Mediating Wor(l)ds:

Teaching and Learning *of* Mathematics *in* English

in Malaysia

by

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Abstract

This study investigates the implementation of ETeMS (***E**nglish for the **Te**aching of **M**athematics and **S**cience*) policy in Malaysia. Teachers, who learnt mathematics and were trained to teach mathematics in Bahasa Melayu, have had to teach mathematics in English since the implementation of ETeMS. This study observes two teachers and their teaching *of* mathematics *in* English to ten-year-old students.

The study draws on sociocultural and sociolinguistic theories of classroom research which strongly advocate that education is a process of interaction. Both theories place importance on the joint construction of meaning through classroom interaction. The research mainly seeks to understand how teaching and learning is mediated in classrooms through the new medium of instruction. Adapting Erickson's (1982) proposed constructs: academic and social participation structures, the study investigates the academic world and social world of linguistically altered mathematics classrooms. Sinclair and Coulthard's (1975) discourse analysis tool has been adapted to study the teaching and learning *of* mathematics *in* English. Principles from conversation analysis and critical discourse analysis have been drawn upon to study the social world of linguistically altered classroom.

Analysis of the classroom interaction showed that the academic world of linguistically altered classrooms is still heavily reliant on triadic dialogue. Despite that, teacher talk, through various discursive practices, was found to be an important mediating tool for mathematical content and mathematical English. Mathematical content and mathematical English were also shown to be jointly constructed through the use of several other mediating tools.

The study revealed that there is more of an emphasis on teaching for testing than teaching for understanding, hence more attention to procedural fluency than to conceptual understanding, thus more emphasis on calculation discourse than on conceptual discourse. However, once the content and concept has been jointly constructed, students take some ownership of the classroom interaction.

As well as the academic world, the study investigates how the new language of instruction mediates the social world of the classroom. The study found that the new medium (re)creates the social world of the classroom as teachers and students position and (re)position themselves and each other, and (re)establish their identities and sense of agency through the new language.

From the insights gleaned from this study, the inter-relationship between ETeMS policy on paper and ETeMS policy in practice is explored. Some important implications for policy, practice and inter-disciplinarity in mathematics education and applied linguistics are discussed. The thesis concludes by proposing an adapted and extended model of mathematics education and directions for future research.

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CHAPTER ONE

Stories of ETeMS: An Introduction

1.1 Overview of Study

In this study, I look at two mathematics teachers mediating (i) the "non-English *world*" of mathematics they and their students come from with (ii) the "*word*", that is the new medium of instruction (English Language) they have to teach and learn in. Freire (1985) advocates that understanding the "world" is as important as understanding the "word". His pedagogy of literacy education involves not only reading the "word", but also reading the "world", "one must read the world in which words exist" (Freire, 1997, p. 211). While Freire talks about critical pedagogy and the culture of power, the essence and concept of what he says holds true for the Malaysian teachers and students and the "non-English linguistic world" they come from. Freire recommends a dialogic exchange between teachers and students, where both learn, both question, both reflect and both participate in meaning-making. Drawing on Freire's concept of the "*word*" and the "*wor*ld", my study explores mediating wor(l)ds: teaching and learning *of* mathematics *in* English in Malaysia.

"All you can do if you want to be truthful," Feyerabend (1991) advises, "is to tell a story." (p. 141). This thesis is a story about ETeMS (***E***nglish for the ***Te***aching of ***M***athematics and ***S***cience) in Malaysia. Particularly, it is the stories of two teachers teaching mathematics *in* English. The stories I capture are the teaching and learning of a mathematical unit on Length to ten-year old students. In any story, the position of the narrator is important. I, the storyteller, relate to you these stories of "the teaching and learning of mathematics *in English*" as seen through my eyes as "a teacher *of English* as a subject" and a researcher.

1.2 ETeMS: *E*nglish for the *Te*aching of *M*athematics and *S*cience

In 2002, the then Prime Minister of Malaysia, Tun Dr. Mahathir Mohamad, made the announcement that science and mathematics subjects will be taught in English from the following year. Many were surprised at this decision. The sudden decision to implement the ETeMS policy drew criticism from various quarters, educationalists, nationalists, and non-government agencies. However, Dr Mahathir gave several justifications for the implementation of this language policy.

