a question try to read it very well, follow the statement ehen, before you draw the diagram. Once you draw the diagram, already all those problems is not a problem, but if your diagram is not correct, there is no way to get the answer. So is just the matter of understanding the question. Thank God, your English teacher is such a fine teacher, you are going to register. That is what the question is all about. Example, examples continue before class work. Are set for 7 now?

81. Ss No/yes

82. T Yes or no, aaa//

83. Ss No

84. T Who said no? Are we serious, finish quick, let me just clean the question before you finishes this? Example 7 now (Teacher writing the question for example7 on the board), Docars//,

85. Ss Sir//

86. T What is happening? The radius//. A chord AB of a circle whose Centre is o is 10cm long, and angle AOB equal to 140. Calculate the radius of the circle. Somebody is still here

87. Ss Yes/no (mixed response,)

88. T Who is that? Who is that? Who is that? Copy from your friend, just like that, if you have a friend there, if doesn't have looked for one. Let's read the question again, it says what?

89. Ss A shod AB (they laugh)

90. T The chord AB of what?//

91. Ss Circle whose Centre is zero

92. T Is not zero

93. Ss Is zero is 10cm long

94. T Is not zero I said O//, that is a letter, not number

95. Ss is 10cm long, and angle AOB equal to 140. Calculate the radius of the circle

96. T So what we would do is to draw our circle. I think is about circle. So we draw our circle

97. Ss Uncle what is this?

98. T I am drawing a circle, so this is my circle. So let's manage what we have, pay attention, you people are not paying attention some of this thing you will not see them. But if you are paying attention you will see the actual situation. Now we have a chord, we are told that there is a chord call; a chord is a line that touches a circle at two points, so now from this my drawing now, let's take example from here to here. Let me call this one now AB, and we have the Centre of the circle. We are told that the chord AB of the circle whose Centre is o is 10 centimeter long. Samo, this chord AB is 10 cm long. Samo A to B is 10centimeter long; you didn't understand the question//, Ehen and what again? And what?//

99. Ss ABD

100. T A what?// This is not B, is O, AOB, that is angle AOB, that is angle at the Centre (a student interrupting the teacher) yes good morning. Collect and go and give us chance

101. Ss yes Uncle

102. T So, and AOB, this is A, ok, let me write the o. I told you the center the name of the center is center o. Now AOB, that is from A to O you join, then like this. AOB, the angle formed here is the 140. That is the meaning; the angle at center there is 140 degrees, now we want to do what? Calculate what?

103. Ss Calculate the radius of the circle

104. T From this line, we have AB, OB, OA OB, which one is the radius,

105. Ss AB

106. T Imum?// Which one?//

107. Ss The one at division

108. T The one at the division?// Imum?//

109. Ss AO and OB

110. T OA OR AO or OB or BO they are same, they are all radius of the circle. Now this is, this now represent there radius, represent there radius. Now we have to calculate the radius. How do we calculate the radius? Please there is something we have under a circle like this; there is a statement or a term that said that a line drawn from the Centre of a circle to bisect the chord is at right angled to the chord, now draw a line, let me make the statement again, a line drawn from the Centre of a circle to bisect the chord, what is the meaning of bisect?

111. Ss To divide

112. T Divide// Ehen//, so if you draw a line from the center of the circle, as you are drawing the line, the line is drawing when it touches the circle, now when it touches the circle at that point, if the distance from that point is the same as from where you draw the line at point where the line touches the circle, the angle formed there is equal to 90 degrees. That is why I said that a line drawn from the center of the circle to bisect is at right angled to the chord. So what I am trying to saying is that to calculate the line at the center going down like this, when it meets to the chord then it divide the chord into two equal parts. That is it bisect the chord

113. Ss Uncle

114. T Ehen

115. Ss Please start afresh

116. T Ok, there is a statement concerning a situation like this, that when you have a chord, you have a radius of a circle and the radiuses are joint to the chord, to ends of the chord, now if you draw a line from the center to the chord, that line that you draw from the center of the circle to go and meet the chord, whether it meet the chord, if it divide the chord into two equal parts, where it meet or at the point of intersection of point of contact, that is when the line touches, is the point of contact or the point of intersection where it touches the chord at that very point that line forms angle of 90 degrees to the chord.

117. Ss Okay//

118. T Ehen//, some of you will say that the line belongs to, try and get the statement or let me say this with your biros, write somewhere, write somewhere, so you remember. A line drawn from the center of the circle, center of the circle, center of the circle Ehen// to bisect a chord, to bisect a chord, to bisect, bisect, to bisect a chord is at right-angled to the chord to chord. A line drawn from the center of the circle to bisect the chord is at right-angled to the chord. Ehen Have you written it? Read your own let me hear you.

119. Ss The line drawn

120. T A line not the line oooh//

121. Ss A line drawn from the center of the circle to bisect the chord is at right-angled to the chord

122. T Ehen, to bisect the chord is at right-angled to the chord, so now if for instance a right angled here so now this triangle the triangle is a right angled triangle from this line follow to the other line is a right angled triangle and this one too is a right angled triangle. This one is r, the other one is still r and from there to B is 10, but this line from our discussion from the statement, from this line to B is the same thing as from this same point here A, so what will be from this point to B?

123. Ss 5

124. T 5, yes, so we now have, what will be, we would now use one of the r to get same

125. Ss Yes

126. T see $5r$, $5r$, 90, 90, but now if this same line, this same that divide this line to give us 5 will also divide the angle too, to give us 70, then we use Sin 70 equal to opposite which 5 over hypotenuse which is r

Teacher S (26/01/2018)

1. Ss Good morning Sir//
2. T Good morning students//. And how are you?
3. Ss We are fine//
4. T Sit down then we start the lesson
5. Ss Thank you sir//
6. T (Teacher writes the topic on the board) So let's just go back to trigonometry before we go back to geometry, is that OK?
7. Ss Yes
8. T So they are almost the same geometry, trigonometry is part of geometry, is that? Now what, what, what do you understand by an, an angle? What is an angle? What does, do you know what is an angle?// Imum? What is an angle? Yes Glory you want to say something, imum?// Nobody?// Nobody?// So when you have lines, two lines, two straight lines, when you have two straight lines meet at a point they form what is call an angle, is very easy. You can draw any two lines provided that they meet at a point, right? Are you listing to me? They will form what is an angle, what we are saying here is look at this. You have a straight line, you don't need… this one is a straight line, imum?
9. Ss Yes
10. T You have another straight line right?
11. Ss Yes
12. T Let this be A, this is B, this is C and D right? So does this two lines formed angle? Imum?
13. Ss Yes

14. T It formed an angle, right?

15. Ss Yes

16. T This one is an angle, this one is also an angle, you have a line like this and this one meet with it at an angle. This is what is called an angle. So an angle is formed when two straight lines meet at a point right? What about this, if I do like this, how do you look at this? Did the two lines meet at a point right? They formed angle, right?

17. Ss Yes

18. T Are you sure?

19. Ss Yes

20. T But are the lines straight?

21. Ss No

22. T This is curve, not an angle right? That is a curve, is that Ok?

23. Ss Yes

24. T So there is no angle there, when two straight, say it let me hear

25. Ss When two straight

26. T Lines meet at a point, right?

27. Ss Yes

28. T An angle is formed, is that OK? Now we have types of angle, these angles are made of different types, if you look at this, look at this angle, is this angle the same thing with this? this angle is big than this one right?

29. Ss No

30. T Are you sure?

31. Ss Yes

32. T This one is bigger than this one, imum?

33. Ss No

34. T Look at the board, this one is bigger and this one is smaller

35. Ss No

36. T Are they the same?

37. Ss No

38. T Ok this one is bigger right?

39. Ss Yes

40. T And this one is smaller

41. Ss Yes

42. T So angles varies depending on their type, types of angles, we have types of angles (teacher writing on the board) types of angles. So when you have, when you have a straight line, this is a straight line, whose straight line meet at one another, one is on top of another, there is no angle linking them, is that Ok? I have two lines, but one is on top of another. Look at this, the other one is this and another one again laying on this one, how many lines are there?

43. Ss Two

44. T Two lines right?

45. Ss Yes

46. T So the…, the one is on top of the other, there is no angle to meet the two lines right, so the angle formed between this two lines is zero, is that Ok, the angle there is zero degrees right, the angle is zero degree, when I decide to left one on the other, ZAN DAGA DAYA A KAN DAYAN.is that Ok, I will shift one, look at it, I will shift one to stop somewhere here. can you look at it, now, I have decided to move the other one somewhere here. So I formed an angle right

47. Ss Yes

48. T Is this one zero?

49. Ss No

50. T Is not zero right?

51. Ss Yes

52. T Is a number more than zero, right?

53. Ss Yes

54. T Now this number will keep on, will keep on, will keep on. They are at the perpendicular side; one is horizontal and the other one vertical, the angle is not zero, and this dotted line meaning is not up to 90 degrees, when it is, when the two lines are at the perpendicular side they form what is call the 90 degrees angle, which is the right-angled, say it let me here

55. Ss The right-angled

56. T Right-angled right?//

57. Ss Yes

58. T Right-angled is an angle at what?

59. Ss 90 degrees

60. T Right-angled is an angle at

61. Ss 90 degrees

62. T Right-angled is an angle at what?

63. Ss 90 degrees

64. T Everywhere we get right angled it means is an angle at what?

65. Ss 90 degrees

66. T They said 90 degrees, 90 degrees means what, right angled, now what about the angle in between, from zero to is not up to 90 degrees. It has a range. So this angle is call an acute angle, say it let me hear

67. Ss An acute angle

68. T An acute angle is any angle between 0-90//, is that OK? Is more than zero but less than 90//. So give me example let me hear, mention any number between 0 to 90

69. Ss 80 degrees

70. T 80, right?//

71. Ss Yes

72. T 80 is an acute angle, right?

73. Ss Yes

74. T Another one again

75. Ss 60

76. T They are, they are many, 1, 0.5, degree, 1 degree, 20 40 50 all of them are what? Acute angle, now, if this is ϴ, with, tell him, let me just mention this to be angle ϴ. I want you to find this angle, I want you to find this angle, so we said that number one, an acute angle this implies that this is greater than zero, can you see it

77. Ss Yes

78. T What is this?

79. Ss Greater than

80. T Whatever is on this side is greater than this angle right?

81. Ss Yes

82. T- But less than 90 degrees, so you can mention any number between 0-90 that number is an acute angle//. Are we moving?//

83. Ss Yes

84. T Did you understand what we are saying?

85. Ss Yes

86. T Any angle between 0- 90, that angle is called an acute angle, and once it is 90 it's no more an acute angle, it is called what?

87. Ss Right angled

88. T The right angled, right?

89. Ss Yes

90. T It has a sign or a symbol, it has a symbol in calculation, in daily practices you see some sign, in an answering, if the angle is not up to 90 or more than 90, that angle may be here or a letter may represent that particular angle, but if it is 90 in most cases it is not created, you will see something like this; right angled, right angled implies angle at 90 degrees, right? We said it has a sign, like this. Anywhere you see something like this in Mathematics it means what? 90 degrees or right angled, is that understood?

91. Ss Yes

92. T Anywhere you see something like this, it implies what?

93. Ss In Mathematics it means 90 degrees or right angled,

94. T- If you see a shape like this, something like this, something like this everywhere then you look at end you now see something like this, then you know that angle is 90. The 90 is not meant to be written there, but you will see something like this which is different from something like that, is that Ok, this sign, this curve, curve sign is not 90; 90 is the one that only representing something, this sign, are we, are we moving? We said the first one is what?

95. Ss acute angle

96. T And the what?

97. Ss Right angled

98. T We still have another one, this angle, this time around is more than what? 90. I want to shift the line; the line is shift, right? To a point somewhere here, look at it from here, all this one, is this line 90 degree?

99. Ss No

100. T Is it an acute angle?

101. Ss No

102. T Is not an acute angle, and is not a 90 degree is more than 90, right? It has a length, so any angle greater than, look at it, this one is a straight line, angle at straight line is what?

103. Ss 180

104. T 180 degrees, we know that one from our primary school right?

105. Ss Yes

106. T Angle at straight line is 180 degrees, right?

107. Ss Yes

108. T Now in this case, this angle is more than 90 but smaller than what?

109. Ss 180

110. T 180, so we said number three, we have an Obtuse angle, obtuse angle, obtuse angle, we said are angles that are greater than 90 degrees but less than 180 degrees, before we go to the main one, is that Ok? And what about more than 180 degree?// Look at it, this is 180. Any angle with 90 to 180 is called an obtuse angle, right? If it is at 180 we said is a straight line angle, is that ok?

111. Ss Yes

112. T Now what about if it is more than 180? Somewhere here, from here keep moving. Can you see it, somewhere, and this side, this line is what? This supposed to be one hundred; this is from here, 90, 90, 90, 270 rights? But this one is more than 180 and less than 360, is that Ok?

113. Ss Yes

114. T So this angle from180 here, between 180 to this side, look at this, a lot is outside the angle. Now this type of angle is refers to as what? Reflex, say it let me hear

115. Ss Reflex

116. T Reflex angle

117. Ss Reflex angle

118. T Is the angle between 180 to 360 degrees, is more than 180 but less than 360 degrees, right? Now reflex angles are angles greater than 180 but less than 360 so this type of angle is call, give me example of reflex angle, mention any number that is reflex angle. Say it let me hear,

119. Ss 340, 350, you can even add one to this one, add one, right?

120. T 340, 350, you can even add one to this one right? add one

121. Ss 181

122. T You can even add 0.5, 180 plus 5 will give you reflex angle, is that Ok? Rather than receiving more than 180 degrees. So this are the three types of angles, we have right? this are the three types. Now let's move on. I hope you can identify them. The very moment we are progressing to triangle now. What do you understand by triangle? Triangle, triangle, yes nobody, yes triangle, triangle

123. Ss A triangle is a shape that has three equal sides.

124. T Somebody said is a shape that has three equal sides, ehen, who next, somebody, a triangle is a shape that has three equal sides right? Yes she is correct, but not all triangle that has three equal sides. As you know we have different types of angles, we also different types of what?

125. Ss Triangles,

126. T What she mentions here is just a type of triangle, right?

127. Ss Yes

128. T So any plan figure, are you listing, any plan figure, any plan figure bounded by three straight lines, what did I say

129. Ss Any plan figure, bounded by three straight lines

130. T Any plan figure, bounded by three straight lines, called a triangle. Three straight lines, look at it if I close my eyes like this, I might form a three lines been meet at a point right? Look at, for example, like, like this, like this, can you see it. So these three lines formed, right? So the form what is called a triangle, right? Tri means what? 3, so it has three sides and three angles, is that Ok. 3 sides and 3 angles, is that ok? Any plan figures, bounded

by three straight lines, is call a triangle. Is there any question? What do you understand by triangle? What is a triangle? Yes, yes you

131. Ss Triangle is a plan figure, bounded by three straight lines

132. T Yes is a plan figure, bounded by three straight lines, is that ok?

133. Ss Yes

134. T Now let me hold triangle, can you hold it, we said is a plane figure right? We can only touch it, feel it, or we have some shapes that are triangular in shape, is that ok? We can only close eyes touch and feel it. Once you hold it, is no longer under two dimensions, right? We have two dimensions and we have three dimensions, by holding something like this three dimension, but two dimensional objects you cannot hold it you can only touch it is that Ok

135. Ss Imum//

136. T The types of triangles, types of triangles, I hope we are moving?

137. Ss Yes sir

138. T Types of triangles, how many types of triangles do we have? How many types of triangles do we have? How many types of triangles do we have? Talk SS2, types of triangles, 1, 2,3,4,5 how many?

