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Language practices involving two languages among trilingual undergraduate students of Mathematics

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Abstract

This paper presents language practices of some trilingual undergraduate students of mathematics as they engaged with a mathematics task. The paper draws from a larger study that was recently completed. The aim in this paper is to explore whether, how and why the trilingual students use languages in their repertoire to make sense of an algebra task. The two languages in focus are the home languages of the students and the Language of Learning and Teaching (LoLT), English. Research shows that there is a research gap on language practices in trilingual contexts. The study adapted a qualitative inquiry process. It was conducted in one public university with a focus on first year students undertaking mathematics in their programs. Data was collected using questionnaires, clinical and reflective interviews. Analysis followed Discourse analysis (Gee, 2005) with a focus on mathematical Discourses. Findings show that the students engaged with competent mathematical Discourses. Furthermore they used their home languages as resources in their repertoire to interpret and understand the task. There were multiple purposes for code switching between the two languages in their solitary engagement. The findings are important to inform Language in Education Policy (LiEP) in Kenya how and why some undergraduate students of mathematics position the home languages when they engage with mathematics. In the global perspective, the findings contribute to the field of mathematics education in trilingual contexts.

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Keywords. Trilingual, language practices, Discourse analysis, Home language.

1. Introduction

This paper presents some findings from a wider research study that explored language practices of some trilingual undergraduate students engaging with mathematics in Kenya. The paper focuses on whether, how and why some students draw on two languages of their three language facility to make sense of an algebra task.

When students engage with mathematics, a range of language practices within one language or multiple language environments may emerge. Furthermore, availability of more than one language in a classroom may open opportunities for the use of different languages for learning and/or teaching. Studies conducted in both bilingual and multilingual mathematics classrooms show how students draw on languages at their exposure to participate and improve their performance of mathematics. These studies have mainly focused on the Language of Learning and Teaching (LoLT) only (e.g. Barwell, 2003) or on two languages: the LoLT and students home

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language (Adler, 1998; Setati, 2005). The LoLT in most cases is reportedly not the students home language particularly in studies conducted in Africa. In contexts such as Kenya, India, and Malawi, students also need to learn and gain fluency in a third language referred to as the national language. These languages are commonly used for communication between and among different language communities. The national languages, however, are not used in mathematics classrooms as LoLT (Chitera, 2009). In these contexts, the availability of the third language exposes the students to a third language in school and makes the students trilingual (see Hoffmann, 2001). Such trilingual students may also have other languages in their repertoire, but the concern of this paper is on three languages.
The languages are home language, the national language and the LoLT, here being English. They have different statuses and mathematics students are at one time or the other exposed to them in school. While research in mathematics education in bilingual and multilingual mathematics classrooms has recently been increasing in diversity and volume (Phakeng, 2013; Setati, Chitera and Essien, 2009), no research addresses how such trilingual students use their three languages while engaging with mathematics. This study will particularly deal with two languages of the three languages in the trilingual students language repertoire.

2. Why focus on tringualism?

[1] [2] Research on trilingualism is limited and as such there is no one definition of trilingualism that has been adopted (Hoffmann, 2001). Part of this limitation could be attributed to the assumptions about trilingualism: that it is an extension of bilingualism or it should be viewed as part of multilingualism (see Beaten Beardmore, 1982 in Hoffmann, 2001)). Furthermore there are implicit suggestions that several lingualisms can be subsumed under bilingualism or multilingualism. While the assumptions may be based on quantitative distinctions between the different lingualisms, research also shows that there are some common characteristics among bilingual and multilingual persons for example, the practice of code switching between languages (see Hoffmann, 2001).
Researchers in the area of trilingualism (Hoffmann, 2001; Ogechi, 2002)) accept the quantitative aspect of trilingualism. But there are also qualitative aspects that are characteristic of trilingualism (Hoffmann, 2001). First is that there different groups of trilingual, depending on both the circumstances and the social context under which they acquire and use the three languages. Second is that a trilingual speaker uniquely uses his/her three languages in ways that are determined by his/her communication needs. He/she has the ability to function like a monolingual, a bilingual or a trilingual depending on, for example, the topic, place or interlocutor. This requires a decision to code-switch. Trilingual people in fact assign, consciously or not, different functions to their three languages (Hoffmann, 2001).
Given these quantitative and qualitative aspects of a trilingual, it is observed that while a trilingual person may share some characteristics with a bilingual and/or multilingual person, a trilingual is not an extension of a bilingual but a special case of a multilingual person who retains characteristics of his/her own. From the foregoing discussion, a question that begs understanding is one on language practices of trilingual mathematics students when they engage with mathematics.

[1]Home language: refers to the language commonly used at home and in the larger community. In some works it is also referred to as main language (e.g. Adler, 1998). A home language may be the first language of a speaker or other language acquired.
[2]This paper I have referred to a bilingual as to an individual who acquires and is proficient in two languages (Grosjean, 1982) and a multilingual as an individual who is proficient in more than two languages (see e.g. Chitera, 2009)

3. Background information and research in Kenya

Majority of Kenyan students become trilingual through schooling. During the first three years of their schooling, the Language in Education Policy (LiEP) stipulates that the predominant language in the school environment is used as the LoLT. The pre-dominant language is in most cases the home language of the majority students. During this period the students are introduced to formal learning of their home languages while Kiswahili and English are taught as subjects. Despite this trilingual facility, research in Kenya has been limited to the bilingual language facility of the students.

Research exploring the use of two languages in mathematics and sciences for instance, Kiswahili and English or Dholuo and English has been conducted particularly from the teaching perspective (Bunyi, 1997; Cleghorn, Merrit, and Abagi, 1989; Merrit, Cleghorn, Abagi, and Bunyi, 1992). However, there is no previous research in Kenya and elsewhere that is available that has dealt with how individual trilingual students, and in particular undergraduates, use their trilingual language facility when engaging with mathematics. In fact in her review of what has so far been researched in mathematics education and language diversity, Phakeng, (2013) shows that there remains a gap in research in trilingual contexts. In view of the aforementioned research gap, the current study is necessary. The study was guided by the following questions;

1. How do some trilingual undergraduate students in Kenya use their languages when solving mathematics tasks?
2. What language practices do these trilingual undergraduate students use when engaging with given mathematics tasks?
3. Why do these students use their languages as they do?

The questions above helped to focus on the students language practices through their verbal and non-verbal utterances, actions and reflections on their linguistic train of thoughts while they engaged with a mathematics task. The language practices of the trilingual students help to understand how the students position themselves as they engage with the task in relation to mathematics Discourse and in the use of the home languages and the LoLT and in turn how they position the languages as they engage with the task.

In the following section, I situate the problem of trilingualism in the wider field of mathematics education by drawing on literature in bi/multilingual contexts.

4. Situating the problem in the field of Mathematics Education

The language practices of trilingual students engaging with mathematics can be addressed through understanding the relationship between language and mathematics and the role that language plays in mathematics students performance. Furthermore, understanding language practices of bilingual and multilingual mathematics students can shed light into exploring language practices of trilingual mathematics students.