One of the main reasons for the implementation of ETeMS, explained Dr Mahathir, was because of the influence of globalization and the vast usage of English in the domains of science and technology. In the early 1990s, globalization brought about many changes in the world. Alvin Toffler (1980), an American writer and futurist, known for his work discussing the digital and communication revolution observed that civilization faces changes in the form of waves:

> The dawn of the new civilization is the single most explosive fact of our lifetimes. It is the central event - the key to understanding the years immediately ahead. It is an event as profound as the First Wave of change unleashed ten thousand years ago by the invention of agriculture, or the earthshaking Second Wave of change touched off by the industrial evolution. We are the children of the next transformation, the Third Wave (p. 25).

Toffler explains that this third wave we are in now is the age of information or the knowledge age. And as Choong (2002) noted, much of the world's knowledge is locked within the English language.

Based on Toffler's observation, Gill (2005), a professor of sociolinguistics and international communication states that Malaysia faces two main challenges within this age of information with its reliance on English:

> The first is the challenge of ensuring that the nation possesses the necessary human resource capability and of asking whether the existing quality of *language capacity* meets the needs of the nation. The second challenge arises out of the knowledge and information explosion and its implications for *language policy* (p. 250).

For the past 30 years, Bahasa Melayu (Malay Language) has been the medium of instruction in all public schools in Malaysia. All subjects were taught in this national language. English was also officially deemed as the second language from the beginning of the 1970s (Gill, 2005). English gradually took a secondary place. In many parts of Malaysia now, English is seen as more of a foreign language (Choong, 2002). To keep up with globalization as well as the advancement in science and technology, Dr Mahathir thus announced the implementation of ETeMS.

The second reason for the implementation of ETeMS was also because of the move towards knowledge economy. Malaysia with its Vision 2020, a blueprint for the achievement of industrialization status by the year 2020, has embarked on a plan to shift from a production-based economy (P-economy) to establish a knowledge-based economy (K-economy). Looking at the implications of this trend on human resource capability, it is vital to refer to the report by The National Brains Trust on Education (2002). The National Brains Trust committee, made up of established and experienced members of Malaysian society from the fields of education, politics, economics and non-governmental organizations, reported that:

> The P-economy demands a brawn-intensive, disciplined workforce. The K-economy demands a brain-intensive, thinking, creative, innovative and disciplined workforce. Malaysia today has a world-class workforce for the P-economy. But we have a poor workforce for the K-economy (p. 1).

For Malaysia to achieve the industrialised status it is striving towards, and for it to develop knowledge workers who are able to innovate in the field of science and technology, the National Brains Trust recommend that access to knowledge and information in the field of science and technology is crucial. Access to knowledge and information is via language and at present English is widely used as the language of knowledge and information in most countries. According to Gill (2005) and Choong (2002), the problem in Malaysia arose because of the successful implementation of a nationalistic language policy over a period of two decades. As a result of this nationalistic policy, there is a generation of school and university graduates educated and fluent in the national language. The converse side of this equation is a generation who are not equally competent in the English language (Gill, 2005, p. 255).

English has been, since the post-independence era, predominantly the language of communication in the domain of business and industry in Malaysia. Summarizing the situation of English in Malaysia in the 1990s, Asmah (1996) explains how the official policy was effective in replacing English with Bahasa Melayu in education, government, and even the law courts, but points out that "business in the corporate sector is conducted more in English than in Bahasa Melayu, in both local and international concerns" (p. 523). Similarly, Nair-Venugopal (2001) notes that "nowhere is the use of English more entrenched in Malaysia than in the private sector domains of corporate business and industry, banking and finance" (p. 21). This is the third reason for the implementation of ETeMS. Malaysia, like many other countries around the globe, competes aggressively for foreign investments needed for the economic growth and development of the nation. Therefore, English continued to possess linguistic power and capital through its dominance over the domain of business and industry.