139. Ss 5

140. T Are they up to 5?

141. Ss No

142. T Yes, yes somebody, yes you

143. Ss 4

144. T 4 yes somebody said 4, can I, can somebody mention number one for us, yes you at the back

145. Ss Right angled triangle

146. T Imum?//

147. Ss Right angled triangle

148. T Right angled triangle, what, which, which type of angle is this?

149. Ss Right angled

150. T This is right angled, right? If I have a right angled, look at this, this one is the right angled, is that ok? And how many lines? This, this right

angled is formed by how many lines? If I have a third line, it will form what is call a triangle, is that ok?

151. Ss Yes sir

152. T Now I want to have a third line, can you see it, so this, this shape is what is call a right angled triangle, a right angled triangle. Now listen, a right angled triangle is the type of triangle that one side is equal to 90 degrees, is still here, look at it now. One side is what?

153. Ss 90 degrees

154. T One side is 90 degrees; one side is always equal to 90 degrees. Number one, we have right angled triangle. We have shorts, we have symbols, signs we use to write all this things right? Number one, this is right angled, right angled triangle. Look at it this is right angled triangle, is that ok? This two signs represent all this language, is that ok?

155. Ss Yes

156. Number one is that, types of triangles we have right angled triangle. A right angled triangle is the type of triangle that has one side equal to 90 degrees, noted right?

157. Ss Yes

158. T If I ask you what is, what is right angled triangle you would, I mean at least you will say something, right?//

159. Ss Yes

160. T Number two, yes//

161. Ss Isoceles triangle

162. T Say it let me hear you

163. Ss Isoceles triangle

164. T Isoceles triangle, I, say it, I

165. Ss I

166. T Isosceles

167. Ss Isosceles

168. T Isosceles triangle

169. Ss Isosceles triangle

170. T Number two somebody say isosceles, isosceles triangle, isosceles triangle. This triangle is also the type of triangle, look at, remember, we said we use this one to represent what? Right-angled triangle, right?// Also we have this sign, after defining this one, I would now tell you, so that if you see it in writing, right? So the name may, may not be there, but from the figure you will know that this is an Isosceles triangle, is that ok? An isosceles triangle is the type of triangle that has two sides equal, are you listing, two sides equal, right? And the base angles are also… Two sides are equal and the base angles are also equal. Look at this, this is an isosceles triangle, something like this, something like this, something like this, now, this side is equal to this side. Anywhere in Mathematics if you see this sign, meaning that, they are communicating to you that, this length is equal to this length is that understood? Now, meaning that this length is equal to this length and the base angle, where they meet, where the two equal lengths meet is call the base angle, remember, it cannot always, it cannot be here ,it can be somewhere either this side, can you see it, now where do they meet?, they meet at this point, right? So this, this is there base angles, so there base angles is equal and is not equal to this one, is that ok? Look at the board, look at the board, stop writing, look at the board. How many lines are here?

171. Ss 2

172. T And how many lines are here?

173. Ss 2

174. T 2 right?// Indicating that this angle is equal to this angle, right?

175. Ss Yes

176. T And how many lines is here?

177. Ss 1

178. T Is not equal to this. So this type of triangle is called an isosceles triangle. The base angles of an isosceles triangle are equal and two sides are also equal. If this one is 5 degrees, this one is also equal to 5 degrees, right? So when we start solving problem we would get to know. If this side is a degree, this side is 20 degree, somebody will ask you to find the value of a? What would be a?

179. Ss 20 degrees

180. T a would also be equal to 20 right?//

181. Ss Yes

182. T But you cannot live the answer like that; you have to state the reason why? Why is it that a is equal to 20? The reason is that the base angle of an isosceles triangle, is that ok? Tou when we start solving problem. Now the next one is what? Is this one understood?

183. Ss Yes

184. T Anywhere you see an isosceles triangle you will identify that one, is that ok?

185. Ss Yes

186. T Yes

187. Ss Obtuse triangle

188. T Somebody, said obtuse triangle, amm, amm, put it in the other way round, yes we have obtuse triangle. Obtuse triangle is aaa the type of triangle that has one angle, one angle more than 90 degrees, is that ok? But eee, is not in the types of triangles, right? Yes

189. Ss Equilateral triangle//

190. T Did you hear what he said?//

191. Ss No

192. T Say it again

193. Ss Equiliteral triangle

194. T Say it again

195. Ss Equiliteral triangle

196. T Say it all let me hear

197. Ss Equilateral triangle

198. T Equal, equal say equal,

199. Ss Equal

200. T Equilateral

201. Ss Equilateral

202. T Equilateral triangle

203. Ss Equilateral triangle

204. T All sides are equal, right?

205. Ss Yes

206. T All sides are equal, and if all the sides are equal definitely all the angles must be equal, is that ok?

207. Ss Yes

208. T Now, how many angles did you mention, close your eyes and tell me, close your eyes, how many angles did you mention, triangles, how many triangles?

209. Ss 3

210. T Mention them

211. Ss Right angled triangle, Isosceles triangle, equilateral triangle

212. T Thank you may God bless you, I have seen you, is ok. So we have, from the word equal, right? This one is not the same thing with this. In this case we have only two sides equal right. But where we are going to now we have come across an angle where all the three sides are equal, and that type of triangle is call an equilateral triangle, equilateral triangle. So in this case is all so, listen, when we start solving problems, right? Partnering this three, if we start with, we can only be using this signs, not the length is that ok? So you have to know them by name and by their signs. An equilateral triangle is always represented by this. Look at this, this side is equal to this side is also equal to this side. So all the three sides are

213. St Equal

214. T What also happen with the angle? What also happen with the angle? The three angles, are the equal?

215. Ss Yes

216. T Yes, that is good, they are equal, right? Since the sides are equal, so this angle is equal to this angle is equal to this angle. So this is only in equilateral triangle that has this. Listen, if I have something like this, look at the board all of you, look at the board, can you see, which type of triangle is this one?

217. Ss Equilateral triangle

218. T Say it let me hear

219. Ss Equilateral triangle

220. T Equilateral triangle right?//

221. Ss Yes

222. T Now if I do this, now what happen? Which type of triangle is this one?

223. Ss Isosceles triangle

224. T Isosceles triangle right?//

225. Ss Yes

226. T It shows that this length is equal to this length and is not equal to this length, are we moving?

227. Ss Yes

228. T Now let's just mention the one before we solved one problem. Yes the next one, can I go to the next one. the last one say, you have, see, the reason now, listen, let, let me explain, number one you have only two sides are equal, right and this one we have only three sides, do you need somebody to tell you. There is another one again, yes

229. Ss Scalene triangle

230. T Ehen scalene and what does that mean? Imum, scalene

231. Ss All sides are

232. T Listen, look at it, this one this only has two sides equal, this one the three sides are equal, can't you reason that there may be another one that no sides are equal to another? Everyone is move on it on. This one sides is not equal to this one and the other one is not equal to the other one, is that ok?

233. Ss Yes

234. T So that one is call the scalene triangle, and how do we represent it? How do we represent it? Look at it, look at it. I will put one here, I will put two here, and what will I put here?

235. Ss 3

236. T 3 right?//

237. Ss Yes

238. T So 1, 2, 3, if you see something like this it means what?

239. Ss Scalene triangle

240. T Scalene triangle, no sides are equal, is that Ok? Everyone is on it on; no one is equal to another. And look at this what about the angles? Can we have two angles equal inside? No right?

241. Ss Yes

242. T So if that is, if that is the case, so this side is not the same thing with this side and is not the same thing with this side. How many types of triangle do we mention so far?

243. Ss 4

244. T 4 types of triangles, is that Ok?

245. Ss Yes

246. T Are we moving on?

247. Ss Yes

248. T Mention them let me hear,

249. Ss Right angled triangle

250. T Ehen

251. Ss Isosceles triangle

252. T Ehen

253. Ss Equilateral triangle, scalene triangle

254. T Note that, note that in all the types of triangles, in all the types of triangles, right, what did I say?

255. Ss In all the types of triangles

256. T The sum of angles in a triangle is equal to 180 degrees, sum of angles in a triangle is equal to what?

257. Ss 180 degrees

258. T What I am saying here is this, despite all the fact there are different, there are different types of triangles. In this triangle, in this right angled triangle, right? If you add this angle, look at it, I have it somewhere, if this is a right angled triangle if you add this, what is here, what is here, and what is here it will give you what?

259. Ss 180 degrees

260. T 180 degrees, this is what is call an interior angle of a triangle, interior, inside, is that ok? The sum of interior angle of a triangle is equal to 180 degrees, say it let me hear

261. Ss The sum of interior angle of a triangle is equal to 180 degrees

262. T Now this one is for right angled triangle, same thing in what? In an Isosceles triangle, if you add this, add this, add this it also gives you 180. This one the same thing, this one the same thing, is that Ok?

263. Ss Yes

264. T Put that one, stamp it in your brain, say it has stamp

265. Ss It has stamp

266. T Sum of angles inside a triangle is 180, say it let me hear

267. Ss Sum of angles inside a triangle is 180

268. T Is 180, now can I ask you question?

269. Ss Yes

270. T Let me ask you question, in a triangle two of the angles are 90 and 25, what will be the other side or the other angle? In a triangle two of the angles are 90 and 25, what is the other angle?

271. Ss 65

272. T Is what?

273. Ss 65

274. T Imum?//

275. Ss 65

276. T Stop, say it, say the answer let me hear

277. Ss 65

278. T And how did you get that answer? The answer is correct but how did you get the answer, what we are saying here is in a triangle, we have 90, we have 25 and we have x, all these are inside triangle, what is the value of x?

279. Ss 65

280. T The x, but how did we get that 65? Yes you

281. Ss We minus 25 from 90, it will give us 65

282. T Is she correct?

283. Ss Yes sir,

284. T Imum?//

285. Ss Yes

286. T Ok, Ok, if you say so what will be your reason? What will be, your, your , you said you minus 90 minus this equal to what? Let me change the question. Ok in a triangle I have one, one, let, I have 25, and 60, now what is the value of y? Is also a triangle right? 1, 2, 3, Ok how do you get this answer? Listen let, let me. Yes, do you have something to say, stand up and say something?

287. Ss You add 25 plus 60 then you minus it from 180

288. T That is that, that is that, listen to what I said. The sum of angle in a triangle is equal to 180 degrees. So what you now do, you have to add all these angles and equate it to 180, is that Ok?

289. Ss Yes

290. T This is the same thing as 25 plus what? 60 plus y is equal to 180 your reason is sum of angles in a triangle. Are we moving?

291. Ss Yes,

292. T Now when you add this and this, shift it to the other side, so the remaining one will be the value of y is that ok?

293. Ss Yes

294. T What is the sum of angles in a triangle?

295. Ss 180 degrees

296. T Now, what is the sum of angle outside a triangle? Let's, you can call this, look at this, if I want to add if this one is A, this one is B, and this one is C. How do we get this? Remember, inside the triangle is 180, what about outside the triangle? The sum of angles outside the triangle is equal to what? We call it exterior angles of a triangle, the sum of exterior angles of a triangle. Say, say it let me hear

297. Ss The sum of exterior angles of a triangle

298. T The first one is what? Interior, right?// What about the outside?

299. Ss Exterior

300. T Exterior, now what will be the sum? Yes

301. Ss 360 degrees

302. T Stand up, say it//, say with a bigger voice

303. Ss 360 degrees

304. T When you have, if you have triangle, right? The sum of the outside angles it will give you 360 degrees, right? The sum of the exterior angles of a triangle is equal to 360 degrees, is that ok? Now we have known the sum of interior angles right? We have known the sum of exterior angle. Now, what is sum of, what is this? Ok, ok yaa, look at, look at this? This angle and this angle they are what?

305. Ss They are equal

306. T They are equal right? We call this base of an isosceles triangle, right? Can we solved one question?

307. Ss Yes

308. T Let's solved one question. I hope you are getting what we are doing? Are you sure? (Teacher writing and sketching a figure to be solved on the board), now look at; read that question let me hear.

309. Ss Consider the isosceles triangle below and calculate the letters shown there in

310. T- Let me just make it clear, right, you know what I mean, is that ok, if I do like this and do like this you also know what I mean, is that ok? Let solved that problem right? Now look at the board. First how many triangles can you see on the board? How many triangles?

311. Ss 2

312. T Are you sure, 2, right

313. Ss Yes

314. T We have 2. Ok, look at; if I close this one, we have one triangle, right?

315. Ss Yes

316. T Again if I close this side, we have another triangle, how many now,

317. Ss 2

318. T If I close this side we have another triangle. How many? We have how many?

319. Ss 4

320. T Say it let me hear,

321. Ss 4

322. T We have one, can you see my hand, two and three, is that ok? Now if I am to consider the bigger one and it is an isosceles triangle, is that ok? And the law is that the base angles of an isosceles are what?

323. Ss Are equal

324. T Are equal, now which angle is equal to this one? Is it this one?

325. Ss Yes/no (mixed respond)

326. T Listen, look at my lines, look at this one and look at this one. This length is equal to this length, right? And this angle is given; this angle is equal to one of either this one or this one. Now which angle is equal to this?

327. Ss Is a

328. T Is a, now, if I clean this one? I will now be left with something like this, can you see it, so this is 35 and this is a, look at, is that ok. So my a is equal to

329. Ss 35

330. T And the reason is what?

331. Ss Base angles of isosceles triangle

332. T Base angles of what?// An isosceles triangle//. Is that understood?

333. Yes

334. T Now, we have this a is equal to

335. Ss 35

336. T a is equal to what?

337. Ss 35

338. T 35 degrees, we said a is equal to 35 degrees, if a is equal to 35 degrees, now, am going to use this a and this angle to calculate this. Look at the board very well, now we want calculate b. how do I find the value of b? Yes

339. Ss a plus 35 plus b equal to 180

340. T Correct, clap for her, she said since we have gotten the value of a equal to 35, and this covers the whole triangle right? So 35 plus 35 plus b will give us the sum of angles in a triangle, which is equal to 180 degrees. So

this the same thing as a plus 35 plus b equal to 180, the reason is what? The sum of angles in a triangle, is that Ok. And we know what is a, our a is what?

341. Ss 35

342. T 35 plus 35 plus b equal to 180, so b is equal to 180 minus what?//

343. Ss 70

344. T And what is b? b is what?

345. Ss 110

346. T 110 is that one understood? Now let get the value of c. look at the board and tell me the value of c. what is the value of c?// Tell me now what is c?// Listen// Look at this what is this one. Tell me now what is c? Look at this//. Look at this one//. What is this angle? (…)// Ok, now listen//. You can see that our time is over, so we meet in our next class, to consider the definitions of Sin, Cos, and Tan of a triangle sides//. Please calculate the value of c as homework//. And submit it tomorrow//

Teacher S (30/01/2018)

1. Ss Good morning Sir//
2. T Good morning students//. And sit down then let's start today's lesson
3. Ss Thank you sir//
4. T (Teacher writing and sketching on the board) What do you mean by θ? What is, in the last class, this figure that is on the board, what is the opposite side of this right angled triangle? Which length is the opposite? Is it this side or this side? (Teacher pointing to the sketch on the board)
5. Ss Down side
6. T If you know it let me see your hand up. Rise up if you know the answer correctly your hands//. Let me see hands up, if you know the answer. Look at this shape (teacher pointing the sketch on the board) which type of triangle is this?
7. Ss Right-angled triangle
8. T In a right-angled triangle we have three sides, we have opposite, we have adjacent and we have hypotenuse. Now with this right-angled triangle

at this angle is our given angle (teacher pointing the sketch on the board) what is the, which side is the opposite side? Yes you.

9. Ss The down side

10. T b, the down side right?// If you have a right-angled triangle, if this angle is not given (teacher pointing the sketch on the board) any side can be opposite, any side can be adjacent, is that ok?

11. Ss Yes

12. T But once the angle has been identified, if the angle has been identified, you can identify the opposite side of the right-angled triangle from the given angle, is that Ok? Now if I take this side to be my angle, given angle, which side is my opposite?