4.1. Language and Mathematics

One way of describing the relationship between languages, that is a natural language like English, and mathematics is in terms of linguistic notion of register (Pimm, 1987). Halliday (1975 in Pimm, 1987) argues that mathematics register has to do with how words and expressions are used in mathematics, styles of meaning and ways of arguing in mathematics. It can be developed in any natural language for instance, Kiswahili or English. In fact research (Halliday, 1974 in UNESCO, 1974; Pimm, 1987) shows that there are some defining characteristics of mathematics register in relation to the English language, hence the development of mathematical language. Part of knowing mathematics is acquiring control over mathematics register so as to be able to speak like a mathematician (Pimm, 1987). The student should therefore learn to use the language of mathematics and hence be able to construct, express and communicate the intended

mathematical meanings (see e.g. Pimm, 1981). As noted by Setati and Adler, (2000), the reality is that speaking, listening, reading and writing mathematics in multilingual classrooms requires the use of the LoLT, which students may not be fully fluent in. The foregoing discussion leads us to think of the ways of knowing and meaning in mathematics. In particular, it leads us to the formal and informal mathematics languages and how they are used in classrooms.

4.2. Formal and Informal mathematical language

Students come to school with everyday ways of knowing, speaking and writing mathematics which are different from the formal ways of using the mathematics register and hence the language of mathematics. According to Setati and Adler, (2000) formal mathematical language refers to the standard terminology or mathematics register which is developed within the formal settings like schools. It is the language valued in school mathematics. On the other hand, informal mathematical language is the kind that learners use in everyday life to express their mathematical understanding. Based on what they have acquired and how they manipulated meanings as young children learning how to mean, learners use their informal language in an attempt to assign meaning to unfamiliar mathematical phrases and expressions (Moschkovich, 2003). Although informal mathematics talks are inappropriate in formal mathematics settings, Moschkovich (ibid) observes that they should not be viewed as obstacles to learning rather they should be seen as valuable resources for developing learners mathematical competence. They can be used to assist learners in learning mathematics by moving from informal to formal language of mathematics that is valued in school mathematics. Hence the classroom plays host to both informal and formal ways of knowing, speaking and writing mathematics.
Moving from informal mathematics language to formal mathematics language involves learning mathematics within mathematics discourses. There are multiple and varied mathematics discourses. In what follows, I briefly discuss mathematical Discourses. To build on them, I start the discussion on Discourse Analysis.

4.3. Discourse Analysis and Mathematical Discourses

The discussion in this paper draws broadly on (Vygotsky, 1986, 1978) socio-cultural perspective and the analysis follows Discourse analysis (Gee, 2005) with a focus on mathematical Discourses (Moschkovich, 2002). Vygotskian socio-cultural perspective examines the roles of social and cultural processes as mediators of human activity and thought (Vygotsky, 1986, 1978). According to Vygotsky, (1986), human thought realizes itself, and is expressed, in words. Furthermore, mediation of the interactional process of thought and word occurs through culturally constructed artefacts which include elaborate sign system such as language. Language then expresses thoughts through verbal and non-verbal communication. The expressions can be found in the interactions within and between human beings, and between human beings and objects. Therefore according to Vygotsky, language mediates human thinking and social interactions, that is, communication within and between humans.
In his work of Discourse analysis, Gee (2005) acknowledges language as a tool for communication and also provides a method for analysis. Gee (ibid) sees the primary functions of language as to support performance of social activities and identities and, human affiliation within cultures, social groups, and institutions, hence Discourse (with capital D) analysis. Gee, (2005) makes a distinction between the terms discourse with little d and big D. He refers to discourse (with little d) as the language-in-use or the use of language on site (p. 7) and to Discourse (with big D) as language plus other non-language stuff. Thus he states Discourse as: ways of combining and integrating language, actions, interactions, ways of thinking, believing, valuing, and using various symbols, tools, and objects to enact a particular sort of socially recognizable identity (these are social practices) (pp. 21). From the quote above, we use spoken or written language in tandem with non-language stuff to perform actions in the world and hence project ourselves as certain kinds of persons engaged in certain kinds of activities (Gee, 2005). In other words,

language supports how we act as certain identities engaged in certain activities, and hence we get associated with groups whose members act as we do. Central to Discourse analysis is recognition; if the activity and identity are recognised, then one will have pulled off a Discourse of a sort (Gee, 2005, 23). The meanings derived in any one Discourse situation are multiple, varied and situated in context of use. In this paper, I focus on Discourse (with capital D) analysis.
Moving from informal mathematics language to formal mathematics language means that students are involved in learning the mathematics register. The knowledge of mathematics register facilitates mathematical conversations in the classroom (Pimm, 1987). In order for students to acquire this register, it is imperative that teachers teach from the basis of conceptual curriculum so that students come to learn and understand the intended curriculum (Thompson and Thompson, 1994).
In conceptual curriculum the teacher provides and asks students for explanations in the process of solving a task (Thompson and Thompson, 1994). Alongside the conceptual orientation is the calculational orientation, which is viewed as composed of procedural steps of mathematical operations. The distinction between these two classroom orientations has been extended into calculational and conceptual discourses by Sfard, Nesher, Sreefland, Cobb, and Mason (1998). These authors refer to calculational discourses as the discussions in which the primary topic of conversation involves describing the specific steps that have been followed to arrive at a mathematical solution. In contrast, conceptual discourse involves reasons for calculating in particular ways. Integrating the calculational and conceptual discourses at play with Discourses from Gee (2005), it is in the interest of this study to ask; when students explain their mathematical understanding conceptually and/or calculationally, in what ways do they integrate and combine language and non-language stuff to communicate this understanding? Literature so far reviewed show that students need to gain control of the mathematics register and use the valued formal mathematics language to communicate their mathematical understanding. However, it is the mathematical Discourses within their communication that is most important in deriving meanings of their utterances.
Using a situated and socio-cultural perspective and the notion of Discourses , Moschkovich, (2002) observes that mathematical Discourses constitute ways of combining and integrating language with other non-language stuff, and ways of saying, doing and being in mathematics. In particular, practices that count as participation in competent mathematical Discourse include particular modes of argument such as precision, brevity, logical coherence, abstracting and generalising, imagining, visualising, making mathematical connections, assumptions and using mathematical representations, justifying, gesturing and predicting (Moschkovich, 2002).
To be recognised as competent in mathematics Discourse, trilingual mathematics students need to engage with mathematics tasks in ways that mathematics competent people do and in ways that are acceptable in the mathematics Discourse community. They need to have developed the acceptable practices within mathematics Discourse. They learn these practices through interaction with others for instance through interaction with teachers, books and with other tools like calculators and mathematical tables, non-tangibles things like formulae and discussion with peers. It is in such interactions that negotiations of meanings happen and probably different and multiple ways of doing mathematical tasks are found. With time and continued practice, and building and rebuilding mathematical arguments, students develop mathematical competence in spoken, written mathematics and ways of acting and being in mathematics Discourse. If they project the ways of being in mathematics that can be identified with the mathematical Discourse; they enact socially situated identities and activities within mathematical Discourse. In learning and teaching then trilingual students are exposed to a range of mathematics Discourses. In line with that, this paper will reveal a range of mathematical Discourses that the selected trilingual students draw on and enact as they engage with mathematics.
It is however, important to note that mathematical Discourses are mediated through natural languages, for example English and Setswana. With that regard, a discussion on language

practices involving bilingual and multilingual students is relevant for this discussion. The most common language practices in contexts of language diversity reported in literature is that of code switching.

4.4. Language practices of bilingual and multilingual students

Studies in bi/multilingual classrooms have shown that code switching between students home languages and LoLT can support their participation and performance in mathematics classroom. In a review of these studies, I find out how and why bi/multilingual learners switch to their home languages when they engage with mathematics tasks that are presented in LoLT. The findings provide insights into language practices of trilingual learners.