Besides the three reasons stated above, because of their competency in English, graduates from the private universities were more sought after by the companies in the private sector. This situation would have begun to lead into serious social and economic problems for the nation (Gill, 2004). For example, in the year 2002, around 40,000 graduates from public universities, where the medium of instruction was Bahasa Melayu, were unemployed (Mustapha, 2002, March 14, pp. 1-2).

Despite the reasons stated above, the implementation of this language policy was seen as ad hoc and viewed as a political decision rather than an educational proposal by many parties. Heated debate centered around two strands of thought (Kulasagaran, 2011). Those who were against the policy argued that the teaching of mathematics and science in English would not help to rescue the deteriorating standard of English, whereas the proponents claimed that making English a tool for learning is the most effective way of ensuring students are proficient in English as well as upgrading students' achievement in mathematics and science.

1.3 Rationale for the study

There is considerable research in the teaching and learning of curriculum content in a second language (Dawes, 2008a; Dawes 2008b; Mercer 2005; Wells, 1999). Most Western literature (Gibbons, 2006; Gibbons, 2003; Clarkson, 2004; Khisty & Chval, 2002) highlights proficient English speaking teachers helping limited English proficiency students in countries where it is predominantly English speaking. And studies from countries, like Africa for instance (Setati, 2002; Adler, 2001), where English is not the first language but remains the official language of government, administration, legal and of interest here, education, again feature proficient English speaking teachers (many of whom multilingual) teaching limited English proficiency students (but who are multilingual in their native language). Even Bakalevu (1999) researching in the Pacific Islands, highlights the frustration and stress of learning in a second language generally and mathematics in particular. Overall, the focus of these studies has mostly been on *learning* in English.

The Malaysian context portrays a totally different linguistic scenario. Bahasa Melayu remains the main language, the national language as well as the language of the official, legal, government and education. While English is officially the second language, in most parts of Malaysia, its status is that of foreign language. Of interest in this study is the teaching *of* mathematics *in* English. The teachers teaching mathematics in Malaysian schools themselves learnt mathematics in Bahasa Melayu during their primary and secondary schooling days. In the teacher training colleges, they again learnt and were trained in Bahasa Melayu. They learnt to teach mathematics in Bahasa

Melayu (Hamidah et al, 2005; Rohaida & Juliana, 2010). It was not a prerequisite condition then that they be proficient in English. With the sudden change in policy in 2003, when the medium of instruction was changed to English, teachers who had *learnt* mathematics *in Bahasa Melayu* and were *trained* to teach mathematics *in Bahasa Melayu* and have, until ETeMS, been *teaching* mathematics *in Bahasa Melayu* now find themselves having to *teach* mathematics *in English*.

My study mainly explores the "*teaching*" *of* mathematics *in* English. The emphasis on "teaching" is because teacher-fronted classroom with its characteristics of the transmission model of teaching is still the norm in Malaysia (Rohaida & Juliana, 2010, p. 193; Lim et al, 2009, p. 243). Within this context, the teacher then is the main mediator in helping students learn mathematics *in* English. Besides teacher talk, several other mediators such as the prescribed textbook and chosen supplementary books, teaching aids, students' contribution and participation in the teaching and learning *of* mathematics *in* English have been taken into consideration. However, this study does not aim to give an account of what works or does not work in the linguistically altered mathematics classrooms in Malaysia. Neither does it attempt to identify "best practices" to be emulated. This study mainly seeks to understand what is happening in the classroom with its altered medium of instruction. Having said that, the insights gleaned from this study do have implications for educational change and improvement besides informing the implementation of the ETeMS policy.

1.4 Teacher talk: A study of classroom interaction

Barnes (1969) and Tharp & Gallimore (1991) strongly advocate the notion that education is a process of interaction. Numerous studies in classroom discourse have shown that the language used by the teacher affects the language produced by the students, the nature of interaction generated and hence the kind of learning that occurs (Haneda, 2009a; Alexander 2008a; Alexander 2008b; Wells, 1999; Cazden, 2001). Hall (2001) says that teacher talk is important in shaping the students' knowledge and skill. According to Greenleaf & Freedman (1993), the study of teacher discourse becomes significant because it provides a lens through which to view the teaching and learning that occurs inside classrooms. Therefore with the change in the medium of instruction, investigating teacher talk as the teaching and learning *of* mathematics *in* English occurs in the Malaysian classrooms is crucially important.