13. Ss Opposite side (student pointing the sketch on the board)

14. T This side, is that Ok? While this side is my adjacent and this side always is the hypotenuse (teacher pointing the sketch on the board). This is what we said in our last class, right? So now we are going to continue from here (teacher writing and drawing a sketch on the board). Now we are going to define the Sin of this θ, the Cos of this θ and the tangent of this θ in this right angled triangle//. Right?// That was what we did in this class, right? Now we will continue with Sin θ, Cos θ, and Tan θ, is that Ok? Now number one, the Sin of this θ the Sin of this θ is define as the opposite all over the hypotenuse, is that OK? The opposite all over the hypotenuse, Sin θ is equal to opposite all over the hypotenuse right? And what is my opposite? Which, which area represent my opposite?

15. Ss y

16. T So is equal to y all over r. Opposite all over hypotenuse, say it let me hear

17. Ss Opposite all over hypotenuse,

18. T Sin θ is equal to opposite all over hypotenuse, remember if you know, if you are to be, if you are given a right-angled triangle, you must identify which side is the opposite and which sides is the adjacent before you know the value you will assign to Cos θ, Sin θ and Tan θ, is that Ok?

19. Ss Yes

20. T Now, so this θ is given, so this side is our opposite, right!

21. Ss Yes.

22. T So the Sin of this θ is equal to opposite all over hypotenuse, is that understood?, right, now what is the Sin of this angle? What is the Sin of this angle?// you//

23. Ss Sin is equal to x all over r

24. T Correct! Tell them all, Sin is equal to what?

25. Ss Sin is equal to x all over r

26. T Is x all over r, because in this case opposite is this side Ok, and the hypotenuse is this. Always Sin θ is equal to opposite all over hypotenuse, remember I said you have to identify your opposite and the adjacent and the hypotenuse, right? Now number two, what is this? Look at, look at the board, look at the board, are we copying? Now is equal to, look at this, this is the Cos of this angle, θ is the same thing as adjacent all over what? Adjacent all over

27. Ss Hypotenuse//.

28. T Adjacent all over hypotenuse, adjacent all over hypotenuse and which letter represent the angle, this adjacent right? So this is x all over r. What is Cos of θ?

29. Ss Adjacent over hypotenuse

30. T Adjacent all over hypotenuse, the Cos of this θ is equal to adjacent all over hypotenuse (teacher pointing the sketch on the board). Now what is the ratio of Cos α. Cosα here is equal to what?// Imum?//

31. Ss y over r//

32. T y all over r.is that Ok?// Now the last one there is Tan θ, Tan θ is equal to what?

33. Ss Opposite over adjacent

34. T Opposite all over?//

35. Ss Adjacent

36. T Opposite all over adjacent, opposite all over adjacent and which letter represents that?

37. Ss y

38. T y right?// y all over what?

39. Ss x

40. T Now these are the three concepts, the first three, you still have others, because these ones are at your level. So we said Sin θ is equal to what?

41. Ss Opposite over hypotenuse

42. T Cos θ is equal to//

43. Ss Adjacent over hypotenuse

44. T Tan θ is equal to

45. Ss Opposite over adjacent

46. T Now I just want to introduce something, one, one formula, Pythagoras theorem. Do we know that?

47. Ss No//

48. T No?// Pythagoras theorem, listen, before we talk, these three (teacher pointing at trig ratios written on the board) Three concepts if you are given one angle, look, stop writing and look at the board, everybody, then you will have, then you will have better understanding, if you are given angle, one angle, one side and one side is also missing right?//

49. Ss Yes//

50. T Your, your angle is given and just one side, and you are asked to calculate whatever number is here, is that Ok, am I talking?// Do you understand what I mean?//

51. Ss Yes sir//

52. T If you want to…//. Assuming you are asked to calculate the hypotenuse//. And this side is given//. But this side is not given//. Right?//

53. Ss Yes//

54. T So look at the existing formula we have here//. This side is opposite//. Is that ok?//

55. Ss Yes//

56. T This is what the question is all about to calculate//. This is hypotenuse//. I am sorry please//. This is opposite//. And hypotenuse is here// (Teacher demonstrating and pointing to the sketch on the board). The angle is given//. Right?//

57. Ss Yes//

58. T And hypotenuse is here//. So I will still use Sin θ//. Is that ok?//

59. Ss Yes//

60. T Now do you know why//. I will not//. I will not//. I will not use this?// Because the question is not talking about adjacent// (Teacher demonstrating and pointing to the sketch on the board). And there is adjacent there//. And there is adjacent//. Right?//

61. Ss Yes//

62. T Now assuming this side is not given//. And this side is given//. And the question is to calculate this side//. Will I going to use Sin?//

63. Ss No//

64. T Because the question is not talking about opposite//. Is talking about what?//

65. Ss Adjacent//. Right?//

66. Ss Yes//

67. T So adjacent and what?// Hypotenuse//. Adjacent and hypotenuse//. The question is not talking about opposite//. And there is opposite here//. So I will not use opposite in tangent// (Teacher gesturing, demonstrating and pointing to the sketch on the board). And I will not use opposite in Sin//. So this one is talking about opposite and hypotenuse//. The question is talking about opposite and hypotenuse//. I will go by Cos//. What about if the angle is not given?// If the angle is not given//. If the angle is not given//. This side is given//. This side is given//. One side is not given// (Teacher pointing to the sketch on the board). In this case the question is not talking about angle at all//. Is talking about the three sides//. Opposite, adjacent, and hypotenuse//. That is what the man is saying//.Pythagoras//. Pythagoras theorem//. The man is saying that in any given right angle triangle// (Teacher gesturing and pointing to the sketch on the board). In any given right angle triangle//. Right?//

68. Ss Yes//

69. T The hypotenuse side//. This is r//. The hypotenuse side r^2//. Meaning the square of the hypotenuse side is the same thing as the square of the

opposite side plus the square of the adjacent side// (Teacher writing on the board). Do you have anything here?// So if this side is given//. This one is given and you are ask to find y//. You can calculate your, your hypotenuse//. Right?//

70. Ss Yes//

71. T (Teacher pointing to the writings on the board), I want to make a deduction//. Any question?// Can I move on?// Imum?//

72. Ss Yes//

73. T Look at this//. This is the deduction// (Teacher writing on the board). I want to make use of this one//. And this one to have a formula//. Very important formula indeed//. What is this?// (Teacher pointing to the board). Sin Ѳ is equal to what?//

74. Ss Opposite allover hypotenuse//

75. T Right?//

76. Ss Yes//

77. T This implies that y is equal to what?// By making y the subject of the formula//. Right?//

78. Ss Yes//

79. T Meaning I cross multiply//. To multiply this one//. Are we moving?//

80. Ss Yes//

81. T I hope you are not just looking//. Looking at me//

82. Ss Yes//

83. T This is $y = r\,Sin\theta$ //. So this formula can be written like this// (Teacher gesturing, writing and pointing to the board). Is that Ok?//Are we moving?//

84. Ss Yes//

85. T It implies that//. If I square this side// (Teacher writing and gesturing). I will also square this side//. Mathematically allow us to do that//. Whatever… meaning//. If you have two, equal to two//. Right?//

86. Ss Yes//

87. T If you add plus one here and also add plus one her, they are simple//. You have done nothing// (Teacher gesturing and pointing to the board). Now

if you square two and also square two you are still able to sale nothing//. So if you square this side and also square…// (Teacher writing and gesturing). Is that ok?//

88. Ss Yes//

89. T Now this implies that $y^2 = r^2 Sin^2 \theta$ //. So we still balance everyone//. Right?//. Coming to this one, Cos θ//. Right?//

90. Ss Yes//

91. T Is equal to what?// What do I write?//

92. Ss Adjacent over hypotenuse

93. T And what is adjacent and hypotenuse?// (Teacher writing on the board). $\frac{x}{r}$ and implies what?// We want to make x the subject of the formula//. Meaning that $x = r\ Cos\ \theta$//. Right?// Now the same thing//. If I square this side I will also square this side//. Right?//

94. Ss Yes//

95. T So I will have $x^2 = r^2 Cos^2\ \theta$//. This thing $Cos^2\ \theta = (Cos\ \theta)^2$//. But you just feel like writing this one looks more easier than this//. Have you notice…// (…) (Teacher writing on the board). So they are the same//. Right?//

96. Ss Yes//

97. T This is equation 2// (Teacher moving back and forth). Now if I mention this one equation K//. Right?// Now I will put equation// (Teacher writing and pointing to the board). Put eqution1 and 2 in K// Right?//

98. Ss Yes//

99. T Already I know what is my y^2// See y^2// Right?//

100. Ss Yes//

101. T I will remove this one//. And put this one// (Teacher gesturing and pointing to the board). Is that ok?//

102. Ss Yes//

103. T I know what is x^2 here//. Look at it//. And x^2 here//. I will put this one//. So that I know// (Teacher cleaning the board). Before we solved one example//. Now look at this//. $r^2 =$, instead of y^2//. I will put this. r^2//. Is the same thing as $r^2 Sin^2\ \theta + r^2 Cos^2\ \theta$//. Are we moving?//

104. Ss Yes sir//

105. T Now we now factor r^2//. See r^2here//. See r^2 here//. That we can remove it outside//. Right?

106. Ss Yes//

107. T $r^2\ (Sin^2\,\theta + Cos^2\,\theta) = r^2$//. Dividing both side by this r^2//. We get $Sin^2\theta + Cos^2\theta = \frac{r^2}{r^2}$ //. And what is $\frac{r^2}{r^2}$ //. The numerator and denominator are the same//. Any number divided by itself//. Any number divided by itself is what?//. OPEN YOUR MOUTH AND TALK// (Teacher gesturing). ONE DIVIDE BY ONE//.

108. Ss One//

109. T Twenty divide by twenty//

110. Ss One//

111. T x divide by x//

112. Ss One//

113. T x^2 divide by x^2//

114. Ss One//

115. T r^2 divide by r^2//

116. Ss One//

117. T Any number divide itself is one// (Teacher gesturing and pointing to the board). Excerpt zero//. Ehen//. Koo?// (right?). Because zero divide by itself is not equal to one//. Is that ok?//

118. Ss Yes//

119. T So this is equal to one// (Teacher writing on the board). This is our $Sin^2\theta + Cos^2\theta = 1$//. We call it an identity//. This is identity//. Is more than an equation//. Is more than an equation//. Is more than an equation//(Teacher gesturing and pointing to the board). It is also an equation//. Right?//

120. Ss Yes//

121. T But it is more than an equation//. All identities are equations//. But not all equations are identities//. Is that ok?//

122. Ss Yes//

123. T Meaning that close your eyes//. Pick any number//. Any number//. Any number from zero//. Any number//. Put it here// (Teacher gesturing and

pointing to the board). Put it here//. Press your calculator//. It will give you one//. Give me any number//. Give me any number//

124. Ss 18 and a half//

125. T 18 and a half (Teacher writing on the board), $(Sin\,18.5)^2 + (Cos\,18.5)^2$ // OOYAAH//. You have calculator//. Put it inside bracket// (Teacher moves near a student and show him how to write it in the not book). Put everything inside bracket//. Open your bracket//. And press your calculator//. Open bracket//. NO, NO, NO//(Teacher showing students how to use their calculator). Open bracket Sin 18.5 close bracket squared, Plus//. Open bracket Cos 18.5 close bracket squared//. You got your one//. Right?//

126. Ss Yes//

127. T Any number you know//. Close your eyes//(Teacher gesturing). And pick any number//. If you put it here//. And perform that//. And this perform this//. It will give you one//. That is why it is call an identity//. Look at the board//. Look at the board//. Look at me//. Look at the board// (Teacher pointing to the board). Is this understood?//

128. Ss Yes//

129. T I am telling you//. Put this thing at the back of your mind//. Even in the market//. If they ask you $Sin^2\theta + Cos^2\theta$//. Tell them is equal to one//. Is that Ok?//

130. Ss Yes//

131. T The second identity before you write//. The second, let me just use this space// (Teacher gesturing and pointing to the board). What is this?//

132. Ss Tan θ

133. T Tan θ//. Right?//

134. Ss Yes//

135. T So tan θ we said is equal to…// (…) (Teacher moving backward and pointing to the board)

136. Ss Opposite allover adjacent//

137. T Opposite allover adjacent//. Now look at//. This is opposite allover adjacent

138. Ss Adjacent//

139. T (Teacher and students chorusing), Remember in mathematics we have two numbers numerator and denominator//. I can divide the numerator by any number//(Teacher gesturing). And I can also divide the denominator by any number//. The number will be the same//. The number will remain the same//. Look at this//. If I have $\frac{2}{3}$//. Right?//

140. Ss Yes//

141. T (Teacher pointing to the board), If I want to divide this number by 2 and divide this one by 2//. The fraction will remain the same//. Is that Ok?//

142. Ss Yes//

143. T Now I want to divide this fraction by a number//. This can also be $\frac{y}{r}$ and $\frac{x}{r}$//. Is that not?// (Teacher writing and pointing to the board). Then if you divide this number by r//. And this one by r it will remain the same//. Like this can also be written as $\frac{2/2}{3/2}$ is still the same thing, any number//. Is that OK?//

144. Ss Yes//

145. T Now if you look at this//. Sin θ is equal to what?// Opposite allover hypotenuse//. So this is the same thing as Sin θ//. Cos θ is equal to what?// Adjacent allover hypotenuse//. This implies that $\tan\theta = \frac{\sin\theta}{\cos\theta}$// (Teacher writing and pointing to the board). Identity number two//. This is identity number one correct//. WRITE, WRITE, WRITE//. So that we can use the remaining time to solved a problem//. Three minutes to write this// (…)// (Teacher moving back and forth while waiting for students copying work on the board). While you are writing//. We said, $\sin\theta, \cos\theta\,, and\ \tan\theta$ are component of a right angle triangle//. So there is a way we summaries the three for easier memorization//. SOH, CAH, TOA//. Meaning Sin Ɵ is equal to opposite over hypotenuse//. And the Cos of this angle Ɵ is the same as adjacent over hypotenuse//. The tangent is same as opposite over adjacent//. Right?//

146. Ss Yes//

147. T So there is a way we summaries it the three, for easier memorization//. If you are done//. Look at this// (Teacher writing on the board). SOH, CAH, TOA//. Meaning Sin Ѳ is equal to opposite over hypotenuse//. Cos Ѳ is equal to adjacent over hypotenuse//. And Tan Ѳ is equal to opposite over adjacent//. SOH, CAH, TOA//.Right?//

148. Ss Yes//

149. T SOH, CAH, TOA, for easy memorization// (Teacher gesturing). If you see a question you just bring them out SOH, CAH, TOA//. If you see a question you read them out very well// (…)//. Now can I clean this side?//

150. Ss No//

151. T Are you still writing? (…)

152. Ss Yes//

153. T Now let me ask you a question//. Let ask you a question//. $Sin^2x + Cos^2x$ is equal to what?// $Sin^2x + Cos^2x$ is equal to what?//

154. Ss Is equal to one//

155. T Is equal to One//. Right?//

156. Ss Yes//

157. T This Ѳ is just a mere letter//. It can be any letter a, b, c, d//. It can be any letter//. So we can put x here and put x here//. $Sin^2x + Cos^2x$ will still give you one

158. Ss Yes

159. T And again $\tan x = \frac{\sin x}{\cos x}$//. Yes can I clean this side//

160. Ss Yes//

161. T WRITE, WRITE, WRITE//(Teacher writing on the board). Example; given that $\sin x = \frac{3}{5}$ calculate 1) $\cos x$ 2) $\frac{1+\tan x}{1-\tan x}$ (…)//. Do it as homework//. And Submit it tomorrow//

Teacher S (01/02/2018)

1. Ss Good morning Sir//
2. T Good morning students//. And how are you today?
3. Ss We are fine//

4. T Please be seated//. So that we can start the lesson
5. Ss Thank you sir// (Teacher writing on the board)
6. T What is today's topic?// Say it let me hear//
7. Ss Cosect, Sec and Cot//
8. T Ehen?//
9. Ss Cosect, Sec and Cot//
10. T Ehen?//
11. Ss Cosect, Sec and Cot//
12. T Hello, hello, say it again//
13. Ss Cosect, Sec and Cot
14. T And Cot right?// Now consider this right angled triangle, given this angle as our given angle θ, ok?//
15. Ss Yes
16. T And this angle is what?
17. Ss 90 degrees
18. T 90 degrees, a right angled triangle and this length, how do you define this length?
19. Ss Hypotenuse
20. T Hypotenuse right?// So we represent it with r, since this a given angle what will be this side?
21. Ss Opposite
22. T Opposite let me put y and this side is what?
23. Ss Adjacent
24. T Adjacent right, so the cosect, sec concept can also be define in a right angled triangle. Now we said Sin θ. From our experience Sin θ is equal to what?
25. Ss Opposite all over hypotenuse
26. T What is Sin θ?
27. Ss Opposite all over hypotenuse
28. T Opposite all over hypotenuse, this side or this?//
29. Ss y over r

30. T If Sin θ is equal to opposite all over hypotenuse, what is wrong if I turn it upside down, this over this,……// What is Sin all over Cos?//

31. Ss Tan

32. T Sin all over Cos is equal to what?

33. Ss Tan

34. T Ok what is Cos all over Sin?

35. Ss Tan//

36. T All of them Tan, Tan, right?

37. Ss Sin

38. T Sin, if you know it let me, let me see your hands up? Cos θ all over Sin θ is equal to what?// Do you have eyes at all? Eeee? Tell me yes or no, do you have eyes?