4.4.1. Code switching. [3] [4] Code switching is the alternative use of two or more languages in an utterance or conversation in a more or less deliberate way (Baker, 1993; Grosjean, 1982). The alternation can involve a word, a phrase, a segment of a sentence, a sentence or several sentences. It is a common characteristic of bi/multilingual speech and there are communicative purposes for which it is used. While the works of Baker and Grosjean portray code switching as a verbal strategy, a corresponding non-verbal strategy of language switching has been proposed and used in research on mathematics education. Language switching refers to the use of two or more languages during solitary and/or mental arithmetic computation (Moschkovich, 2005). Language switching is here seen to mean switching between two languages in thinking through computations. In this study I choose to refer to all situations where students switch between languages in verbal conversations or in mental computations as code switching. However, the differences between the language skills of conversation and mental computations or thinking will be noted appropriately. In a single speech, code switching may serve different purposes in communication and the languages involved may have a range of functions. In what follows I discuss the purposes for which code switching has been used in bi/multilingual mathematics classrooms and its influence in the learning and teaching process. In so doing I highlight the how and why code switching is practiced.

4.4.2. Purposes for code switching in bilingual and multilingual mathematics classrooms. Research shows that code switching between learners home language and LoLT supports learning and teaching in bi/multilingual classrooms (Clarkson, 2006; Cleghorn, Merrit, and Abagi, 1989; Merrit, Cleghorn, Abagi, and Bunyi, 1992; Moschkovich, 2005; Parvanehnezhad and Clarkson, 2008; Planas and Civil, 2008; Planas and Setati, 2009). Whenever it is used in the learning and teaching of mathematics, code switching is used for a range of purposes. Some of the purposes are discussed below with the functions of the language(s) embedded in the communicative process. Furthermore, most of the studies that give focus to code switching focused on learners who are still learning the LoLT and had limited ability in it. Exceptions to these are for example studies of Clarkson (2006) and Parvanehnezh and Clarkson, (2008) where some learners had high proficiency in both the LoLT and the respective home languages.

Translating from one language to another

Code switching is practiced with the purpose of translating from one language to another for a range of linguistic reasons (Kern, 1994). It can assume verbal, written and mental communication. Furthermore, translation is only possible when the message is first understood in the original language. Some reasons for which translation has been used in mathematics classrooms are;

a. To express words or phrases in the language that is more familiar than the other

[3]The situated and socio-cultural perspective looks at the use of situational resources students use and ways that mathematics Discourses are relevant to the situation.
[4]Discourse Analysis from Gee, (1996)

It has been observed that bilingual mathematics students translate mathematics task content due to familiarity with certain words and numbers in home language, and not due to lack of knowledge of such words (Moschkovich, 2005; Parvanehnezhad and Clarkson, 2008). Studies in multilingual settings show that teachers commonly switch from the LoLT to learners home languages to make lesson content familiar for the learners (e.g. Cleghorn, Merrit, and Abagi, 1989). Cleghorn et al., (ibid) observed that the use of local and familiar words may have expanded students' awareness of word meaning and language differences, helping to develop their English competence while also fostering understanding of the concepts taught. This was necessary as the students were still developing proficiency in English as they learnt science in it. The discussion on students familiarity with home languages is important for the trilingual students in Kenya. Some of the students translated the task content mentally because they were more familiar with home languages than they were with the LoLT.

b. To emphasize a point or certain words

Translation is used to emphasize a point or words or phrases (Baker, 1993; Merrit, Cleghorn, Abagi, and Bunyi, 1992). In this case of translation words are substituted with words of another language with the aim of putting emphasis; however no explanations are given for the words (Merrit, Cleghorn, Abagi, and Bunyi, 1992). For instance, in their study, Merrit, Cleghorn, Abagi, and Bunyi, (1992) observed that while speaking of a container, a Standard eight teacher used the word mkebe, the Kiswahili equivalent word for container, similarly for tapeworm, he used jofi the Dholuo word for tape worm. In so doing the teacher emphasised specific objects without explaining their meanings. Translation of some English words to home languages was evidenced in this study.

c. Translating all the time

Some students translate text all the time with the ultimate goal of transforming the information into a more usable representation (Kern, 1994). In his study with Vietnamese-English bilingual students, Clarkson (2006) observed that the Vietnamese mathematics students translated problems from English to Vietnamese. The use of Vietnamese was associated with the assistance the students got from the parents who prominently used Vietnamese or from siblings who used English and Vietnamese. Consequently while in school, the students translated the problems into Vietnamese while reading and thinking through them. They then translated back to English to make the ideas compatible with the classroom language situation. While it is not clear whether the students in Clarksons study translated all the content, he noted that the students did not translate individual words to check for meaning. Translation of all content may, however, pose a challenge since some of the terms of the mathematics may either not be available in home languages or are not readily used (Setati, 1998). Furthermore, translation does not always work to the advantage of students (Kern, 1994), since if content is inaccurately translated it may lead to misconceptions. Trilingual students may translate a given task to their home languages all the time for a range of reasons for example to seek understanding or due to familiarity with home languages. Such languages have implications for how they engage with mathematics. Most of the research reviewed here, which focuses on the use of code switching for translation purposes was done with learners in their early or middle stages of learning their LoLT. In contrast all the students in this study were academically proficient in LoLT, despite that; they translated the task content from LoLT to their home languages.

Context of using language

Research shows that the contexts in which bi/multilingual learners find themselves may facilitate or constrain code switching (Cohen, 1995; Grosjean, 1982). Contexts involve both physical

environment and the presence or absence of other people. Research in mathematics classrooms provides evidence of influence of context in language use (Clarkson, 2006; Parvanehnezhad and Clarkson, 2008; Planas and Setati, 2009). For instance, bilingual learners switch between home language and LoLT while operating in their individual private world or in small groups where they share a home language (Clarkson, 2006; Planas and Setati, 2009). On the contrary, bilingual learners remain in the LoLT when they are organised in linguistically mixed groups (Planas and Civil, 2008; Planas and Setati, 2009). In the study by Planas and Setati (2009), the students in their study continued using the LoLT despite being prompted to use their home languages, probably viewing their home language as a language that is not valued in mathematics classroom learning. This constraint to code switching may be more pronounced in environments where learners are restricted by the LiEP.

Given that code switching may be prompted by contexts, it is important to identify and understand the contexts that facilitate or constrain trilingual undergraduate students to switch between languages when they engage with mathematics tasks.

In concluding this section on situating the problem of trilingualism, it can be seen that language and mathematics are complexly related. Expressing their relationship in terms of mathematics register involves expressions that go beyond words and structures to styles of meaning and modes of argument. Students need to gain control of the register in order to use it as mathematically competent people do. While they need to learn the formal and valued mathematics register in school, they report to school with informal ways of knowing, more so in different languages which are not valued in school. In deriving meanings of their mathematical utterances, what is most important is to consider the mathematical Discourses within their communication either in LoLT or home languages or both.

For trilingual speakers, switching between any two languages is an important speech strategy (Hoffmann, 2001), as discussed earlier. They use their three languages within their linguistic environment and communication needs. Hoffmann observed that in education, trilingual students use the LoLT more commonly in external communication, while other languages are used for inner functioning. In the light of Hoffmanns observations on trilingual speakers, I explore how and why some trilingual undergraduate students in Kenya use two of their three languages facility when they engage with mathematics.

In the following section I briefly summarise the theory and method of Discourse analysis, which I have used to analyse the data.