1.5 Situated sociocultural model of mathematics education

This study takes on a situated sociocultural perspective because it has important implications for instruction. Lave (1988) argues that learning is a function of the activity, context and culture in which it occurs, that is, learning is "situated". In this study, learning is situated in linguistically altered classrooms since the implementation of ETeMS. From a sociocultural perspective, learning processes are a product of social interaction. In this study, the learning processes would then be the product of linguistically altered social interaction. This situated sociocultural perspective can be used to describe the details and complexities of how teachers in Malaysia use resources from their multilingual registers and languages to communicate mathematically in English. This perspective is indeed necessary as Moschkovich (2002) points out that "a situated sociocultural perspective moves away from the descriptions of obstacles and deficiencies to a description of resources and competencies and widens what counts as competence in mathematical communication" (p. 197). I therefore describe a situated sociocultural perspective of the teaching and learning *of* mathematics *in* English in Malaysia because according to Donato and McCormick (1994), "Sociocultural theory maintains that social interaction and cultural institutions, such as schools and classrooms, have important roles to play in an individual's cognitive growth and development" (p. 453).

Current ideas of sociocultural theory draw heavily on the work of Vygotsky (1962, 1978, 1981a, 1981b, 2004). A key feature of Vygotsky's view of human development is that higher order functions develop out of social interaction. Lantolf (2000) states that the most fundamental concept of Vygotsky's sociocultural theory is that the human mind is mediated. According to the Vygotskian view, it is through social mediation that knowledge becomes refined and viable and gains coherence. Mediation is seen as the mechanism through which external, sociocultural activities are transformed into internal, mental functioning (Le Pham Hoai Huong, 2003). As Kozulin (1990) puts it, mediation is the instrument of cognitive change. Lantolf & Thorne (2006) expounded on Vygotsky's idea on the mediational function that language serves in the mental life of human beings. Buchanan & Helman (1997), like Perl (1980), strongly feel that language must not be a barrier to full participation in any subject. Students in the linguistically altered Malaysian classroom need teachers to mediate the non-English linguistic world they come from with the linguistic practices of an English based content classroom. In other words, students need teachers who actively play the role of "mediating wor(l)ds".

Khoon, Zaitun & Palanisamy (2001) say that, "sociocultural context encompasses many inter-related factors: history, politics, ethnic composition, languages, cultural values and ways of life, customs, different gender roles, and others. These factors have different impacts on the nature and practice of mathematics education of a country" (p. 113). They proposed a situated sociocultural model (figure 1) as they explored how it applies to mathematics education in three ASEAN countries: Brunei, Malaysia and Singapore.