39. Ss Yes

40. T Yes, what is Cos θ all over Sin θ?//

41. Ss Cot θ

42. T Is equal to Cot θ right?

43. Ss Cot θ

44. T Now what is Cos square θ all over Sin square θ?

45. Ss Cot square θ

46. T Cot square θ, so this one plus Cot square θ equal to, what is this?

47. Ss One

48. T And what is this?

49. Ss Sin square θ

50. T What is one all over Sin square θ? One all over Sin θ is equal to what?

51. Ss Cosec

52. T Now what is one all over Sin square θ?

53. Ss Cosec square θ

54. T Cosec square θ, so this one is Cosec square θ. This one is another equation let say equation ® do you know we obtain this thing from (K) where we divide each member in (K) by Sin square θ. Divide this one by Sin square θ, you will now have one, divide this one by Sin square θ, you

will now have Cot square θ, divide this one by Sin square θ, you will now have Cosec square θ. this one is another identity is that ok? Now the next one here is still on (K). This is divide (K) by Cos square θ and see what we shall have, when we divide (K) by Cos square θ, look at it, this is a, right? Now, we will now have Sin square θ all over what?

55. Ss Cos square θ

56. T Cos square θ plus Cos square θ over Cos square θ is equal to one over Cos square θ. Now again what is this, Sin square θ all over Cos square θ will give you what? What is Sin over Cos? Sin over Cos

57. Ss Tan

58. T Sin over Cos is Tan, right? Sin square θ all over Cos square θ will give you what?

59. Ss Tan square θ

60. T Tan square θ, now you have Tan square θ plus this Cos square θ all over Cos square θ

61. Ss One

62. T Plus one right? One all over Cos square θ

63. Ss Sec square θ

64. T Sec square θ, right? Equal to Sec square θ, right?

65. Ss Yes

66. T This one is another identity. Now look at how I will arrange them and I will give them a name, this one is call the Pythagorean identity, you have the, first one is what?

67. Ss Sin square θ plus Cos square θ is equal to one

68. T One right?// Now look at this, look at this one can I bring, can I shift this one to this side? Look at this Can I shift this one to this side?

69. Ss Yes

70. T If I can do so, I will now have Cosec square θ minus, right? Cot square θ is equal to what?

71. Ss One

72. T- Is equal to one, right? Is equal to one and the other one is, look at this one, Can also shift this on to this side?

73. Ss Yes

74. T I will now have Sec square θ minus Tan square θ equal to one. Now these are what we refers to as Pythagorean identity, is that Ok? Now we have Pythagorean identity. Now copy so that we can solved some problems. Write, write, write. Remember what we said while writing this is right angled triangle right? And we said Sin θ is equal to opposite over hypotenuse, we said Cos θ equal to adjacent over hypotenuse and we said Tan θ is equal to opposite all over adjacent, and we now introduce the concept of Cosec, Sec and Cot, right. If you take the reciprocal of Sin, the reciprocal of Sin θ which will now become one all over Sin θ and which we said is equal to the Cosec θ one over Sin θ is the same thing as Cosec θ and which is the same thing as hypotenuse all over opposite, is that ok? And taking the reciprocal of Cos θ we have one over Cos θ and which is the same thing as Sec θ and which is the same thing as hypotenuse all over adjacent. And the last one is when you take the reciprocal of Tan θ, the reciprocal of Tan θ is the same thing as one over Tan θ and which is the same thing as Cot θ, right? Now we move ahead to introduce another concept, the Pythagorean identity. Last week we know how comes about this identity, right? We obtain this one from this right angled triangle. From what, from Pythagoras theorem is that ok, where the law said that when you square the hypotenuse, it will give you the sum of the square the opposite and square the adjacent. That is how we got the first identity. And the remaining two came from the first identity. Which we said these three identities here we said they are Pythagorean Identities. Can I clean this side?

75. Ss No sir

76. T Yes can I clean?

77. Ss Yes

78. T (Teacher cleaning and writing an example to be solved on the board) Given that Sec x is equal to 5 all over 3 calculate without using table i) Cos x ii) 1 + Tan x all over 1- Tan x iii)3 + Cosec x all over 1+ Cosec x. Now stop writing everybody. If you done with that, I can only be telling you what to write, number one, stop writing all of you. All of you stop writing, stop

writing, now look at the board, look at the board. Now, what is given in the question, look at the question, what is given in the question?

79. Ss Sec x

80. T Sec what?

81. Ss Sec x

82. T Sec x, given that, this is given right?

83. Ss Yes

84. T Given that, this Sec x is equal to what?

85. Ss 5 over 3

86. T 5 all over 3, now how can I translate this one, what is Cos x? How can I translate this one? Yes somebody should tell us, if you know the answer let me see your hand up. From the, even from the last example we solved same way. When you read you're book at home you will know to do this, then how do we do this? I, we have, we have three methods, I mean two methods. If you have an idea stands up and tells us. Stand up, stand up. You that is laughing, stand up, stand up and tell us. You stand up and say something. I will now put my eyes on you. Ok//, because I know, I thought you something like this in our last class. Now the two methods, if you like you can go by identity or you can do what? You can draw what? From Pythagoras, draw what? Right angled triangle right?// Oohyaa, stand up and tell me what to write, just be telling me, I will be writing, just be telling me. Ok, he said I should draw a write angle triangle, now let me draw, right angled triangle. Something like this right?

87. Ss Yes

88. T Ok, I should give a sign of an angle or what? I should now include the angle before writing the angle or what?

89. Ss Yes

90. T Ok, you said I should, the angle can be anywhere right? Let just choose this one. This side is mark angle x, now, this is what will tell you where your opposite is and where you adjacent is ok, now. What is this?

91. Ss Sec

92. T What is Sec?

93. Ss Hypotenuse over adjacent

94. T Hypotenuse over, you have said it now, Sec is what? Hypotenuse over opposite, Is it opposite?

95. Ss Adjacent

96. T Over adjacent right?// Now where can I write 5, look at the board, where can I. If I see you writing I will send you out. I don't want to see anybody writing. This is Sec equal to Hypotenuse all over what?

97. Ss Adjacent

98. T Adjacent right?// Now which side is my hypotenuse?

99. Ss That side

100. T This side?//

101. Ss No

102. T This side

103. Ss Yes

104. T So this my hypotenuse right?//

105. Ss Yes

106. T And which side is my adjacent?

107. Ss Down

108. T Somebody said this side

109. Ss No

110. T Adjacent is where?

111. Ss Down

112. T This side right?

113. Ss Yes

114. T Now how do I get this side? What is this? Ok, ok, ok is ok. Now how can I get this Cos x from here? What is Cos?

115. Ss Cos is here

116. T Just define it what is Cos? Cos is this over this, say it let me hear

117. Ss Adjacent over hypotenuse

118. T Adjacent all over

119. Ss Hypotenuse

120. T Right, now, finally I will now say Cos x is equal to what?

121. Ss 3 over 5

122. T 3 over 5, 3 over 5 this one is the correct answer right, because it will not take long. Since you know what is Sec right, Cos x is equal to P over Q right. Look at the board, sit down, sit down, If Cos x is equal to P over Q and you said Sec is reciprocal of what? Cos right//. Ehen you turn them upside down it will give you the value of Cos. And this is Sec now, look at this, what is this?

123. Ss Sec

124. T And if Sec is given, and the question is find Cos, why can't you put this one here and bring this one down that is all//. With one line you have finish, is that Ok? Ehen//. So Cos here is the same thing as bring this one up and bring this one down, Cos is 3 over 5. So we have finish with this, is that Ok?

125. Ss Yes sir

126. T Now number two, look at this 1 + Tan x all over what? 1- Tan x. I want you to solved this thing through the identity we have there. Look at//, look at among the three identities. Which one will I use to evaluate this if this one is given, and the question is, I don't want live this with right angled triangle? From that identity somebody should stand up now and tell me which one will I use to solved this? The Sec is given and the question involve there is Tan, which one will I use, if you know the answer show by rise of hand, yes

127. Ss The last identity

128. T She said the last identity, yes, sit down she is correct, that is good right? Can someone tell us why are we going to use the last identity, why? Yes, stand up and tell us why are we going to use the last identity. Why are we not using this one, why not this one, is only this one we will use to get what is needed here. Yes

129. Ss Because Sec is given and we are looking for Tan

130. T The answer is what is given there is Sec, right? And look at Sec here and the question concern content Tan, is that ok?

131. Ss Yes

132. T So that is why we will bring this and use it not this, is that ok?

133. Ss Yes sir

134. T If you use this you will get the answer but it will take you a long way. But there is a very short way for us to get this, now the process. What is given and what is even this one. This is Sec square x minus Tan square x equal to one. (Another teacher excuses the lesson teacher for announcement to the students on school fees issues). Now listen, what is given? Look at it

135. Ss Sec

136. T Sec right?// Sec x is equal to what?

137. Ss 5 over 3

138. T 5 over 3, and in the identity, listen, be careful. The identity content squared, squared, so if I square this side, I will also square this side, is that ok. so if I square this side what will I have this side?

139. Ss 25 over 9

140. T 25 over 9 is that?

141. Ss Yes

142. T Now can I bring this one substitute it to this one?

143. Ss Yes

144. T So I will now have 25 over 9 for the Sec square minus Tan square x equal to one. I will now bring Tan x here and bring one here, any how you do it, provide you look for any easier way. So we will have 25 0ver 9 minus 1 equal to Tan square x. Do you understand what I did here? No problem right?

145. Ss Yes

146. T Tou// (right), 9 times 1

147. Ss 9

148. T 25 minus 9 over what?//

149. Ss 9

150. T All over what?// Is it all over 9 or all over 25?

151. Ss All over 9

152. T Look at, this can be written as 25 over 9 minus 1 over 1, so what is the LCM

153. Ss 9

154. T What is the LCM of 9 and 1?

155. Ss 9

156. T 9 into 9

157. Ss 1

158. T 1 times 25

159. Ss 25

160. T Minus 1 into this

161. Ss 9

162. T 9 times 1

163. Ss 9

164. T So this one is 25 minus 9 over 9 is that ok?

165. Ss Yes

166. T 25 minus 9, 25 minus 9

167. Ss 16

168. T 16 right?// Over 9 remember is equal to Tan square x, so this is 16 all over what?

169. Ss 9

170. T 9 equal to Tan Square x, this a perfect square number?

171. Ss Yes

172. T What about 9? How do I write this as a perfect square number?

173. Ss 4 over 3

174. T So this is the same thing as 4 over 3 all in bracket square equal to Tan square x, so the square will go, meaning that no one is having square now, so Tan x is equal to 4 over 3.Now I go back to my question anywhere I see Tan x I will remove away the Tan x and replace it with 4 over 3 and I will simplify, is that ok?

175. Ss Yes

176. T So this is equal to 1 right plus 4over 3 all over 1 minus 4 over 3. 1 times 3

177. Ss 3

178. T plus 4

179. Ss 7

180. T 7 over 3, right?//

181. Ss Yes

182. T 1 times 3

183. Ss 3

184. T Minus 4

185. Ss Minus 1

186. T Minus 1 over 3, what do I do with this 3 and this 3, they will cancel them self-right?

187. Ss Yes

188. T Minus 7 right?//

189. Ss Yes

190. T 7 divide by minus 1

191. Ss Minus 7

192. T Any question? You don't have any question

193. Ss Yes

194. T Good// (Teacher pointing to the board) Write, write//. Ok//That is where we will stop on this topic for now// please solved this as homework iii) 3 + Cosec x all over 1 + Cosec x // Tomorrow we continue with geometry.

Teacher G (25/01/2018)

1. Ss Good morning Sir//

2. T Good morning students//. And sit down//(Teacher write the topic on the board and ask students a question on triangle, then gave them dictation)//.What is a triangle? Write, write. A triangle is a plane figure, plane figure, a triangle is a plane figure, bounded, bounded, bounded by three straight lines. A triangle is a plane figure bounded by three straight lines, right? I didn't say a triangle is a plane figure bounded by a line. Did I a line, I said straight lines. So that means just write down what I said. This is a straight line, if I draw anyhow, if I draw like this, is this line straight?

3. Ss No

4. T This one did they come together? Draw it slow, slow. This one has come together that give you the triangle. Where is a graph? What is a line? What is a line? Any way lines does not exist, only God that see lines, do you know this line, this is a rectangle, is this a rectangle?

5. Ss Yes

6. T Ehen, rectangle, we still have demarcations, then you have the small one like this, can you see that now, it have a very small width, right//. Ehen//. Just, we just use this one to draw a line, a line is a distance between two points//, Ehen// we only use this to represent the line, are you here right. And a straight line is the shortest distance, a straight line is the shortest distance, a straight line is the shorted distance between two points. Don't worry; I still explain so that you can understand what I am saying. Now, listen, listen once again, this a mountain, and you are travelling to let's say from point A to point B. can you pass through the mountain?

7. Ss No

8. T What do you do? You can either clamp up the mount from point A to point B and when you go by air, you can just go straight from point A to point B, which of the two make it straight?

9. Ss Air

10. T Which make it straight?

11. Ss The air

12. T You can see now, this one is straight while this one, you go, go, until you move down to point B but you can see now this once they are all lines but they are not straight, you can go straight, you can go down. You can go straight. A line is a distance between two points and a straight line is a distance between two points, are you there?

13. St Yes

14. T So a triangle is made of lines. Now types of triangles. Somebody says what? Yes

15. Ss Right angled triangle

16. T Right angled triangle Ehen// look at me, Yesterday I (…).Stop writing, yesterday I talked about triangles, I remember talking to you about

triangles. What did I say about triangles, I say that the handle of a clock is right angled right//. What is right angled? What is another name for right angled?