5. Theory and method of Discourse Analysis

5.1. The Theory

In his work on Discourse analysis, Gee, (2005)provides a theory and a method for studying how language is used to enact specific social activities and social identities. He provides tools of inquiry and strategies of applying them in analysing data. The tools that are important for my analysis are social languages, Discourses, situated meanings and Discourse models. The tools help us to ask questions about what he refers to as the seven building tasks (Gee, 2005, 11), that we build when we use language and to understand how language is used as it is used. He identifies the building tasks as significance, activity, identity, relationship, politics, connections and sign system and knowledge. Gee observes that whenever we use language, we build at least one of the seven building tasks in more or less routine ways, because of our cultural inclinations of doing things. In line with these building tasks, discourse analysts can ask questions about any piece of language-in-use connected to the building tasks (Gee, 2005, 11-19). Alongside the identity and relationships building tasks, pronouns can help us to recognise the identity and activities that a speaker is enacting. Pronouns are commonly used when people talk. They code and convey aspects of speakers' personal identity and group association (Rowland, 1999). The

commonly used pronouns in mathematics talk are I, you and we (Pimm, 1987; Rowland, 1999). In using the pronouns, the referent(s) may be clear for instance I referring to the speaker, and you to the audience (single or multiple), or they may overlap for instance, I and you can be used to refer to the speaker, while you and we can be used to detach the speaker from immediate reference and hence make a generalization. Rowland observes that the variations in the way speakers use pronouns can be associated with delicate shifts of social positioning of the speaker in relation to his/her audience, to own up to something as an individual (I) or as a group (we) or partially dissociate oneself (you). The shifts in social positioning noted by Rowland resonate with shifts in identities and relationships (Gee, 2005) discussed earlier and hence the more the reason that the pronouns be used alongside the two building tasks in the analysis. It should be noted that when analysing utterances involving the pronouns you and we, there is complexity in decoding the co-referential. Therefore there may be multiple meanings that can be derived.
According to Gee, social languages and Discourses are primarily relevant to how people build identities and activities and recognize identities and activities that others are building around them. These tools help us to talk about, and thus construct and construe, the world. Situated meanings and Discourse models are the primary tools of inquiry that deal with intricacies of how language is used (Gee, 2005). Gee observes that these latter tools guide inquiry in regard to specific sorts of data and specific sorts of issues and questions. It is worthwhile noting that all the tools do not work independently but are integrated one with the other.
In using language, we enact certain Discourses in the same or different contexts (Gee, 2005). He argues that that Discourses can be understood by situating meanings of words in specific contexts of use. In order to make sense of the situated meanings, we need to select the patterns and sub-patterns that are relevant in a particular context. The guide to the selection of the patterns resides in Discourse models of a persons socio-cultural groups and the social practices and settings in which they are rooted (Gee, 2005). Discourse analysis can be used to analyse language practices within one or multiple language environment. In fact when trilingual students engage with mathematics, they may project themselves as members of mathematics Discourse community using one language or switching between languages as par their communication need. Therefore I have flexibly adapted the four tools of inquiry, so as to ask certain questions about the building tasks in an attempt to understand language practices of the trilingual students involved in this study.

5.2. Method of Discourse Analysis

Gee, (2005) observes that discourse analysts are interested in analysing situations in which language is used. Such situations involve the contexts in which building tasks take place. He refers to the situations as discourse situations.
Any piece of language, oral or written, used in a situational network is composed of a set of grammatical cues and clues (Gee, 2005). The cues and clues contribute differently to the seven tasks and they guide us in knowing which of the building tasks are being built. They are carried out all at once and together and they may be in the same or different social languages.
Trilingual students control many different social languages and switch among them in different contexts. They also mix social languages in complex ways for specific purposes. In fact they can mix or switch between different social languages that are drawn from different languages at the level of national languages such as English or Kiswahili or home languages. As a result, a range of cues and clues are evident in their social languages.
The cues and clues help to assemble here-and-now situated meanings through which the seven building tasks are accomplished (Gee, 2005). In turn the situated meanings activate certain Discourse models. Finally the social languages, situated meanings, Discourse models at play allow people to enact and recognize different Discourses at work. This study identified similar patterns of grammatical features that are indicative of particular kinds of social languages that the trilingual students uttered as they did and reflected on the mathematics task.

To identify the indicators of cues and clues in the social languages, I have adapted some of the 26 questions that Gee (2005, 110-113) has proposed and I added other details of language that appeared relevant to my analysis. I looked at the utterances that illuminated my research questions in the light of Discourse situations and then took the key words or phrases which I analysed for cues and clues. In general, I have structured my analysis into three main phases:

1. Identifying the grammatical cues and clues in social languages of students responses to the algebraic task and in their reflections.
2. Identifying some key word(s) or phrase(s) in the social languages and looking at the situated meanings that they had. To make sense of the situated meanings, I selected the patterns of features that were assembled in the particular context and that implicated the Discourse models at play.
3. Explaining the different Discourses that the students seemed to enact through the social languages, situated meanings and Discourse models.

6. THE STUDY

[5] The data analysed in this paper focuses on first year trilingual undergraduate students of mathematics of Procity University , a public university in Kenya. Data was collected using three instruments; questionnaires, clinical, and reflective interviews. A structured questionnaire (Kothari, 2009) was used to gather the baseline data, which was necessary for selecting interview participants. A sample of 15 students was selected. They had a range of home languages and they indicated that they used other languages apart from English while responding to mathematics tasks. They also indicated the language in which they preferred for the interviews. Clinical interviews (Keats, 1997; Minichiello, Aroni, Timewell, and Alexander, 1990) were used to establish how the students used languages and other non-language stuff in relation to the mathematics task that was given. The reflective interviews were used to identify, ascertain and confirm various actions and languages and that were used during the clinical interview most of which were not visible during the interviews. Semi-structured questions were used to enquire on some critical moments while the students were engaged with the task. The reflective interviews also provided data on how and why the participants used each language while processing the task, in speech or in writing or other non-verbal means. Both interviews were video recorded and transcribed. Field notes, copies of students worksheets and questionnaire details provided supplementary data. The transcripts formed the primary data for analysis.
The task that the learners responded to was adapted from the standardized Kenya Certificate of Secondary Education (KCSE) of 2010 and read as follows:

[Q] A hall can accommodate 600 chairs arranged in rows. Each row has the same number of chairs. The chairs are rearranged such that the number of rows is increased by 5 but the number of chairs per row is decreased by 6
(a) Find the original number of rows of chairs in the hall.
(b) After the re-arrangement 450 people were seated in the hall leaving the same number of empty chairs in each row. Calculate the number of empty chairs per row.

Data from transcripts of the clinical interviews is analysed. It is supplemented by data from reflective interviews and the questionnaires. The students who switched between English and home languages were six. Four of the students S8, S6, S15 and S10 engaged with the task by switching to translate the whole task while two of them S3 and S4 translated parts of the task. The home languages of these trilingual students are Kiswahili for S8 and S6, Kikuyu for S15 and Kikamba for S10, Luluhya for S3 and Dholuo for S4.

[5] A pseudonym for the university

Table 1. Key questions posed during the interviews

Clinical interview question	Reflective interview questions
When you first read the question, what impression did you get? Or other question that was relevant based on point of concern.	1. When you first read the question, what impression did you get? Or other question that was relevant based on point of concern. 2. The question was written in English, which other languages did you use as you engaged with the task? 3. Which other languages do you use while engaging with mathematics either in discussion groups or alone? 4. Why did you use the languages as you did?