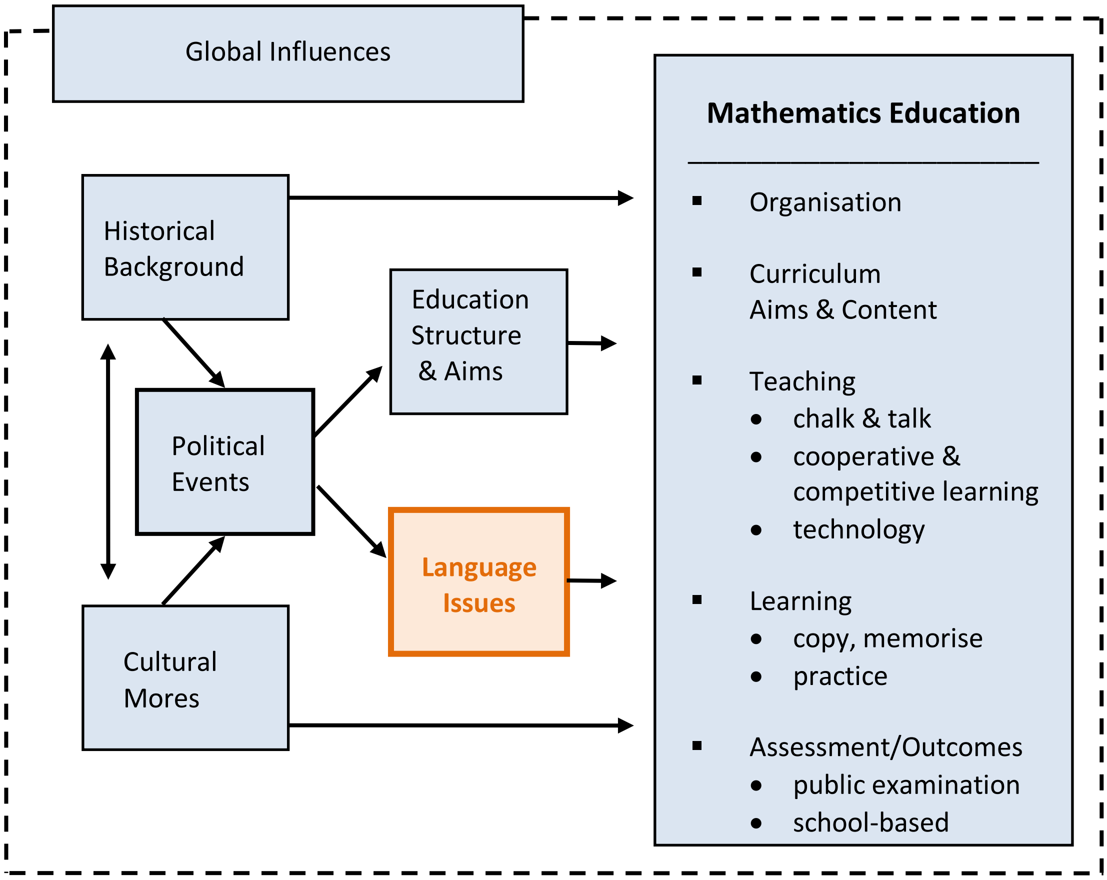


Figure 1: Situated sociocultural model of mathematics education
(Khoon et al, 2001, p. 113).

I have adopted their proposed situated sociocultural model as I explore the teaching and learning *of* mathematics *in* English in Malaysia. While I acknowledge that all the factors in the model impact mathematics education, my study focuses mainly on language issues, specifically the language of instruction and seeks to gain insights into how this new medium of instruction affects mathematics education.

1.6 Research questions

This study draws on Vygotsky's concept of mediation from a situated sociocultural perspective as it mainly seeks to examine how mathematics teaching and learning is mediated by teachers' talk in two linguistically altered mathematics classrooms in Malaysia. Besides examining the teaching and learning event(s), that is the academic wor(l)d of the mathematics classroom, this study also explores the impact of changing the medium of instruction on the social wor(l)d of the mathematics classroom for both the academic wor(l)d and social wor(l)d co-exist in the daily life of the classroom.

This study particularly examines the following research questions:

1. How does teacher talk mediate the learning of mathematical content and mathematical English?
    - 1a) What discursive practices are made available for the learning of mathematical content and mathematical English?
    - 1b) What opportunities are made available for the learning of mathematical content and mathematical English?
2. What other mediational tools, besides teacher talk, mediate the learning of mathematical content and mathematical English?
3. How does the new medium of instruction alter the social wor(l)d of the mathematics classroom?

1.7 Organisation of the thesis

This thesis is made up of six chapters. Chapter One has introduced the rationale for and the background of the study. It briefly summarised the position of the participants in this investigation including my own aims and position. It also briefly describes the theoretical lens through which I investigate ETeMS. Chapter Two provides a review of relevant literature to my study. I introduce the theoretical framework that informs my investigation of both the academic and social wor(l)ds of teaching and learning of mathematics in English. In Chapter Three, I explain my research design and develop my methodological framework which informs the interpretation of my data. Chapters Four and Five deal with data analysis, findings and discussion. Chapter Four is an account of the teaching and learning *of* mathematics *in* English, followed with a summary of findings around my first two research questions and their sub-questions. It ends with an exploration of some of the important and far reaching ideas of sociocultural theories of learning and sociolinguistics approach to the study of interaction as I apply them to my findings. Similarly, Chapter Five captures a glimpse of the social wor(l)d in the linguistically altered classroom and is also followed with a summary of the findings. Chapter Five also explores the findings with sociocultural and sociolinguistic theories. Chapter Six is concerned with synthesizing my study with ETeMS where important converging and diverging aspects of my study and ETeMS are highlighted. I also go on to suggest an adapted model of situated sociocultural model of mathematics education. Finally, I discuss the pedagogical implications and suggest directions for future research.