17. Ss 90 degrees

18. T Clap for him once, right angled means what? 90 degrees, right? That means right angled triangle has one angle that is 90 degrees. Draw a line like this, this angle is the 90 degrees that is why we call it, right angled triangle. Yes another triangle, you

19. Ss Equilateral triangle

20. T Yes, Equi means equal right, equilateral triangle means all the sides and all the angles are equal right? And each angle is 60 degrees, emum? What is the sum of angles in a triangle? 180 rights?// (Teacher sketching a triangle on the board) Look up if I do like this, do like this, that means this and this have the same length, that is what it shows. If I do like this that means all of them have the same length. If this one is 10 units this one and this one will also be 10 units each and all the angles are 60 degrees each , equilateral triangle. Next one, yes

21. Ss Isosceles triangle

22. T Isosceles triangle, yes, Isosceles triangle is a triangle in which just two sides are equal and the base angles are all so equal. This mark shows that they are equal right?// Isosceles triangle//. Next one, yes

23. Ss Acute triangle

24. T What???

25. Ss Acute

26. T Acute triangle, BANSANIBA, come, you said acute triangle

27. Ss Yes sir

28. T Come, come, come, KUN SAN LISAFI IRIRI NE, BANSAN ABIDA YAKE NUFE BA KOO? YAWA. You said acute triangle?

29. Ss Yes sir

30. T Ok, let’s see, maybe, can you help us, draw, draw it here (Student unable to draw). Yes, hey this boy

31. Ss Obtuse triangle

32. T No sir, we don't have obtuse triangle yes

33. Ss Scalene triangle

34. T Scalene triangle, scalene triangle, none of the side are equal, none of the angle are equal, are you there?

35. Ss Yes

36. T Yes, yes, I will come to you later scalene triangle and the last one, yes

37. Ss Obtuse angle triangle

38. T Obtuse angle triangle, one of the angles there, one of the angles is more than 90 degrees. We call it obtuse triangle; now let's go back to scalene. This triangle to me is very, very important triangle, because you can all this other triangles from it. Look at this, (Teacher draw and partition a scalene triangle into many types). You can get right angled triangle, isosceles triangle and others from it. To me scalene triangle is a black man, because you can get all colors from it. What did I say?

39. Ss- Scalene triangle is a black man

40. T All colors, when you put them together turn black//; you don't know?

41. Ss Yes//

42. T It turn to black, we are blessed with black skin. All this people, white, red are in us. All this people, do you know them? BATURE, those in America, all Chinese, everybody are in us. Good girl, I love that, good drawing, use your hand. Don't use biro (Teacher asks students to draw the sketches on the board, while moving and encouraging them). You don't obey simple instruction? Why? Please close your book, where is your own, you are not even writing. Get out, get out. Solving triangle, you can do with your triangle like this. I said you should solved this triangle, listen to me all of you. If I say solved this triangle, solved, meaning you should find all the angles, are you listing to me, the length of the sides and the space occupied, that means the area. If you do that that means you have solved the triangle, is that clear. So in this case we are not, we are not going to consider right angled triangle imum?// We are not going to consider rest of the triangles, are you with me? In right angled triangle we use SOHCAHTOA and the

other one, so we don’t need them. So we are going to use two methods; one Sine rule, Sine rule and what? Cosine rule, are you there?// Sine rule state that, sine rule says that in triangle ABC, just say that in triangle ABC. Look up in triangle ABC, when you write in triangle ABC then come back to this write in triangle ABC then come back to this in triangle ABC, are you all here? Small a allover Sin capital A equal to small b allover Sin capital B equal to small c allover Sin capital C //. if you reverse the formula, you will have Sin capital A allover small a equal to Sin capital B allover small b equal to Sin capital C allover small c if you reverse it you will still get the answer.(Teacher sketching a triangle on the board). Now look up, this A, can you see, when I talk listen and look at me, you are busy writing. This A you are seeing is the angle, all the capital letters are the angles while the small letters are the sides. Side AB is small c, side BC is small a, while side AC is small b. Small a allover Sin capital A equal to small b allover Sin capital B equal to small c allover Sin capital C .when you see small letter means distance or length are you with me now?

43. Ss Yes

44. T When you see capital letter they are talking about angle, do you understand what I am saying

45. Ss Yes

46. T if you take your text book you will think that this formula comes from heaven, it has been derived , take your text book now you will see this formula is for calculating sides and angles of triangles. Let me see, let me see, see now this proof is given for interest only//.eeee, the proof they are here, this proof is given for interest only. Remember the formula c allover but don’t memories the proof. So as it is just try and remember this formula, Small a allover Sin capital A equal to small b allover Sin capital B equal to small Sin capital C , or the reverse of it, Sin capital A allover small a equal to Sin capital B allover small b equal to Sin capital C allover small c, you will still get the answer, and remember we use surd to get answer, are with me now?

47. Yes sir

48. T Any problem?// Any problem?// In our next class we are going to see how to use this formula to find, to solved a triangle. If they give you triangle with two sides to find the other sides or they give you angle to find the other angles, is that clear?

49. Ss Yes sir,

50. T And remember is not for right angled triangle, for other triangles but not right angled triangle, all other triangles but not right angled triangle, are here?

51. Ss Yes

52. T So no problem, no problem are sure//

53. Ss No sir, I have a question

54. T Yes

55. Ss You said is not for right angled triangle, for other triangles, any reason for that?

56. T Sit down, all women ware brassware, Koo?

57. Ss Yes

58. T Why is it that you didn't buy brassware? Stand up and tell us, why is it that you didn't buy brassware Why is it that you didn't wear brassware? Is there any reason for that?

59. Ss Yes

60. T What is it?

61. Ss Because men don't put it

62. T Ehen, yes men only ware singlet. See this right angled triangle, we use SOHCAHTOA, but not Sine rule, when they ask you to solved right angled triangle don't even think of Sine rule and also don't use SOHCAHTOA for other triangle, imum, imum, imum, you either use Sine rule or Cosine rule. Is there any problem?

63. Ss No

64. T Are you sure?

65. Ss Yes

66. T You said you don't have any problem?, come stand and face the class, state the Sine rule, KA IYA AYI, you said you don't have any

problem, come and write it on the board (Student was unable to write the Sine rule correctly, the teacher and the class laugh at him and ridicule him with hand clap). That means he start getting it right, he just reverse it. Please don't make that mistake. Learn it gradually please//. We meet in the next lesson//.

Teacher G (30/01/2018)

1. Ss Good morning Sirs//
2. T Good morning students//. And sit down//. Let's continue from where we stop in our last lesson// i.e. solving triangles//. To solved the triangle meanwhile//.To solved the triangle meanwhile, you have a triangle like this (Teacher sketch a triangle on the board) to solved it, either find the length side or that of the angle, right?
3. Ss Yes
4. T That is the problem. So I checked the formula for finding triangle? We call it Sine rule, what?
5. Ss Sine rule,
6. T We have, we have Sine rule and Cosine rule, please let me be the one, I have forgotten, what is Sine rule? I have forgotten, yes, come where is the boy of that day, where is him? KAYI DAN ISKA. Can you remember now? Eeeee, Are you sure? Come out. That day HAAAAA, no, go there, there and write.
7. Ss $\frac{a}{SinA} = \frac{b}{SinB} = \frac{c}{Sinc}$ (Student writing the Sine rule correctly on the board)
8. T Please clap for him, clap for him. Yes, Sine rule state that, in triangle ABC $\frac{a}{SinA} = \frac{b}{SinB} = \frac{c}{Sinc}$ a allover Sin A equal to b allover Sin B equal to Sin C ,and also, you can also say $\frac{SinA}{a} = \frac{SinB}{b} = \frac{SinC}{c}$ Sin A allover a equal to Sin B allover b equal to Sin C allover c, you will get same answer, don't crime it, don't boarder how they get their formula, but just use it, is that clear?
9. Ss Yes

10. T Fine, example 1: In triangle ABC, in triangle ABC, angle B, you write capital B, angle B, just $B = 39°$, because of time, then $C = 82°$ and side a= 6.73cm that means this a side, right?

11. Ss Yes

12. Find c, Find c. in triangle ABC, AB (Teacher pointing to $B = 39°$ on the board) whenever you see capital letter means angle, right?

13. Ss Yes

14. T Angle $B = 39°$, angle $C = 82°$ and side a= 6.73cm, find c, (teacher cleaning the board) see, now look up, you observer the three angles, imum, you can draw the triangle. Angle B and C are they the same?

15. Ss No

16. T Just draw and show the angles, remember we are not measuring the angles. Just draw (Teacher sketching a triangle on the board), which among the two can we label as angle B and C?

17. Ss That one (Students pointing to the angle on the left hand side of the sketch on the board)

18. T This one right?// (Teacher writes $82°$ at angle C)

19. Ss Yes

20. T And B, anyhow, anyhow, let's call this one angle $B = 39°$, and this one is angle A. Which was given? a right?

21. Ss Yes

22. T a is what?

23. Ss 6.73cm (chorus answer)

24. T 6.// I don't want everybody to speak, yes

25. Ss 6.7cm

26. T 6.7cm, what are we ask to find?

27. Ss c (chorus answer)

28. T BAGA C NAN BA//. Ehen, see c now, please, umm I am coming, you come, come and show me c please come and show me small c//, show us small c

29. Ss (Student pointing to angle C)

30. T (Teacher collects the chalk from the first student and gives to the second student to try and he correctly) this is small c, do you get it now?

31. Ss Yes

32. T And this space is small b, and small a is here in this space, that one is given (Teacher pointing the sides of the sketched triangle on the board) and small b is this place, this length. That means if you observed line AB is small c, so don't be confused if they ask find line AB, line BC is small a and line AC is small b is that clear

33. Ss Yes

34. T So next, that is the first thing is the sketch, this is the idiot, like this, in fact this is where maths are, maths, because once you didn't get here, you cannot progress forward. So, next is the formula, what is the formula please?

35. St $\frac{a}{SinA} = \frac{b}{SinB} = \frac{c}{Sinc}$ (Chorus)

36. T Our a here is what?

37. Ss 6,73cm (Chorus)

38. T Substituting in the formula//. Instead of a you writes 6.73, then Sin A (Teacher rises his hands up, expressing surprise) Sin A is what?

39. Ss 6,73cm

40. T Where is it now? Where is Sin A? Where is it? You have this and this, what is the total angle in a triangle?// Is 180 eeee. Please help me find it. If you like we can do away with this triangle and get the one with angle A eeee, or in fact, let us calculate the A on this one. So angle $A = 180° - (39° + 82°) = 180° - 121° = 59°$. So our A is 59 degrees, we can now use it. Substituting in the formula let me do it here so that everybody should see. a is $\frac{6.73}{Sin59} = \frac{c}{Sin\ 82}$ Yes sir (Teacher pointing at c on the formula) that is what you are ask to find. If you like you can cross multiply, eeee. Just cross multiply and solved the problem. Now $cSin\ 59 = (6.73Sin82)cm$ remember you want to find c right?

41. Ss Yes

42. T You have to divide both side by the coefficient of c, right? So $c = \frac{6.73\ Sin\ 82°}{Sin\ 59°}$ use your calculator and tell me the answer for Sin 82. What is the answer?

43. Ss 0.9902689

44. T 1,2,3,4 you count 4 digit form decimal point to approximate 6 then it will become 0.9903. So instead of Sin 82 you now write 0.9903 and Sin 59 is what

45. Ss 0.8972

46. T By substituting $c = \frac{6.73 \times 0.9903}{0.8972}$ use your calculator to get the final answer please

47. Find the remaining angle of triangle A, B, C, yes//. Just draw triangle and put A, B, C 292 (Teacher gestured with and demonstrated the position of A, B, C on a triangle). Find the remaining angle of triangle A, B, C, taken?// Of which a, eee,// put a, I mean small a, side a, write small letter a = 12.5 cm, a is 12.5 cm taken?// Small c is 17.7cm, 17.7cm and capital $C = 116°$, $116°$//. So what do we have?// If you observe, one of the angle is $116°$, right? Do you observe? Do you observe in the question? One of the angle given is $116°$//. Just draw like this, just draw the triangle like this//. (Teacher sketched several triangles on the board and showing students the position of angle C) one of the angle is $116°$//. So from the drawing now where is your c, where is our small a?// Where is our small a?//

48. Ss Small a is 12.5cm on line BC//

49. T Small is 12.5cm//. And where is our small c?// Come and show me small c//

50. S (A student pointing at middle of line AB)

51. T That one is small c, what about here?// What about here?// You come and show me small c// (Teacher call another student)

52. S (A students pointing on the whole of line AB)

53. T Ehen//, from here to here that is small c, don't just show like this, the whole line. So small c is given to us as what?//

54. Ss 17.7cm//

55. T 17.7cm, you can even see it that is longer than the other side// (Teacher pointing at the sides of the triangle). Ehen, we are going to find the value of this one and this one now//. We use sine rule which says that $\frac{a}{SinA} = \frac{b}{SinB} = \frac{c}{Sinc}$ a allover Sin A equal to b allover Sin B equal to Sin C//. So we want to find here//. So this over Sin this, equal to what?// See this over Sin this equal to this over Sin this, that means you use the value of this one to find the value of this angle, are you there?// (Teacher pointing to the values on the sides and angles of the triangles). Do you get it now?// We are solving this problem//. Listen now//. We said using Sine rule, then we solved it//. Any problem?// (Teacher writing). Using Sine rule $\frac{17.7cm}{Sin116°} = \frac{12.5cm}{SinA}$//. So with this thing now, we want to find the value of angle A//. THIS IS DANGEROUS//. Because this question is different from what we have been doing before imum?//. Do you get now?// We are now going to find the value of angle A//. We now cross multiply this by this // (Teacher pointing to the problem on the board). We will have 17.7cm times Sin A = 12.5cm times Sin116, ok?// Now, what have I done, times BA//. Even me I was looking at that boy outside, said times and I wrote something different//. So remember, what we want to find is the value of A//. So we divide, we divide// Just live it there, look up//. We are going to divide both side by the coefficient of Sin A right?//

56. Ss Yes//

57. T I SAID JUST LIVE IT THERE//. We have Sin A right equal to 12.5times//. Please, what is the value of Sin 116? Eeee?, what?//

58. Ss we cannot find the value

59. T (Teacher collected calculator from a student and find the value of Sin 116). Sin 116 equal to see it there now//. Read it out for me

60. Ss 0.8989

61. T 0.8989 all over 17.7cm//. This cm will go//. What you have there is Sin A = this times this is what?//

62. Ss 11.23625

63. T 11.23625 all over 17.7//. So now Sin A = divide it for me//

64. Ss 0.6348163

65. T 0.634816, therefore Sin A = 0.6348, 354. We want to find the value of A//.Because A is an angle//. So let's look at the value of A. who will tell the value of A? Yes//

66. S You will take Sin inverse

67. T Sin Inverse, what do we mean by Sin inverse?// Inverse, that is the reverse of what you are going to do, do you get me now//, the reverse//. PLEASE LOOK UP//. Please; we are going to find Sin 60 degrees, imum?//. We are going to use calculator//. Or four figure table//. Then we get Sin 60 = 0.866//. Who is answering again?//

68. S I am

69. T WHO ASKED YOU?//. And you are giving nonsense again//. Is 0.688//. Sometime you will be given 0.866 to find Sin 60//. That is the inverse//. I mean, you know what we are saying now//. Like here again I will just say find Sin 60? Is there any Sin 60 here?//. But if you are ask to find Sin 116 we were able to find 0.9 whatever//. Sometime I will ask you to get back Sin 116//. That exactly what we are doing here imum?//. So $A = Sin^{-1}(0.6348)$ can you see it now?//. Now what is the inverse of 2?//. The inverse of any number is that number raised to the power of minus one//. Do you get me now//. That means the inverse of two is 2 raised the power of minus one//. The inverse of $P = P^{-1} = \frac{1}{P}$ imum?// 383. The said Sin A inverse that means the reverse of it eeee. Opposite of it// (Teacher gesturing). $Sin\,A = Sin\,A^{-1}$ 386//. That is what we have here//. Please in our next period come with your four figure table//. Are you with me now?//. If you have it//. Please open to page 238 now//. If you are there you will see Sin of angles//. All of you open to sine of angles, are you all there?//. Now, check, 60, go to 60, 60 are you there//. KUNGAMANE?// (Have you all finished?). Please show me sin 60 along this 60 you have 0.8660 right?//