In the analysis, I present detailed analysis of S8 and S3 while I briefly examine the responses of S6, S10, S15 and S4 in the interpretation of the task. The aim of the brief examination is to support the findings from the language practices of S8 and S3 and perhaps raise other pertinent issues in the use of the languages. Furthermore parts of language practices of these students that involved identifying and explaining cues and clues in the seven Discourse situations are typical of the language practices of S8 and S3 under the same Discourse situations. However, since how and why other languages were used was key to my study, the brief analysis focuses on the aspect of code switching.

In the light of my research questions, during the interview I posed some key questions to the students. From their responses, I extracted the utterances that illuminated responses to my questions. With a focus on how they made sense of the task, I have analysed their utterances in the clinical interviews when they were interpreting the task, which was supported by their corresponding utterances in the reflective interviews. The questions are outlined in the Table 1 below and the utterances are presented as extracts. Below I present the analysis and subsequent discussion of the findings. The findings are that the students engage with activities and enact identities that people in mathematics Discourse community engage with. Furthermore they switched mentally between the LoLT and their home languages when engaging with the task to translate the whole task or parts of it for a range of reasons. Prior to the analysis, I present brief language and academic background of each student.

7. Analysis and findings

7.1. Translating the whole task

7.1.1. Analysis of S8's utterances in the interpretation. S8 was 20 years old student at the time of data collection. His first language is Kikuyu and the language he commonly uses at home is Kiswahili. He commonly used English and Kiswahili with himself, peers and lecturers. He scored a Grade A in mathematics and Grade B- in English. At the time of data collection he was undertaking a Bachelor's degree in Mechatronics Engineering. S8 switched between Kiswahili and English in interpreting the task. While this was not evident in his verbal and written explanation, he explained during reflective interview that he switched to Kiswahili in

thinking throughout the task.

Identifying and explaining cues and clues in the interpretation
S8 first worked on the task silently and then proceeded to explain from his workings. Below I analyze his response to what does the question require of you?

Extract 1
S8: This question, because here we have unknowns, we have kind of like before the rearrangement we know that the hall had a certain number of rows and each row had a certain number of chairs. So you give the number of rows an arbitrary letter like a like I have done here *(pointing where he had written)* a. I have said let the number of rows be a then, before the rearrangement, then I've said that because after the rearrangement the number of rows are increased by 5, so after the rearrangement the number of rows will be $(a + 5)$

Activity:

S8 was involved in making assumptions and formulating an expression and justifying both activities. Making assumptions, formulating and justifying are practices that are valued in mathematics Discourse (Moschkovich, 2002). Making assumptions was evident when he said "give the number of rows an arbitrary letter like a". He justified making the assumptions with the argument that since there were unknowns, then arbitrary values have to be assigned to these unknowns in an attempt to solve for the rows and chairs. Similarly S8 explained how he formulated the expression $(a + 5)$ and justified the formulation. Therefore S8 is recognized as a student who is involved in the activities of making assumptions, formulating and justifying the steps he took.

Identity:

In his explanation, S8 referred to *we*, later to *you* and in direct reference to his written work, he used the pronoun I. These pronouns are commonly used in mathematics talk (Rowland, 1999; Pimm, 1987). From the extract, his use of *we* and *you* suggest shared understanding of the conditions set out in the task and the unknown variables. In using these impersonal pronouns in formal mathematics language, S8 engaged with the task the way mathematicians do. Later he moved on to explain how to make the assumptions from his own perspective, which was based on his earlier written work. In using I he shows knowledge and ownership of the interpretation process again using formal mathematics language. His use of the pronouns is in line with mathematics register which researchers (Pimm, 1987; Rowland, 1999) argue that it is not entirely impersonal. Alongside using the pronouns, S8 is presenting himself as a mathematician, which is evident in the words he uses and how he approaches the problem. Choosing an arbitrary letter to represent a number which is not known is what mathematicians do. Formulating and justifying expressions to define or describe a situation are also some of the things that mathematicians do. S8 is recognized as assuming the identity of a mathematician at once in a general and a personal perspective.

Relationship:

The use of the pronouns *we* and *you* shows that S8 shares his understanding of the task like other mathematicians do. Later he uses I while explaining how the task should be done from his point of view. In doing so, he relates with other mathematicians as a student who ably approaches the task as other mathematicians do while at the same time uses words and modes of argument

as used in mathematics register and hence formulates the necessary mathematical expressions. Hence his relationship with the other mathematicians changes from a general relationship to a personal one.

Politics:

According to the first year mathematics syllabus of Procity University, students are expected to formulate and solve quadratic equations. Therefore formulating and solving quadratic equations in the context of the syllabus are social goods. These social goods were worth having in solving the algebraic task that was at hand. S8 made assumptions using arbitrary values and then formulated a mathematical expression. In making the assumption, he used formal mathematical language as used in mathematics Discourse. He then used the arbitrary values to formulate the mathematical expressions. Therefore S8 can be recognized as a student who distributed social goods across the task using formal mathematical language within mathematics Discourse.

Connections:

S8 is connecting his arguments with conceptual mathematics discourse (see Sfard, Nesher, Sreefland, Cobb, and Mason, 1998). This is evident in the way he connected unknown values of rows and chairs with some arbitrary values within the task which enabled him to formulate the required mathematical expressions. S8 described the assignment of arbitrary values to the unknowns and explicitly justified why he did so. By justifying, he connected his conversation to conceptual mathematics discourse. S8 is thus recognized as a student who made connections within the task, with conceptual mathematics discourse.

Sign systems and knowledge:

Throughout the Extract 1, S8 used formal mathematics language (in English) as noted in the discussions above. For example in assigning arbitrary values to the unknown number of rows and chairs he said So you give the number of rows an arbitrary letter like a. While this language is acceptable in mathematics discourse, it did not involve words commonly used in making mathematical assumptions, but it is clear that he was involved in making an assumption. Therefore S8 privileged using formal mathematics language in English.
S8 uses English language only in his verbal explanation. With the awareness that he used Kiswahili and English when working on mathematics when on his own, with peers and lecturers and the fact that he also uses Kikuyu at home, I inquired about his use of other languages in this particular task during the reflective interview. He responded as follows:

Extract 2
S8: Kiswahili only ⋯ even I found the answer using Kiswahili because now I was reading the question and interpreting it into Kiswahili and even these things I was writing I was saying wacha hii ikuwe hivi [Let this one be like this] referring to scribbles on arbitrary values on the question paper so in Kiswahili.
R: Why did Kiswahili come into play?
S8: Because I'm mostly acquainted to Kiswahili as a language; I'm best in Kiswahili than in English. So it was the language that I was using to interpret now this. So, even though it's written in English here, whatever was coming from my mind was in Kiswahili. I was just writing in English because it's like a requirement.