CHAPTER TWO

Mediating Wor(l)ds: A Review of Literature

2.1 Introduction

My stories of ETeMS generally and "the teaching and learning *of* mathematics *in* English" specifically are influenced and informed by both sociocultural and sociolinguistic theories. Sociocultural theory of learning and sociolinguistic approaches to the study of social interactions in classrooms have contributed to the understanding of teaching and learning in educational contexts. In this chapter I explore some of the contributions of both these theories to the cognitive and affective dimensions of teaching and learning in linguistically altered classrooms, specifically the teaching and learning *of* mathematics *in* English in Malaysia.

This study resides at the intersection of language and mathematics. Vygotsky's sociocultural theory (1962, 1978, 1981a, 1981b, 2004) has been widely used in both these disciplines and two quite different dialogues have emerged as the concerns of language classes and mathematics classes are different. However, both disciplines recognise that language is not only a resource, but also an important mediating tool for teaching and learning and that meaning is always jointly constructed and mediated in the process of social interaction.

Similarly, studies on interactions in the classroom have also been richly influenced by sociocultural and sociolinguistic theories. Studies of classroom discourse based on these two theories highlight the importance of understanding the processes of interaction and the characteristics of talk in the classroom. Both sociocultural and sociolinguistic theories of classroom research also recognise the intertwined cognitive and affective domains of teaching and learning. These theories have contributed much to the understanding of everyday life in the classroom as it is jointly constructed and mediated by teachers and students.

In short, the theoretical and methodological basis of my study on the teaching and learning *of* mathematics *in* English are shaped by Vygotsky's sociocultural theory and complemented with sociolinguistic theory of learning as it investigates the entwined cognitive and affective dimensions or for the purposes of this study, the academic and social wor(l)ds of the linguistically altered classrooms.

In section 2.2, I briefly describe my overarching theoretical framework, Vygotskian theory of learning and development and in section 2.3, I explain how Vygotsky's sociocultural theory of learning differs from its predecessor, Piaget's theory of cognitive development. The concept of mediation is central to Vygotsky's sociocultural theory and this is discussed in section 2.4. In section 2.5, I discuss relevant literature related to discourse and aspects of cognition from both sociocultural and sociolinguistic theories of learning. Finally in section 2.6, I further elaborate, from both sociocultural and sociolinguistic perspectives, aspects of affect and emotions in education and how a multimodal view of interaction gains us insights into the affective domains of the classroom.

2.2 Vygotskian theory of learning and development

This study of the teaching and learning *of* mathematics *in* English adopts Vygotsky's sociocultural theory of learning and development (1962, 1978, 1981a, 1981b). One of the innovative contributions made by Vygotsky was his idea that our sense of the world is shaped, mediated (explored further in section 2.4) and jointly constructed by symbolic tools in the course of education and learning. In other words, Vygotsky sees learning as a mediated activity that is jointly constructed by teachers and students using their shared language. That means teachers and learners use language to transform experience into knowledge and understanding. The concept of joint construction recognises that learning is a social activity carried out via interaction (language). Vygotsky's contribution of the world shaped, mediated and jointly constructed by symbolic tools is an important concept behind this study of mediating wor(l)ds. In Malaysia, the teachers' and learners' world of mathematics has been shaped, mediated and jointly constructed via Bahasa Melayu until ETeMS.