70. Ss Yes

71. T So next, I will give you 0.688 so that when you are to find the value of that Sin, you start from right and go to the left//. But now you are given if Sin 60 is given to you, then you start from the left and go to the right//. Look

for Sin 60//. Now go to the value 0.688 in your four figure table and find Sin60

72. 401. Are you there?//

73. 402. Which number is by the side?//

74. Ss 60

75. T Now we have 0.6348//. Please try and test, go to that place, that environment// And trace this one 0.6348 is there any number 0.6348, please fast, 0.6348, can you find it there?//

76. Ss 0.6347

77. T 7 instead of 8, that is right//. IN KUNGAMA, SAI A JA LAYI //(If you finished, then draw a line). That means, yes sir, so our A=39 degrees//. That is the final answer//. Let me see your calculator//. Press Sin//. Then press second function or shift//. Did you press it? Press second function or shift, did you press it?//. Then Press Sin, what did it appear there?//

78. Ss Sin inverse

79. T Sin inverse eeee, Sin inverse//. Then press 0.6348

80. Ss 39.4

81. T Can you see now 39.4 is it not 39 now? That is the answer//. So let us use calculator to calculate the other one//. You see inverse//. Press second function//. And press Cos, what did you see there?// Did I give you any value? You will see Cos and inverse//. (Teacher move around encouraging students to write the work given to them on the board). So yes//, yes this place angle A, we have find it//. But we have not find, the value of angle B//. So $\hat{A}+\hat{B}+\hat{C}=180°$ sum of angle in a triangle//. So our A is 39//. Our B that is what we don't know//. And our C is 116//. Therefore we have $39+B+116=180$, $\hat{B}=180-(39+116)=180-155=25$ //. We are left with small b to find and we will do that, We will do that, we will do that// (Teacher pointing hand down). To find the value of small b we still use the sine rule. $\frac{b}{Sin25}=\frac{12.5}{Sin39}$ $b=\frac{12.5\times Sin25}{Sin39}=\frac{12.5cm\times 0.4226}{0{,}6293}=\frac{5.2825}{0.6293}=8.3942$ //. Therefore $b=8.4cm$//. You can see that I have solved the problem completely//. Example 2: in a triangle A, B, C, angle A is 54.2

degrees, angle B is 71.5 degrees and small side a is 12,4cm find b//. I have given you this to solved//. In our next class we would discuss Cosine rule.

Appendix E: Examples of Reflective interviews

Teacher E (01/02/2018)

1. R what are the most important challenges in the teaching of Mathematics at SS2 in your school?//

2. T Actually, theeee, the task, there is the students' themselves//. After teaching, no time for them, they don't have that time for them to sit down and practices//. Maths needs time to practise every day//. Every day you have to practise and after teaching, they will tell you IMUM OOOOOH//. Ok we understood everything, when you ask them a question// (…). Maybe, after two or three days, when you go back to ask them question on that particular topic you treated with them, you will find out as if you did not teach them//. Because they did not go back to practise, they need to sit down//. After each lesson they need to sit down and work over what they were taught on that topic//. So they don't have that discipline to go back and practise//. So that is a challenge// is a problem//.

3. R why do you think that this practice is so important?//

4. T The practice of going back to study…//

5. R Exactly//

6. T That is good//. Because, if they go, if they practise it, it will become part of them//, it will be easier for them and any time you meet with them, they might ask questions even in exams or tests//. It will be part of them, they may grow with it//. Because practice makes perfect as long as they did not practise it, it will, it seems, it will be difficult for them//. Maths is not like other subjects that you can just read a story//, you need to sit down, use your hands, write, practise it//. Not reading like reading a novel//. Maths is not like reading a novel, it is not like history or other subjects//. It needs you

concentrating, to study, to practise//. So that it becomes part of you, even if they don't use it now later in life they can use it//.

7. R What, for you are the problems (E.g. cultural, language) of teaching Mathematics at SS2?

8. T The problem here is right from the foundation, the foundation is not built properly, like this is a federal school, is been expected that the, the girls, this is a girl school, at least they have a good foundation. Some of them are coming from eeeee, L. E. A. primary school that is local Ehen. Where basically they are been taught with Hausa or other tribes. So coming to a federal school, a federal school is supposed to be a STANDARD SCHOOL, where any child that is coming should have a good foundation, if the foundation is not laid properly, the building on it will shake. So that is what is affecting us. Some of them, EVEN THOSE IN SS2 SOMEBODY CANNOT SPEAK VERY WELL, and because is a federal school is been eeeeemm, we don't use Hausa excerpt if it is Hausa lesson, we don't use Hausa to teach Mathematics. It is sole English, but if there will be, if maybe federal government will say use maybe any language to teach, then we would cooperate. BECAUSE SOME OF THE FOUNDATION HONESTLY IS BAD

9. R To you, the problem of the foundation, is it attributed to the language or the content of the subject?

10. T By foundation I mean, when a child is not, we are talking of Mathematics, that eem fear in you eeeem, how will I call it, fear of Mathematics, HEARING THE NAME MATHEMATICS, it's scared them, you know scared them, I remember in our Secondary School during Mathematics, you will see students will be running out of the class, because that fear is the fear of Mathematics is difficult, Mathematics. So if you see a Maths teacher you will start, in fact you will hate the teacher or you will be running away. There is fear, there is lack of foundation. Proper up bringing

in Mathematics, because the fear, even now you have to be talking to them, Mathematics is not difficult. Like example, I use myself, this is a girl school, so I use myself as an example, I say to them, if I will study Mathematics up to this level then you don’t have anything to fear. So I tell them remove fear, Mathematics is very simple; if only you will concentrate, and study and develop interest. Some is lack of interest, when you see Maths teacher, (teacher heist) oooooooh, this man is coming again, or this woman is coming again, so interest is not there. So they need to get interest, remove fear, then they can understand (…)//. And Language also contributes, and so like this our terrain, when they are not vast in English, they don’t want to study English, and now you are bringing eeeeeee, Mathematics in English, and language itself is not well, is not eeeee,is not strong enough, so it bring problem.

11. R What is it in the language that is a problem?

12. T You know this language is a borrowed language. The English itself is not our indigenous language, is a language that we captured it (teacher gesturing by raising hands up), and we need to make use of it. So you find out that a child, we are still going back to foundation, a child brought up in Hausa, or maybe Jukun at home, everywhere around the child is Hausa and the child find his or herself in a school where there is no Hausa. So the child tries to grab (teacher gestures with hand), by all means, I have to speak English (…). So, but they, the knowhow of that language is not in the child. I capture it in the afternoon, so I must use it, but if a child, in a home where you know they communicate in English, the child is conversant with it, they communicate in English, even though their traditional language is there, but the child is use to those small, small English. So when it comes to Mathematics s/he just applied it, what I know already, so you know we are going back to foundation Ehen//

13. R How have you been trying to overcome these challenges in your teaching?

14. T You know the eee, in Mathematics we don't use this big, big grammar like English. So since we are not allowed to use Hausa to teach, personally, I try to explain in such a way that they will understand. I try to use the language as simple as they will understand. I give so many examples. I explain, if it is one example, I try to explain for them to understand. I will ask them do you have problem, they will say no, then I go to the next one, I go to the next example.

15. R Now, what for you are the practices which worked well? Can you describe briefly what you do and why you do it?

16. T I give, in Mathematics after teaching, it is expected you give assignment. When you give assignments and students know that you are the type that insists on them to bring it for you to mark, they will do it, even though some of them, they will copy. Do you understand? But few once will sit down and do the assignment them self, while others will come and say just give let me copy, but if one or two can sit down and do it// (…) faithfully, they can do it themselves. And another thing is I try to remove the fear in them, that Mathematics is simple, simpler than any other subject. I tell them to practise it that is my day to day. Make sure you practices Maths every day. Even if is five minutes of your time, make sure you practice that Maths. Don't allow a day to pass without you siting down and practicing it. So with that some of them picked up, some of them can bring it and to say ma or aunty, solved this and this, I have problem with it//. when teaching using English, because of the problem of language, some seems not to understand very well, but if eeeee the, eeee the teaching will, maybe slow down to Hausa, since Hausa is the general language around this place, if the teaching will be slow down to maybe Hausa, then some of them may

understand it better, better. Like I was studying eeeee , like, I did my project in mother tongue in teaching Mathematics

17. R Why do you think these mentioned problems deserve special attention?

18. T Mathematics in general deserves special attention because is a subject where people imum in quote (teacher gesturing with her two hands) think does in the Mathematics has two heads imumm, but this is not so. Mathematics is just like any other subject, just like any other subject, so Mathematics need right from home, from the parent, needs to, parents needs to encourage their children. That is why in school, Mathematics is very important, because like in this school, if you don't pass Mathematics, you are not going anywhere. You need to sit up to read, to study it, not reading, to practise it. You use your hands to practise and know it. Not for exam seek, you just cramp balabalabala, you go and pour it that is all, is off, you cramp, you off, off your brain. You practise; you know it, so that it will be part of you. So Mathematics in general need special, if you, I don't know how to quantify it, very special attention.

19. R You mention a couple of things, particularly the use of home language. To you personally, how do you look at the use of home language in teaching Mathematics?

20. T The using, personally, personally, because I have done the research in it, I know that the using apart from English, using their local language to teach Maths, they will understand better, they will understand, in fact, they will move along with you by, because it is in their own dialect. So they will move along with you, their attention will not be divided, they will go with you. If it is like, some of them will not even understand. But if it is their dialect they will understand aummum. You know, I told you SIFILI, I didn't know that zero is SIFILI in Hausa, is the students that said ma SIFILI, zero is

SIFILI. SIFILI NE IYI, and so I also learn that zero is SIFILI. So anything that involve zero, they know eeeeh this one is SIFILI. We live it simple and easier.

Teacher M (30/01/2018)

1. R Now, what are some challenges for you in teaching Mathematics at SS2?

2. T Some of the challenges, you know this our students, eeeeeee, problems with some of the subject, at that level. You know students, some of the students, their, their foundation at the primary level, in truly addressing the teaching of Mathematics in SS2, because some of them, the problem of foundation is that, some of the students don't know it, because they did not finish the Primary School. Some of them left Primary School, at Primary four, Primary five, some of the ideas they supposed to have gotten before reaching the Federal School, those ideas are also yet be address in the learning of Mathematics, even at SS2 level. Some of the ideas are very important, once you don't get them, they will continue to affect you except if you make eeeee greater effort to cover all those aspects, if not they will continue to affect you. The foundation counts a lot, so apart from the foundation aspect some students lack of concentration or some of them, apart from concentration already they have gotten idea that Mathematics is a difficult subject, so they find it difficult to meet up, so that idea is still in them. So anything you are teaching is difficult to them. Is already inbuilt in them because of the mentality some people have given to them right from the beginning or along the line at that level.

3. R Can you give example of some of the difficulties you face in the class?

4. T An example, like example, let's say this issue of, maybe you ask, maybe you came to a particular aspect you say 5 times 7 and students they don't response to it immediately, some of them will go back and be looking

at their multiplication table which they supposed to have learnt since Primary school. That is why I said that it is affecting the teaching of the subject, so it takes them time to give an answer to 5 times 7 is 35. Some of them will have to go to their multiplication table, some of them will go to a calculator to go and press before the will give 35. You can see that it is delaying, it's a kind of go slow to the teaching of the subject because they, you will not cover much, because of this kind of a thing.

5. R Apart from these two or three issues, you have mentioned as challenges, do you also look at culture or language as one of the challenges?

6. T Actually is also one of the things, there are some students eeeeeee, we have different, maybe the short coming in the area of language is, maybe there are some of the students that they are used to this Hausa, Hausa, maybe you try to tell them some things in Hausa, they will understand it better than when you are using English language, so there is one thing that there is a situation, you know that they are not all Hausa students, they are, some are Hausa, some that are Yoruba or Igbo, but some in the some in the area of Hausa, there are some if you take it in their own language, they will understand it, and some will prefer English. So there are some like that, so if you say that you will concentrate on Hausa, they are some of them that they don't understand Hausa, so there will be problem again. Actually, some of them when you take it to their own language, their culture, EHEN//, they understand it better, there are some who they have the way of timising(multiplying) numbers, if you take them to that direction, the will get it better, you understand. The problem now is that not all that can follow that pattern, so if you want to follow that aspect only, it will affect others.

7. R Now Can you give an example of a situation which needed explanations in their own local language?

8. T In like, maybe like the area of number base, if you look at number base, number base is a way of a counting, you discover, these our people, even the students, when the get home, at times they will sit down and be playing either, there are some games that they use stones to play, so they have some numbers of stones they have to put inside the hole or apart from that their parent, or most at times their parent will tell them, in those days, if you want to count maybe you count five and put it in one place, any group that you see, you see it means that it is five, so by the time you want to know this is the total, you count how many number of group you have, from there you will be able to get the total, there are some their parents will begin to tell them that in those days, the way we instituted counting is that they put it in group of tens, put ten here put ten here put ten there. If they want to know the number, the total, just count, begin to add three of the groups, you know that is thirty. So the number base is also number form that is why we have taken that base ten numbers. We also have base nine, base seven, base five, base two and base eleven, EHEN//,. So those ideas also help, EHEN//, those are the ideas that I use, so putting those ideas across to the students.

9. R Ok, now what are some of these language-related issues you always encounter in the class? And how do you manage those terminologies such as cube, cuboid and prism in the class?

10. T Imum, those terminologies, they are always there, the only thing is that you in order to make them understand, you make use of or I give them some local, local examples, that is from practical examples of those things like cuboid, show them a box of chalk, then by the time, or something like cube, and then cuboid, cube and then cuboid, that is the combination that is you try in short. This issue of cuboid, by the time you use, or you demonstrate, you use something like cuboid, the students will capture it faster Ehen//, even if you find it difficult to pronounce it, but when you know that there is something that the uncle has called it in class, they will try to master it, because they are trying to relate it to what you show them and even

how you pronounce it or you mention it. So they will begin to get use to some of the things and the aspect that will bring confusion, to the different types of shapes.

11. R Now can you remember a classroom episode which illustrates the issue of using local language or home language, so that the students can be able to understand?

12. T I can, we have, let me take, let me think// (…), that is one thing, we use language to demonstrate something eeeeeeeee, I want eee to use eeee, let say eee matches, although it is still in relation to cuboid, I tell them is ASHANA, ASHANA, EHEN//, the ASHANA you are seeing, if you are using to light the stove and this and that. The box, that box, that ASHANA box EHEN//. If you are using their language the ASHANA box, the box, that AKWATI of the ASHANA EHEN//. That one is the same thing as cuboid, is an example of the cuboid EHEN//. So you can see that, I am using ASHANA, using the Hausa language EHEN//. They know that ASHANA is the stick of the matches inside in the cuboid EHEN//. So if you want to demonstrate sphere, you can take them to KWAI, you want to teach a sphere is like, if you want to take an object in language side of it KWAI, KWAI, as you can see the shape of it EHEN//,, the shape of it is a sphere EHEN//, because is different from eeee, something that is round like a ball, a ball actually is partly a sphere too, but there are some balls that are not totally spheres but all the same, I want to say that KWAI as a language. Apart from using Hausa, you can use others, to have an idea about other languages, you can still bring in , you can asked some of the students, ok egg, how do they call egg in your language? Then by the time they mention it you now use it too, to tell them that, that thing you mention is an example of this, like that so that other, other languages will have a share of that knowledge, so that they don't complain, because it is not only one tribe that is in the class, EHEN//. So you try to diversify (teacher laughs), so you are using a term now, so as to let others know that you value their language too EHEN//,,

because we are in Hausa area, it highly concentrated of Hausa, because like this one, you know that this is a federal school, there are many people from different parts of the country, so you have to teach with caution.