S8 said that he used "Kiswahili only", meaning that he did not switch to Kikuyu in the particular task. He read the question as it was and interpreted it into Kiswahili. By listening and observing him interpreting the task, I could not tell that the arbitrary values had been thought of in Kiswahili since these were all written in English in his worksheet. In using languages that way, he privileged Kiswahili, his home language, in interpreting the task. [6] S8s use of Kiswahili was based on the fact that he was more familiar with Kiswahili than English. This resonates with research findings (see e.g. Parvanehnezhad and Clarkson, 2008) that show that some bilingual students switch between LoLT and home language because they are more familiar with the home language than the LoLT. Furthermore S8 said that he is better in Kiswahili than in English. Being better in Kiswahili than in English could probably mean fluency in Kiswahili since Kiswahili was his home language, he used it at home and with the larger community. This explains partly why S8 used Kiswahili more than Kikuyu. Furthermore he commonly used English and Kiswahili with himself, peers and lecturers.
The fact that he only wrote in English was because "it was like a requirement". This positions English as a powerful language in S8's communication of the task. With such power of the language, he communicated in English whereas he would have done the same in his more familiar language of Kiswahili. After all English is the LoLT at Procity University. The perspective of English holding more power than Kiswahili in S8's case is similar to the view that English is the language through which one can have access to social goods like employment and language of examination (Setati, 2008). Since initially he had a choice of the language he preferred to be interviewed, in my view S8 restricted himself to using English in his communication with the researcher due to the power that English held.
In essence, S8 translated the whole task from English to Kiswahili solved it and then wrote in English. The two languages had different functions; Kiswahili was a language for internal communication that he used for thinking and interpreting the task, while English was for external communication, in writing and verbal communication with the researcher. He switched to Kiswahili for the purpose of translating the task due to familiarity with the language. Therefore code switching supported S8's participation in competent mathematics Discourses.

Discussion on S8's interpretation

From the analysis above, S8 made formal mathematics language significant. He used it in describing, formulating, making assumptions and justifying his workings. He at times positioned himself as working from a personal point of view and at another as working with other mathematicians. He used language to make connections within the task and with mathematics register, formal mathematics language, conceptual mathematics discourse and mathematics Discourse practices. In all his verbal and written explanation, he used a formal mathematics language in English and in thinking he used Kiswahili. He used Kiswahili because he was more familiar with it than with English. However, he wrote his work in English because the context required so, that is it was the expected language in such situations. Since initially he had been given the option of using any language in his repertoire, I argue that by using English in his reporting while he engaged the task in Kiswahili, he positioned English as the more powerful language than Kiswahili.
Therefore S8's utterances in interpreting and solving the task contain cues and clues for mental code switching, formal mathematics language, and conceptual mathematics discourse, and general and personal relationship with other mathematicians and in general mathematical Discourse practices.

[6] This contrast of performance in Kiswahili and English was not based on any available academic records.

7.1.2. S8 Negotiating the situated meaning of key word "hall". S8 situated the meaning of a hall from the perspective of an auditorium or a theatre. He explained his experience with theatres in high school, as elevated from front to back. S8 had experience with theatres in that as a student of English and Kiswahili literature in high school he attended performances of a range of English and Kiswahili literature set books in theatres. He therefore was operating with the Discourse model of a hall as an auditorium or a theatre.

7.1.3. Emerging Discourses. From the discussion on the cues and clues in S8's language practices in interpreting the task and situated meaning and accompanying Discourse model, S8 "pulled off" a Discourse of a student who combined and integrated verbal words with formal mathematics language, and conceptual mathematics discourse, mathematics register, and mathematics Discourse practices. He did so by switching from English to Kiswahili to translate the whole task in his thinking to interpret the task. He assumed both general and personal perspectives of a mathematician whose view of the hall in question was an auditorium or a theatre.
In the next section, I analyse in brief how S6, S10 and S15 used their two languages as they interpreted the task. The analysis supports the findings from the analysis of S8 utterances and raises other pertinent issues on language practices in the interpretation of the task.

7.1.4. Language practices of S6, S10 and S15 in the interpretation. S6 was 21 years old Mechatronics Engineering whose first language is Kikuyu and his home language is Kiswahili. He explained what the task required of him in both verbal and written forms in English language only. To be able to do this, he translated the whole task to Kiswahili in an effort to understand the task better. This was because he had a better understanding of Kiswahili than English. S10 was a Civil Engineering student aged 19 years. His home language is Kikamba. He rarely used either Kiswahili or English at home. All the three languages were relevant to him when engaging with mathematics such that he used all of them when consulting with himself and when discussing with his peers. With the lecturers he used Kiswahili and English. In working on the task, S10 used English throughout his written and spoken explanation of the interpretation. In his reflections, he revealed that he translated the whole task to Kikamba in an attempt to interpret it, because Kikamba was the more familiar language. Below are his reflections.

Extract 3
R ... Did other languages come anywhere in between when you were responding to the question?
S10: Yeah, yeah, yeah. First after seeing the question, in all my studies, I try to interpret in Kikamba, which I'm more conversant with. I read in English then I interpret it in Kikamba, which I can understand more than English.
R: Are there particular parts or it is the whole question that $\cdots$.
S10: The whole question.
R: How do you put it in Kikamba?
S10: I do it in Kikamba then I transfer to the paper in English.
R: Is it *(translation)* something that you can write?
S10 No, no, no. Yeah, I'm more conversant with Kikamba more than any other language.

The Extract 3 shows that S10 not only translated the task that was at hand but he did so all the time in other tasks. He does so because he is more familiar with Kikamba than English. He interpreted the task to Kikamba in his mind and neither verbalised it nor wrote it in Kikamba. It is interesting that when requested to write the interpretation in Kikamba, S10 said an emphatic 'no' while still arguing that he is more conversant with the language more than any other. While this explanation may seem to contradict his use of Kikamba, it in a way shows that conversational proficiency in a language is not commensurate with written proficiency (see Gerber, Engelbretch, Harding, and Rogan, 2005). He used English to communicate the task expectation and interpretation with the researcher. Therefore, Kikamba his home language was

significant for understanding and interpreting the task while English served to communicate with the researcher.
Similarly S15 read the task in English then interpreted the whole task internally in his home language, Kikuyu, for better understanding and he wrote out the solution process in English. This is a practice that he engaged with even in other tasks. Similar to S10's position, S15 he could not write the translation in Kikuyu though he could speak the language.

7.1.5. Discussion on translating the whole task. The language practices of the trilingual students S8, S6, S10 and S15 above show that they mentally translated the whole task to home languages in interpreting the task because they were more familiar with the languages, then they were in English. This finding supports Hoffmann's finding that some trilingual students use LoLT for external communication while their other languages are used for internal communication (2001). Furthermore the students translated tasks at all times similar to how English-French bilingual students mentally translated French text to English (see Kern, 1994). Their translations are associated for the common use of the languages as home languages for communication within their home environments (S8, S6, S10, and S15) and in mathematics group discussion (S8, S6 and S10). The fact that their switched to their home languages because they were the languages of common communication at home, are similar to the reason why English-Vietnamese bilingual students in Australia switched between their two languages (see Clarkson, 2006).
Setati, (1998) observes that translation may pose challenges when everything is to be translated from one language to another. Setati observed that some of English mathematical terms may not be used or are readily not available in home languages. The students in this study translated the whole task and did not report any challenges in translating the task. The fact that the task that the students engaged in did not have technical terms could be reason that they did not report translation challenges from English to their home language and vice versa. Next I analyse the utterances of S3 and S4 who translated parts of the task into their respective home languages.

7.2. Parts of the task

7.2.1. Analysis of S3's utterances in the interpretation. S3 was aged 19 years at the time of data collection. His home language is Luluhya, the language he commonly uses with his family and with little use of English. In the questionnaire, he indicated that he communicated with himself and peers more in English than he does in Kiswahili, while he used both English and Kiswahili with lecturers. He was pursuing a degree in Geomatic Engineering and Geospatial Information Systems.

Identifying and explaining cues and clues in the interpretations

S3 explained and wrote his interpretation simultaneously. In responding to what the question required of him, he explained:

Extract 4

S3: so the total number of chairs *writing* total number of chairs is 600 then each row has the same number of chairs. If it is 20, twenty, twenty per row is the number. Reading from the question he continues, so you just let the original number, original number of rows before the increase of rows be a value let's say x. So after the increase the new number of rows is now $(x + 5)$, yes after the increase. But the number of chairs per row is decreased by, by 6. So if there are x rows initially and the chairs the total number of chairs are 600, it means that the number of chairs per row in this will be $600/x$

Activity:

S3 used a specific assumption about the number of chairs that is 20 chairs per row which seemed to lead to the general assumption on the number of chairs. The reason as to why he first used a specific assumption before coming up with the general assumption about the number of chairs does not seem obvious. It could probably be explained by his response to the question of the impression the task created in him, which he associated with a real life situation as he explained during the reflective interview;

Extract 5
S3: First of all, when I read the question I looked at it and I tried to relate it to real life situation. When I / I read it further, I imagined myself arranging that *Inaudible* may be somebody has been appointed to arrange chairs in a certain hall. I was imagining if it were me, what could I do?
R: The real life situation?
S3: It's like there is a meeting in a certain hall, and may be the guests have been invited and everybody. So the chairs are supposed to be arranged, may be I'm there and I can be consulted / to arrange those chairs. So I was imagining, I'm the one to be appointed to arrange those chairs, what could I do?
R: Did that *(real life situation)* influence how you solved the problem?
S3: Yes in that, I was now seeing things like physically not like on the paper, because when I was focusing, the chairs as objects. That really motivated me, helped me a lot in solving that question'.

S3 explained his view of the real life situation as one in which guests had been invited to a meeting in a hall and he was required to arrange the chairs for them. The chairs were physical objects that assisted him in solving the task. While this activity was not visible when he was interpreting the task, it was important in understanding how S3 came up with his assumptions. S3 is recognized as making assumptions based on a real life setting a practice that is common in mathematics Discourse. Identity: He refers to "you", "let" and "let's" in making an assumption on the number of chairs. "Let" is commonly used in formal mathematics language in making assumptions in the mathematics Discourse community and is a defining characteristic of mathematics register (see Halliday, 1974 in UNESCO, 1974). Using the three referents, S3 positioned himself as working with and like other mathematicians who share the knowledge of making assumptions. In so doing, he assumed a general identity of being one of the mathematicians. Relationship: Following the general identity of belonging to mathematics community, S3 created a general relationship with the community. Connections: S3 makes connection within the task, and with formal mathematics language and calculational discourse (Setati and Adler, 2000; Sfard, Nesher, Sreefland, Cobb, and Mason, 1998). This is evident in that he initially takes on a specific assumption of the number of chairs and then connects it to a general assumption of the number of rows and finally to the number of chairs. Further he describes the steps he follows using formal mathematics languages. Sign systems and knowledge: Throughout the task, S3 used English. In the questionnaire he had indicated that he engaged in mathematics in English and Kiswahili, to know whether this also applied in the given task, I enquired how he used other languages.

Extract 6

S3: *(Laughs)* in interpreting that question, yeah to some extent. For deeper understanding of the question, when I read it I tried to interpret it in my language which is Luhya . I tried to translate the words written there in Luhya using my brain.
R: Are there specific words that you may have used in Luhya?
S3: Yes / like chairs is 'izidindeve', 'Izidindeve' are arranged in rows meaning chairs arranged in rows, arrange is "kubanga'a". When I had these two words, I now know that, I had the deeper meaning of this question, because I understand this language better, it's my original language, the language that I learnt.

S3 explained that he translated words like chairs and arrangement mentally to emphasize their meaning (Merrit, Cleghorn, Abagi, and Bunyi, 1992). It was necessary for him to understand the words chairs as 'izidindeve' and arrangement as "kubang'a" so that he could experience a deeper meaning of what the task was all about. He translated these words into Luluhya because he understood the language better, as he put it; Luluhya was his original language, the language that he first learnt. His statement suggests that he strongly relates with Luluhya and understands it better than English and Kiswahili languages. It was the more familiar language and hence was most relevant in interpreting the task. However, the words were neither verbalised nor written while he was engaging with the task. While he understood Luluhya better than other languages, I wondered why he preferred to be interviewed in English. In his explanation, English is positioned as the official language that should be used in engagements such as the interviews.

Extract 7

R: Much as you understand the Luluhya language, you preferred to be interviewed in English.
S3: *(Laughs)* the language I thought that the English is the most official to be used in interviews.
R: Otherwise,
S3: if they could allow laughs for any other local language then I could choose on this Luluhya. [7]

From the utterances in Extract 7, S3 shows that he would have preferred to be interviewed in Luluhya if it was allowed. When he was given the opportunity to choose his preferred language for the interview, S3 chose English. This shows that he may have avoided using his home language because English was the official language of communication in such settings particularly at university level. His choice of English shows the tacit power that the English language held in S3's language practice. Furthermore, when he says that 'if they could allow laughs for any other local language then I could choose on this Luluhya', it shows that the allowance given by the researcher in the context of data collection was not enough encouragement for him to use his home language. Therefore S3 remained in English language for his verbal communication and switched to his home language in thinking due to the context in which he found himself at the time of the interview.

Discussion

It is observed that S3 made the required assumptions based on some real life situation. Relating a task to a real life situation is a common practice among mathematicians. He used a single variable to form simple equations. Furthermore, he used plural pronouns which suggested

[7] Luhya language is also referred to as Luluhya

that he identified with and worked in collaboration with members of mathematics community. S3 switched to Luluhya in thinking to capture the essence of the words chairs and arrangement. He argued that when he translated the two words he gained deeper meaning of the task. He translated the words in order to express them in the language that he was more familiar with. In contrast, S3 was restricted from switching to his home language in his verbal communication by the interview context. He thought in such context, English was the most appropriate and official language. This is consistent with the situation in which bilingual students remained in the LoLT (Planas and Civil, 2008; Planas and Setati, 2009), he perhaps did not feel permitted enough, to use his home language, Luluhya. In fact like the bilinguals in the study of Planas and Setati, (2009) he probably did not view his language as valued in such context. S3's self-restriction to code switch left me wondering how else he would be convinced that he could switch between different languages as he communicated verbally in the given context. In his explanation, S3 makes connections with mathematics register, formal mathematics language and calculational discourse which suggest that he identified himself, and related, with mathematics Discourse community. S3's utterances contained cues and clues for mathematics register, formal mathematics language, calculational discourse, generality, and code switching during thinking, and mathematics Discourse practices.

7.2.2. Situated meaning of the words "chair" and "arrangement". According to S3, his understanding of the task capitalized on grasping the meaning of the words "chairs" and "arrangement" (see Extract 6). He situated the meaning of chairs and arrangement in a real life situation of a hall. He simulated himself arranging the chairs in the hall in which a meeting was scheduled which helped him to view the chairs in the task as physical objects (see Extract 5). It seems that it is in such an environment that he could talk about chairs as 'izidindeve' and to arrange as 'kubang'a'. Thus he situated the meanings of chairs and arrangement relative to his socio-culturally defined experiences with how he could arrange the chairs in such a familiar setting. He applied the situated meanings against a Discourse model of a hall in his familiar environment and the socio-cultural practices involved in such an environment to which he belongs.