13. R You said “I am speaking Mathematics English”, may I know why you use Pidgin English during lessons?

14. T That is, they that is the pattern, that is what I mean is, you know I said consecutive number. So now, these numbers, I said they are numbers that follow each other//, like that after this one, this one, this one, Ehen//, because there are some numbers are not consecutive. If I write 1,2,3,4, now if I pick 3 here and then pick 7 in front there, the numbers, the numbers and maybe, I pick 7 and pick 2 here these numbers are not following each other, based on the ones that I picked. That is, let’s write 1, 2, 3, up to let’s say 8. So, if I pick 3, let’s indicate 3, now 3 is a number now, if I take 7, I now come and take 2, but my intention is on the base is 3. So picking 7 and 2 here, these numbers are not following each other, but this 2 is here, while 7 is at the other side. The number that follow each other base on my 3 here is 1, 2, these once, they are following each other in this pattern like these. So when numbers like these 2 and 7, 7 is on the other side, so base on the 3 that I picked initially here, these numbers are not following each other EHEN//,, So they are not consecutive. The one that follows, let say after this 1, you move to 2, you move to 3, they are following each other, they are consecutive. I am trying to eeeee, I am trying to bring it down, I am trying to explain, so that they understand the CONSECUTIVENESS

15. R Now as a result of coming to their level you use a mixture of Pidgin English so that they will understand, am I correct here?

16. T I, I cannot say no to this

17. R Why do think these issues we have just discussed, foundation, talking about using a bit of Hausa, why do you think they deserve attention?

18. T Imum, there is a need for addressing as you rise. Mathematics is a subject that is very importance to the society now, because Mathematics is a subject that is needed everywhere. Whether you are a mathematician or not, you need it and apart from that this period of time, because of the importance in the society and for them to move forward to the higher level they still need it. And there is a need up in terms of, they still get this ideas of necessity for Mathematics, because without Mathematics they can't go anywhere, even if they have so many passes, they still need the Mathematics, even there are some students like those in arts class, they don't need Mathematics, but because of the system now whether you are from Maths or not, whether commercial or arts or science, you still need Mathematics. So because of necessity in that field of that subject, there is a need to address this area. So that we will not have students left behind after they have study up to the secondary level. Because there are lot of people now that are at home now because of this Mathematics we are talking about. They might have other subject hundred credits, distention in other subjects but once they fail Mathematics, they are not going anywhere. That is why you see a lot of people are roaming about, sometime not that they didn't pass very well, but because of this Mathematics, they are nowhere. You know there is a lot of competition now on Admission, this and that even jobs at times when the see that the number of people are too high for that, they now go into another area, they know that, if they go to that side a lot of people will be drop. So they can use Mathematics as a point for those who, so that there will, those who have probably ordinary pass in Mathematics, they drop their own aside. So is a way of screening, you know the grade in English is even better, but in Mathematics people know that, they have problem with maths. So when you need Admission, they look at that area very well to reduce students, even job at times, when they see that the going is too tough, the competition is too

keen, they go into that aspect. So Mathematics is very important and because of it important you have to address these issues, is a most.

Teacher S (07/02/2018)

1. R What are the most significant challenges you face in teaching Mathematics at SS2?

2. T We have challenges//, challenges like…// challenges we face, challenges I faced in teaching Mathematics are the overcrowding of students, and the students not understanding Mathematics, mathematical languages, like mathematical concepts// (teacher gestures). At times, before students move to…//, before students will enter into SS2, there are specific languages, the language of Mathematics that they supposed to got understood//, which at time they don't normally understand the concepts, when they come into SS2//. So, instead of you to build on what they have learned in their previous classes//. You now move back again to cover those topics//. This is also the challenge// (teacher gesturing and nodding). And the challenges of emm…// though this one is just a minor one sha//, is the movement of students to classes//. This one occur at times, due to the overcrowdings' of the students in a class, because at times we teach almost 100 students in a class//(teacher gesturing). Which is at least is a big, is big problem and how to control the students in the class is also a problem (teacher gesturing by describing hand).

3. R Let us talk about language. You mentioned mathematical language, what do mean by that?

4. T Mathematical language//, there are some concepts in Mathematics that at least an SS2 student' needs to understand, or got them understood before moving them into SS2//(teacher gesturing and nodding). Like if you are discussing shapes//. When I said geometrical shapes, or a triangular, shape, or a shapes that are found under trigonometry, like that, so a child can find it difficult to differentiate between this is trigonometric and this is a

geometrical shape, so these are languages that a child needs to understand this before even going into SS2, in fact, even SS class not only evenSS2. So you can, you…// so at times me, I discover them as a problem//. You understand//. The difference between one shape to another or one topic to another//, which will help a child at least to understand the current topic to be taught (teacher gesturing, nodding and pointing his finger on the desk).]

5. R When I said language, I am referring to the languages that you and the students also understand. What challenges do you encounter in that aspect?

6. T Yes, we have official language for teaching which is English//. That one is generally accepted as English, for us to use English to teach, but at times, as I said, one you have to go back to your local language//. The language that students understand, because as a teacher, you have a stated objective// (teacher gesturing, nodding and pointing his finger on the desk). If you say, you will build upon what it is the official as a language for you to deliver your lesson//, your, your lesson, you may not achieve those objectives. So at least you have to deviate // (teacher gesturing). By deviating, I mean you need to go, you leave that official language and then go to another language that you teach and the students will understand you//. If a teacher is…// If I am teaching at times, I use to leave English language and go to Hausa, explain the concepts properly in Hausa before coming back to English//. So at that, at that junction, you will understand that the child will understand what that particular concept is, is all about.

7. R I also observed you, using a little bit of Hausa. Are saying when you don't use a mixture of the two, the students will not understand?

8. T Yes, I tried that, I tried that// There was a time I taught a concepts fluently using English, and then I assessed them, definitely…//. And I tried the, the, the two, I used English for whole concept, when I introduce a

concepts. Started to, I started that concept with English, and ended that concept with English and I assessed them// (Teacher gesturing), and I kept the record aside//. And I mixed the two languages, and I explained, the same topic, I assessed them, and compared the two results. When I look at the result of when I used the two languages: English and Hausa, students performed better than when I used English alone//. That is why I prefer using both languages. At times I teach Hausa in my teaching, to get them understand

9. R What for you are the practices which work well, when you are using one, or two or three languages?

10. T Yes, if I am using the two, if I am using the two languages, though I will not be//, the Hausa will not be consider as…//, as eee a medium for communication between I and the students, but at times, as I said I deviate a little bit Ehen//. I teach Hausa into my …//, into my classroom lesson note, not throughout//.

11. R So what are the practices which work well for you when you encounter these challenges and you want overcome them?

12. T Is during explanations, during explanations//. You give them a little note, at times you find it difficult to understand what the note is all about// (teacher gesturing). So at times I do leave that aspect, I do use Hausa to explain that concepts, before going on to examples.

13. R Why do you think explaining in other languages works well for you?

14. T Is for me to understand what has been stated as my objectives and to achieve my objectives.

15. R Now can you exemplify some of these challenges which needed a switch to another language? Or is it all?

16. T Not all, it can’t be all//. No matter how, there is at least a little part of what you think the child will understand, because teaching is all about building, build upon what the child has learned previously//. Example, if you want to teach a geometrical shape like, like a cone//. You know a child had been used to how to measure, how to measure Garri//, or something like that//. Also all these round books, like that//. If you now mention a…// If you introduce a, a concept and I put it on the board cone. They will not understand, no matter how I explain, they will even see the structure been drawn on the board//. Do you understand//, now if I deviate now//. Do you know how to measure Garri (Cassava flour) in the market? They will now say yes//. Now, can you differentiate between from the mouth, mouth level of the Garri and the one on top? They will say yes//. Now take the one on top, that is what is refer to as cone//(teacher gesturing, nodding and pointing his finger on the desk). Have you ever seen the hooks around wood? Yes//. Have you ever seen the cover, roofing? They say Ehen//. That roofing is what is refer to as a cone//. Now, I will now use Hausa to explain those things, now before coming back to English to teach.

17. R Now, what of symbols, using symbols, because I observe you always draw triangles and when you are talking you point at the sketch, why do you think this is important?

18. T Is very important, those symbols are very important to differentiate between one angles to another. They can be…//, they can be represented, I mean, replaced by any other symbols too, or by any other sign or letter//. Is very, very important oh, because it will give the image of what to, what you have in mind to teach

19. R Are you saying that in the textbook you are using or in any material you are using, they have those sketches?

20. T Not all

21. R Then why do you always sketch?

22. T For the students understanding, yes, because they understand well, if we, we begin with the information I mean, and also the representation//, with two you will get the information (teacher gesturing, nodding and pointing).Yes the students understands, yes, very, very important.

23. R I observed you always move round the class why?

24. T I do move round the class, if not as I said the class is somehow congested, I used to move from behind to the front like that// (Teacher gesturing). But if you observe I don't normally go in between the students, because there is no space for the teacher to move, due to the condition of the school. That is why I can't move. At times I can observe those that are writing and those that don't write//Ehen. And If they are not writing at times I ask why//. And if they write I check if there is a mistake. At times what the teacher will write on the board will be different with what the students will write their books//. So I move round to correct students writing in their books.

25. R Now another thing I observed in your lesson is when you write a particular question or example you read it again, over and over. Is it that the students can't read or why?

26. T No//, they know how to read, not that they don't know how to read//. I did that because I want them to understand the question//. To understand the question and before I move into the solution//, I did that only for them to understand the question and those that don't get the write up very well, so

that they will be able to get it. If there is any spelling error, they will now effect it in there notes.

27. R So can you itemise some of the rules and regulatings in your class?

28. T My rules, that is, these are…// At times I call them my principles. You know I don't normally allow students to…//. This one is constant; I don't normally allow students to write, if I am solving a problem on the board. I don't allow them. If I am explaining, they don't write, if I am writing they don't write (Teacher gesturing). I give them time for them to copy// Imum. And why do I do this such, kind of thing, because, you cannot tell me that if I am explaining, you are writing, you will be understanding what I …//, you may end up copying what, what, what you don't know, Imum//. This is the main reason why I give them time to copying, after explaining, and while you are copying I will still be explaining while they are copying//. And for the first time I have stop them. I stop them, let them understand before they write, so that if they are reading it at home they will understand, they will get the image very well//. They will now be remembering, thinking all this what the teacher said in the class, and so on, and so forth//. So if you allow them like that//, you are explaining and the child is busy//, where will he put his attention? Is it on the explanation or on the writing?// That is number one. And I don't allow movement in the class//. I don't know, I don't know//, but umm//, I don't allow movement in the class//. But umm// I have said it before, because of the overcrowding//. At time, if you are…//, a child will just come and say excuse, excuse, excuse, like that// (teacher waving his hand). So when I don't…// It reached to a stage whereby that movement principle, I put it aside, I said now if you want to come inside just come in without saying excuse, the same thing if you want to go out just go out without saying any excuse, so that you don't disturb the teacher and the rest of other students. So you are free to go out quietly and also come in. so if you say an excuse, when you are outside, you

will not then come in because you have distracted the attention of the whole class and the lesson. So this are some of my principles//.

29. R These issues you have mentioned; the practices and the norms, why do you think they deserve attention?

30. T Yes, they deserve attention because emm, these are the, these…//, those issues I mentioned, I think they are the once that if the teacher did not properly handle them, he may end the teaching without achieving his objectives. Yes you may end up, you, you may I mean you may teach thinking that, the students yes, they understood what you mean, but at the end, they may not.

31. R What is your advice to the policy makers or the government?

32. T (He laugh) The advice are, one // one, among…// they are many sha. But let me just concentrate on one. The policy makers and the government should restrict the numbers of students they are admitting into schools. For so, teacher will at least…//, the work load of teacher will be at least a little bit reduced. Sheey you witness the number of students we have?// Ehen, and deem defiantly, like emm, the government , a school cannot do this thing ooh//. The one I am about to mention like emm Mathematics laboratories if you look at, most schools don't even have Mathematics laboratories like the concept I taught on trigonometry , do I even need to write them on the board? I don't, I am supposed to just go and look for at least if it is an aid, you know, that will attract students' attention, so that if you are teaching, your attention will now be there at least, at time they can be using the locally one, locally made once//.But emm if the one that government can provide, so that to even show an effort that, to even show any attention that they will do so that I mean so that the school will build upon what the government did, is ok like that. But the government should not be leaving the work to the

school. Of which the school management cannot afford to do that, at the end they will now ask the teacher to go and improvise.

Teacher G (19/02/2018)

1. R What are the most challenging tasks for teaching Mathematics at SS2?

2. T eeeeeee one, they are many: 1) I had the problem of most of the students don't have textbooks. 2) eeeeee even those that have the text book don't even read. 3) Problem of eeeee let's see// the work load is just too much. 4) I called it Mathematical phobia; because the students, they are already// they felt that Mathematics is difficult and other things

3. R Can you give an example of Mathematics phobia?

4. T Mathematics phobia means fear// fear of// fear that cannot even be explained, and so they are afraid of the subject right even before they came to secondary school. They have been telling them stories of this subject from their eeeeeeee brothers that were not even serious, that Mathematics is extremely difficult. So they feel discourage. So they are even discouraged before the learning.

5. R Do you think these issues deserve attention?

6. T I//. I really, I'm really, in fact, let's say, I'm trying before every lesson, I have to take my time in explaining to them, that this things you are doing is not all that difficult. If you can put in your little effort you will surely succeed, and Mathematics is not just for people that are special. If you can do Mathematics, I tell them this that Mathematics is not just for those that have brilliant heads, but for those that are serious, those that can do it with perseverance.

7. R Do you have language challenges?

8. T Seriously yeah

9. R Can you exemplify?

10. T I want to say something about language barrier. As I sit in the school today, they have put a law that speaking vernacular is prohibited. And so I, I on my own side, I have to break the law, because sometimes a student, you see a student that is brilliant, but because of the language barrier, s/he cannot speak the English, they cannot ask question, they cannot even answer. That was what I do if I teach, sometimes I have to go down to their level, is not only Hausa, I even go down to the use of a local dialect so that students can understand. Now once I am able to explain what I'm to teach, then I go back to English. Let me give you one instance, there was one student of mine, his name is Bashir. As I am speaking to you now the boy is in ABU, he wanted to read medicine, but could not get in, he is reading micro biology now. When I met that boy, that boy could not even speak one English word. He is always in the class. It was a question of if I stage to speaking in English. So that is what I do, I decided to come down to his level; I discovered that the boy was good at Mathematics, but could not ask question because he could not speak English. I now gave him room (leeway). I said Bashir, if you have a problem; just ask me, in fact even in Hausa. So when I said that people where just laughing. From that day hence forth, whenever he had a problem he would come and ask me in Hausa, then I now used Hausa to explain to him, and then go back to use English to explain again. That was when I saw the best in him. In fact before he finished his Secondary School and went to ABU, he became one of the best students at the school, and represented the school in one of the national competitions in Mathematics. Now tell me if said I had stage to the use of English only, that boy would have ended up been a failure, that is why I use Hausa in my teaching

11. R What are some of the specific language problems in the uses of symbolism, and objects?

12. T You have to use something similar to it. For instance, you see linear equation, $2a + 5 = 0$. If you are to explain coefficients to the students, how do you do this? Eeem, you will only say coefficient is a number attached with a variable. How do you do it? How do you give example, for say ok, for you to separate the number and the variable, you have to divide it. I now use, let me give an example; a child and the father and the wife. So you can easily separate the man and his wife. Why because, that number will just climb, eeeeee, just cross over that equal sign and become minus, ok, now if a woman marry and she is divorced, so and if she goes back to her father. She became minus because she is a divorcee. But if you have a child with the father, there is no way you can separate them, only death. That is why, if you have $2a = 5$, for you to separate a and 5, you will multiply both side by this. So that is what I use. I don't even need to use any symbols. I use vernacular to explain to them. I use English, and then I will use Hausa, the general language that everybody understands. In fact, not only that, I will even practicalise it, let them see, yes

13. R How have you handled the issue of many languages?

14. T I can't understand what you are looking at. Unless you are looking at the youth corps members who are serving around here, even those who have, once you are here, you can understand Hausa very well. That is what I mean, and sometime, there are some terms that you don't know their meaning in other languages but they are in Hausa. So what I do, if I eeee, what I do is that, I now bring somebody that can speak that language of that students to explain to the student who cannot understand the language I use. I want to give you an instance, there was a time I was teaching statistics. One of the girls said I don't understand. The topic was eeeee, median. You know median is a number in the middle when you arrange set of numbers in either

descending or ascending order. So I have to call one girl, I said please explain to this girl in your language what I am teaching. She now explained it to her, even me I didn't understand what she was saying to the girl, but I saw the girl nodding her head. After that, I now asked her to explain it to me and she correctly explains it to me. I now asked her again to use another language to explain to other students, even me I don't understand.