7.2.3. Emerging Discourses. From the preceding discussion on how S3 used language, he is recognised as having pulled off a Discourse of combining and integrating English and his home language in interpreting the task, mentally translating key words of the task into his home language for the sake of gaining deeper understanding. Further he combined and integrated formal mathematics language, mathematics register, calculational discourse and mathematics Discourse practices and he identified himself with mathematics community. He also operated in the Discourse of a student who viewed the use of other languages in their communication with the researcher as restricted. In the next section I analyse how S4, used languages when he interpreted the task. The brief analysis focuses only on code switching between English and his home language Dholuo. The analysis supports the findings from the analysis of S3 utterances.

7.2.4. Language practices of S4. S4 commonly spoke Dholuo at home than either English or Kiswahili, in fact Dholuo was his home language. When doing mathematics alone and with peers he did it in English and Kiswahili while he used English with the lecturers. He was enrolled for a degree in Geomatic Engineering and Geospatial Information Systems. In responding to what the task required of him, and in fact throughout the task, S4's verbal and written explanations were in English. I asked him during the reflective interview if, and if so when, he used Kiswahili and/or Dholuo in solving the task. He responded that he translated the task at the interpretation stage; in particular he translated the third sentence to Dholuo because he found it difficult to interpret English. In his words, Dholuo was the language that he was more familiar with and by switching to translate the third sentence; it was easier for him to understand the rearrangement and the task at large. Therefore S4 privileged to translate the part of the task he found difficult

into his home language in order to understand the task in a better way. I observed that when I asked S4 to say more on his translation, in his response he first asked whether he can say it in Dholuo to which I responded in the positive. S4's request to use Dholuo shows that it's uncommon to use other languages other than English especially in external communication at this level of education in Kenya. His request to verbalise and write in Dholuo resonates with S3's response when he said that if he was allowed he would have used Luluhya in the interviews.

7.2.5. Discussion on translating parts of the task. Students can switch between languages in order to express words or phrases in the more familiar language. S3 and S4 switched to Luluhya and Dholuo respectively because the languages were more familiar to them than the LoLT. At the same time they needed to gain better understanding of the task that was at hand. While S4 had challenges in understanding the third sentence and hence the translation, S3 needed further understanding beyond what he had captured in English.

8. Summary of findings on language practices involving the use of English and home language

The major findings of the case study reported here are that the language practices of the trilingual undergraduate students are identified with mathematics Discourse and with the use of two languages in their mathematics engagement. They participated in mathematics Discourse practices in a range of ways similar to those indicated by Moschkovich, (2002). While only the findings of S8 and S3 are presented in detail, in most other aspects, the language practices of the other four students were similar to those of S8 and S3. The language practices that show that the students used languages to engage with mathematical Discourses include: making assumptions, identifying variables, and formulating simple equations and justifying (or not) their workings in logical manner. Furthermore they constructed sentences that were rich in words and modes of argument used in mathematics register, formal mathematics language, and in mathematics Discourse. Their approach and ways of working as well as the use of pronouns positioned them as individuals and/or as members associated with mathematics Discourse community, thus assuming individual and/or as well as a general identity and relationship. It can be observed that the students had acquired control over mathematics register, they engaged with conceptual or calculational mathematics discourses and in general participated in mathematics Discourses switching between the two languages.

The language practices that emerged, involved English and home languages. The home languages were either first languages or Kiswahili. The first languages are however not taught or used at university level in Kenya while Kiswahili is taught as a subject. Despite that the home languages were resources for interpretation and understanding the task. For these students, code switching was necessary in making sense of the task. The purposes of code switching were translation and context in which they found themselves. Out of the six students, four students switched mentally to translate the whole task and did so all the time while the two others switched to translate parts of the task, to emphasize meanings. This latter case of translation is in some way similar to how bilingual Persian-English students translated certain words due to habitual use of the words in Persian language (Parvanehnezhad and Clarkson, 2008). They all switched to the home languages because they were more familiar with the languages than they were with English, the LoLT. The interview context restricted S8 and S3 from using their home languages, arguing that English was the appropriate language in such contexts.

The two languages had different functions: home language was for translating and exploring meaning mentally and English was for communicating verbally and in writing with the researcher. Furthermore S3, S4 and S8 were of the view that English was the language for formal communication and hence the need to use it when they engaged with the researcher. This

positioned English as the more powerful language of communication in such contexts of interview. Thus while the students home languages are not the LoLT in mathematics teaching and learning; they were resources for the students as they engaged with the algebra task. The trilingual students used two languages in their repertoire similar to how bilinguals students do (Moschkovich, 2002; Planas and Civil, 2008; Planas and Setati, 2009) and multilingual mathematics (Adler, 1998; Setati, 2005) and in fact in line with the observation by Hoffmann (2001) that trilinguals may use two languages in their reperrtoire as bilinguals do. Therefore the LoLT and the home languages that the trilingual students used in in verbal communication, writing and thinking in relation to their social culturally defined experiences, shaped the identities they enacted and activities they were engaged in within mathematics Discourse and in the use of their trilingual language facility.

9. CONTRIBUTIONS OF THE STUDY

The findings are important to inform LiEP in Kenya how the some undergraduate students position the home languages when they engage with mathematics. The students positioned their home languages as the dominant languages that facilitated interpretation, and understanding of the task, and English was dominant in the initial reading, verbal reporting and writing. The home languages were used in solitary and mental engagement with the task. The fact that they mentally engaged their mathematics in other languages was most unexpected because the students had learnt mathematics in English for the previous nine years and like in the study by Clarkson, (2006) one would have expected that they had learnt the LoLT sufficiently for them not to switch codes. Furthermore, their mathematics grades did not suggest that some of them could be struggling with understanding mathematics presented in English. The LoLT was used as a language of external communication while the home languages functioned as internal languages of communication. Thus while Kiswahili and home languages are not LoLT's beyond Standard three, the languages had a social value and worth in students interpretation and understanding of the task. Thus while English is the official and dominant language of teaching according to the LiEP, home languages played a significant role in students interpretation and understanding of the task. Furthermore, this finding has added to scholarly work (Clarkson, 2006; Parvanehnezhad and Clarkson, 2008) by establishing that code switching is not a reserve of students who are learning the LoLT rather code switching is a reality even for trilingual students who are competent in LoLT when they engage with mathematics.

In the global perspective, the findings contribute to the field of mathematics education in trilingual contexts. The fact that no research on language practices have been conducted among trilingual mathematics students (Phakeng, 2013) makes the findings of this study significant in field of mathematics education. As has been shown, the trilingual students in mathematics have specific ways of using their three languages (Hoffmann, 2001) which they have demonstrated in this study. That is they functioned like bilinguals. Therefore this study has provided insights on whether, how and why trilingual students use their languages as they do when engaging with mathematics tasks. Further since in this study trilingual speakers are considered as a special case of multilingual speakers, the findings of this study have helped to broaden the view of the language practices of multilingual students already investigated. Furthermore research on mathematics education in bi/multilingual contexts has commonly been concentrated at primary and secondary levels (see e.g Bunyi, 1997) with some exception in college level (Chitera, 2009). The study reported in this thesis was conducted a university level and probably the first research on language practices at university level. Findings of this study will give clues to mathematics lecturers of what transpires linguistically in their trilingual students as they engage with mathematics tasks.

10. Conclusion

In this paper, I have analysed language practices of six trilingual undergraduate students of mathematics who switched between two languages in engaging with a mathematics task. The languages were the LoLT and the respective home languages of the students. Using Discourse analysis (Gee, 2005), the language practices of the six trilingual undergraduate students have been analysed in an effort to communicate the socially situated identities and activities that students enacted as they engaged with a mathematics task. The analysis helped to understand whether, how and why the trilingual students' use language as they do when they engage with mathematics tasks.

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