15. R Why do you break the law by using home languages in class?

16. T See the end justify the means. I am doing that for students to understand what I am teaching. So I just have to use that my method. That I am using Hausa or vernacular doesn't mean I will use Hausa throughout, no, I use English, but at that instance, I have to go down their level, so once they are able to understand me, I just go back again to use English. In fact, even eee, I have been saying this that even those people that have enact those laws, they have been using Hausa in their office and in their teaching. Go to their office, you will meet those speaking Hausa in their offices. Why are they saying that we should not use Hausa? I can use Hausa and English or any language to teach my students if they can understand me.

17. R You used these words: "do this assignment sharp, sharp or solved this problem sharp, sharp" in one of your lessons. What do you mean by 'sharp, sharp'?

18. T That word sharp, sharp, innaaaaaa, this is the type or one of the term we use when we speak Pidgin English. If I said sharp, sharp; then it means fast, immediately, let it be fast, that is sharp, sharp.

19. R It means that; you also make use of Pidgin English?

20. T Yes

21. R Why?

22. T I want to teach, some, some of the students there in my class, they can speak Pidgin English. Yes that is what I am doing. I want to also say something familiar to them. So, if I just say please clean this board with immediate effect and finish now, now, now. They will feel as if I bring these words from somewhere, but if I say sharp, sharp. They will clean it fast and say, so this maths that we do at home is what we are doing in the class. So I want to fill the gap.

23. R In one of the lessons you used the words: “WALLAHI I will not forgive you when I am marking”. The word ‘WALLAHI’ is a Hausa or Arabic word?

24. T Is an Arabic word

25. R Ok an Arabic word, so why do you switch between the two languages?

26. T Generally, I said earlier, if you can observe, this ‘WALLAHI’ I use the word that are locally spoken out there, that is what we speak. Most of these our Muslim friends use the word when they want to show you that they are very serious; that is why I use the word ‘WALLAHI’. Now observe my words, for example this test I gave them last week, once you make use of the word ‘WALLAHI’, you are now preparing their mind to be serious.

27. R And I also observe when you are writing, is like you use both two hands, in writing, why do you do it that way?

28. T eeee, one I will tell you , one is, one is my nature of using both right and left in writing. And the second reason is that, some time I will write and this right hand will be tired and I have to change to use the left hand. And

another reason is you know the class is congested, when I stand like this, I am writing, I hear students say ‘sir you are blocking me’. I will take that advantage of using the other hand. These are the reasons why I use two hands in writing.

29. R Why do you think these language challenges are very important issues to be considered?

30. T It is very important because, you understand what I mean is not just about Mathematics that matters, this is even eeee toward our own communication. The most important thing in life is concepts, concepts. If I am communicating with you, so like, I want you to// the concept I have in me should be what you have, if not there is going to be misconception. If I just come and teach without the students understanding. What are they giving me here, if I just come and just teach this eeeee, this problem, bala, bala, bala. I will just be speaking English, like to me eeee, is not the **beauty** of the language that matters to me, but the **concepts** I have in me. How do I teach it to them, to me these issues should be addressed in every general way possible. Please I am just pleading; as far as I am concerned I will not stop using eeee, local languages to teach. That is why when I teach I will speak English and switch to local languages, if not my students will not understand.

APPENDIX F: Example of textual Discourse practice analysis of the data

Analysis of Language practices category of teacher G					
Text (data)	Keywords/ phrases/sentences	Building tasks/tools inquiry	Sub-categories	code	Code identification/comments
T A triangle is a plane figure//. (Teacher dictating verbally). Plane figure (…) A triangle is a plane figure//. Bounded//. Bounded by three straight lines//. (Teacher selectively writing words on the board). A triangle is a plane figure bounded by three straight lines//. Right?// Ss Yes// (chorus) T I didn't say a triangle is a plane figure bounded by a line//. Did I…?// (Teacher gesturing with hands). A line, I said STRAIGHT lines//. So that means just write down what I said//. Is this line STRAIGHT?//	I, Just, Bounded, and Straight lines	authoritative identity, and significance	Mathematical Defining practice	DfP	The keywords that seem to indicate authoritative identity from the above sentence are **"I"** and **"Just".** Again other keywords or terms such as **"Bounded",** and **"STRAIGHT lines"** on the stipulated definition of triangle seem to be made significant by teacher G through his talks; he re-emphasises with extra stress and loud voice during his teaching.
T Solving triangle means//, if I give you a triangle like this// I said you should solved this tri-angle//. Listen to me all of you//. If I say solved this triangle//. SOLVE// (Teacher gesturing and demonstrating with the	We are blessed with black skin	African identity	Mathematical Explaining practice	ExP	ExP as enacted by teacher G in his lessons seems to suggest that scalene triangle was made relevant in the Discourse. Using an illustration of a skin colour the teacher seems to compare scalene triangle with black African. He told the students

sketch on the board)// Meaning you should find all the angles//. Are you listening to me?// The length of the sides and the space occupied//. That means the area//. If you do that// (…) that means you have solvedd the …//. You have solved the triangle complete//. Is that clear?// Ss Yes// (chorus) T So in this case we are not…//. We are not going to consider right angled triangle//. Imum?// Ss Yes// (chorus) T We are not going to consider rest of the triangles//. (Teacher gesturing). Are you with me?// Ss Yes// (chorus) T In right angled triangle we use SOHCAHTOA//. And the other once, so we don't need them//. We are not going to consider other triangles//. We will only consider scalene triangle//. Are you with me now? This, this, this triangle to me is very, very important triangle//. (Teacher gesturing and pointing to the sketch on					that; "We are blessed with black skin" (see line 9 Stanza 3). It was baffling to see how the teacher compares the scalene triangle with the humans' skin colour. In the comparison as above, teacher G made the black African identity of the whole class visible and recognisable.

the board). Because out of it you can get all this other triangles from it//. So, to me scalene triangle is a black man//. Because you can get all colors from it//. We are blessed with black skin//					
T This is a STRAIGHT line//. If I draw like this//. (Teacher sketching and gesturing). Is this line STRAIGHT?// This one did they come together?// This one has come together//. That gives you the triangle//. I think is something like this//. Right?// Any way (…). Is this a rectangle? Ss Yes// (chorus) T Rectangle, we still have demarcations//. Then you have the very small one like this//. Can you see that now//. If I draw like this//. (Teacher sketching). Rectangle, we still have demarcations//. Then you have the very small one like this//. It have a very small width//. Listen once again//. This a mountain//. (Teacher gesturing and pointing to the board). Draw a line like this//. And you are travelling to let's say from	Like this, and example	connections and intertextuality	Mathematical Exemplifying practice	EP	The case of spontaneous example was observed. Teacher G enacted as follows: **"If I draw like this. Is this line STRAIGHT? This one did they come together? This one has come together. That gives you the triangle. I think is something like this."** Clearly teacher G had a lesson plan, but no example on the drawing. He constructed the example on the spot during the lesson in class to illustrate with a sketch of lines forming a triangle. It was a spontaneous example because it was provided without premeditation. The keywords used during the construction of these kinds of example as above statements uttered by teacher G were: **"like"** and **"this"**. Furthermore, the teacher keeps on correcting and cleaning parts that did not fit in until he attain to the desired example that met the

point A to point B//. Can you pass through the mountain?// Ss No// (chorus) T Which make it straight?// If I do like this, do like this, that means this and this have the same length that is what it shows//. (Teacher gesturing and pointing to the board). If I do like this that means all of them have the same length//. You have a triangle like this// Right?//And remember we use surd to solved other triangles//. But not right angled triangle//. Example 1(…). In triangle A, B, C, in triangle A, B, C, angle B (…). That means you write capital B, angle B//. Just $B = 39°$ //. Then $C = 82°$ and side a = 6.73cm//. That means this a is side//. Find c//, Find the remaining angle A of triangle A, B, C Taken?// Of which a, eee,// put a I mean small a side a, write small letter $a = 12.5$ cm, a is 12.5 cm taken?// To find the value, what do we use?//					intended purpose. Never the less, the teacher used a keyword such as **"example"** in providing a pre-planned example to the students on how to solved a particular task in the Mathematics classroom. Teacher G made connections to previous and future topics in Mathematics such as "surds", that was relevant to trigonometry, while working a mathematical task in the class which according to Gee (2005) it refers to as intertextuality
T Capital C= 116°, 116°//. If you observe,	cross multiply	valued and made	Mathematical	PP	This is a step-by-step approach to solving a

one of the angle is 116°//. One of the angle given is 116°//. Where is our small a?// S Small a is 12.5cm// T Small is 12.5cm// Or in fact, let us calculate the A on this one So angle A=180°-(39°+82°)=180°-121 This is what? Ss 59°// (chorus) T Just cross multiply and solved the problem//. Now cSin 59=(6.73Sin82)cm//. Remember you want to findc//. You have to divide both side by the coefficient of c//. Right?// So c=(6.73 Sin 82°)/(Sin 59°)//. What is the answer?// Ss 17.7cm// (chorus) T 17.7cm//. You can even see it that is longer than the other side Ss Yes// (chorus) T Example 2: in a triangle A, B, C, angle A is 54.2, angle A is 54.2 degrees taken? Angle B is 71.5 degrees 71.5, degrees and small side a is 12.4cm, 12.4cm find b//. I am not going to do this	and solved the problem	important Mathematical Proceduralising in his language use	Proceduralising practice		particular Mathematical problem (Setati, 2002). Using Sine rule: $\frac{a}{SinA} = \frac{b}{SinB} = \frac{c}{SinC}$, the teacher took the students through a step-by-step procedure: **“Just cross multiply and solved the problem. Now $cSin\ 59 = (6.73Sin82)cm$. Remember you want to find c. You have to divide both side by the coefficient of c. Right? So $c = \frac{6.73\ Sin\ 82°}{Sin\ 59°}$. What is the answer?”** He then arrived at the answer: $17.7cm$, without justifying the approach for the calculation (see lines 7-16). These observations suggested that he valued and made important Mathematical Proceduralising in his language use as a Discourse of the subject. Teacher G’s approach for the calculation in his class was similar to what Setati (2005a) stated, Mathematical procedural Discourse is where the emphasis in teaching Mathematics is aimed at establishing the steps which should be taken to calculate certain mathematical problems with no development of the concepts. This Discourse practice

one on the board//. I will give you, I will live for you to just solved//					would limit students to merely accepting procedures. Even though solving Mathematics requires knowledge of algorithms, this must be backed-up with a great deal of conceptual understanding, so that students would know why and how the steps were undertaken in calculating problems.
T A STRAIGHT LINE is the shortest distance//. A straight line is the shorted distance between two points//. A line is a distance between two points//. And a straight line is a distance between two points//. Now types of triangles//. Somebody should give us one// Yes//. Not you, the other person// S Equilateral triangle// T What? S Equilateral triangle// T Equilateral triangle//. Equilateral that means is from the word equal//. Right?// Ss Yes// (chorus) T Equilateral triangle means all the sides and all the angles	STRAIGHT LINE, Equilateral triangle	Formal Mathematical language (social language)	Mathematical re-voicing practice	RvP	Mathematical re-voicing practice essentially tries to repeat some or all of what has been said in a preceding tone as the basis for a shift in the interaction (Enyedy et al., 2008). It could also involve repeating what has been said using the correct mathematical language. Re-voicing mathematically was enacted using correct (formal) Mathematical language and grammatical expressions. the teacher repeated a Mathematical definition with expansion: **"A STRAIGHT LINE is the shortest distance. A straight line is the shorted distance between two points."** G Mathematically re-voiced the definition of a straight line with the addition of the words: **"between two points".** As described by

are equal//. Right?//					Planas and Morera (2011, p. 1357) this repetition could be identified in two ways; "linguistically exact copy, or as a reformulation"

T WHAT? Acute triangle?// (…) BANSANIBA// (I don't know)//. COME//. You said acute triangle?//
S Yes sir//
T Come, come, come//. KUN SAN LISAFI IRIRI NE (you know Mathematics are of different kinds)//. BANSAN ABIDA YAKE NUFE BA KOO?// YAUWAAA// (I don't know what he meant now?)// Right?// Draw it, the acute triangle//.
(Teacher gave a pieces of chalk to the student to draw acute triangle, and he is unable to draw)
T Why do, do…you say something that you can't even draw it?// Yes, you//
S Scalene triangle//
T Scalene triangle//
(Teacher writing on the board, then he turn and regulate the students)
T I don't want everybody to speak (…), yes//
	KUN SAN LISAFI IRIRI NE (you know Mathematics are of different kinds)	Politics (social goods)	Mathematical code-switching practice	CsP	Mathematical code-switching practice refers to the alternating between two or more languages within the same conversation. Or is the use of Words/phrases/sentences from one language to a different language (Chitera, 2011; Halai, 2009)
					An interesting observation which seemed significant was that the teacher appeared to be the only one switching between English and Hausa during the lessons. He switched in his discursive language to improve the understanding of a triangle type. The teacher uttered the following words: **"Come, come, come. KUN SAN LISAFI IRIRI NE (you know Mathematics are of different kinds). BANSAN ABIDA YAKE NUFE BA KOO? YAUWAAA// (I don't know what he meant now?)// right?// Draw it, the acute triangle."** G's switch to the Hausa language was for the purpose of clarifying ideas on the acute triangle, as

S 6.7cm// T 6.7cm//. What are we ask to find? Ss c// (chorus) T BAGA C NAN BA?//.(Don't you see letter C here?) Ehen// see c now//. Heeey//. WHAT IS WRONG WITH YOU?// KAI INGONA (you be careful)// go to 60, 60 are you there?// IN KUNGAMA, SAI A JA LAYI (If you finished, then draw a line)					well as managing students' behaviour in the class. The use of Hausa language in G's class was valuable in the construction of the social goods (the knowledge of Mathematics). As teacher G and the students did not share the same home language, the use of Hausa might evince the political and cultural significance to the knowledge of Mathematics. By politics, I am referring to how social goods are, or ought to be distributed. Gee (2005) explained that social goods refer to anything a certain number of people believe to be a source of power, worth and/or status. Students need the knowledge of Mathematics (the social goods in this instance) to succeed in several professions in Nigeria. Hausa language as used in teacher G's class was for the purpose of teaching this vital subject (Mathematics). It also suggests that Hausa possesses great potential of it being used in the teaching and learning of Mathematics in multilingual classrooms.

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