Bahasa Melayu was the medium of instruction, the shared language and the language of social interaction in the mathematics classrooms in Malaysia. When Bahasa Melayu, the medium through which mathematical meaning was jointly constructed, was replaced with English it would then imply that cognitive development might be affected. This is because Vygotsky understands intellectual development in terms of intellectual tools, such as language, that we can accumulate as we grow up in a society and that mediate the kind of understanding that we can form or construct (Lantolf & Thorne, 2006). Teachers and learners in Malaysia have until ETeMS accumulated mathematical understanding in Bahasa Melayu. Looking at ETeMS from Vygotsky's point of view, one is bound to wonder if a difference in medium of instruction mediates a different kind of mathematical understanding that is formed or jointly constructed as mathematics is taught *in* English. While Vygotsky stresses the importance of language as a mediating tool, his work does not take into consideration the linguistically altered scenario as in Malaysia where the shared language has been switched.

Language is also closely related to culture and "way of being" especially in multiethnic, multiracial Malaysia with its multilingual and multicultural "ways of being" within and beyond classrooms. This has also been observed by Vygotsky who besides developing his ideas related to cognition in the classroom, also talks about the issue of affect in the classroom. For Vygotsky, "emotions interact with other processes in a social-cognitive process of development" (DiPardo & Potter, 2003, p. 320), which means teaching and learning is also an emotional affair besides being a cognitive one.

The central premise of my thesis, based on Vygotsky's sociocultural theory, is that mathematics education is a social practice. Learning is both individual and sociocultural (Kozulin et al, 2003, p. 35) within the cognitive and affective domains of the classroom. Thus it is important to understand not just the individual but also the social and cultural dimensions as well as the cognitive and affective domains of the learning situations. In Vygotsky's view, learning and development are consequences of the dialectic interaction between natural and cultural/historical. And it is in this dialectic interaction that both cognitive and affective aspects of learning and development are mediated and jointly constructed. It is, then, in the linguistically altered interaction, brought about by the implementation of ETeMS, that the cognitive and affective wor(l)ds of the mathematics classroom are mediated and jointly constructed. This study thus seeks to understand the teaching and learning *of* mathematics *in* English in its academic and social wor(l)ds in the context of Malaysian classrooms.

2.3 Shifting perspectives: From Piaget to Vygotsky

Vygotsky and Piaget have both contributed to the research on children's learning and development. Vygotsky's focus on learning as a social activity differs from Piaget's notion of learning as an individual activity. In this section I highlight the main difference between Piaget's theory of cognitive development and Vygotsky's sociocultural theory of learning and development.

Vygotsky is the pioneering psychologist of social development theory while Piaget is the pioneering psychologist of the constructivist theory. Both Piaget and Vygotsky placed a lot of importance on the education of children. While Piaget investigated the role of psychological maturity in the development of the child, Vygotsky investigated the role of culture and interpersonal communication in child development (Kozulin & Presseisen, 1995, p. 67). This was, Chapman (2003) says, a shift from:

> early constructivist-oriented approaches (dealing with individual, internal, mental constructs) to discourse-oriented/social construction approaches (focusing on the social, interactive nature of meaning and learning) (p. 7).

Vygotsky's emphasis on learning as a social activity brings to the fore the importance of language and interaction in meaning making. It is in this new language implemented since ETeMS and the linguistically altered instruction that my study seeks to investigate as teachers and students jointly make meaning in the mathematics classroom.

Although both Piaget and Vygotsky researched cognitive thinking and knowledge construction, Piaget's study revealed the individual construction of knowledge and the process of construction as a relatively solitary act while Vygotsky emphasised the importance of social interaction as the main influencing factor of the individuals' cognitive development. In his analysis of formal instruction, Vygotsky placed great emphasis on the nature of social interactions, particularly between adult and child. As Meacham (1996) attests,

> Vygotsky locates mind within the interactions of individuals situated within societal, cultural, and historical contexts, whereas Piaget locates mind within the head of the individual (p. 304).

Vygotsky was interested in how societal and cultural mind reproduces itself within individuals. Piaget, instead, was interested in the question of how individuals construct new knowledge with the potential for the transformation of society and culture. This sociocultural aspect of learning largely remained beyond the scope of Piaget's theory. My study seeks to explore this sociocultural aspect of learning in the linguistically altered classrooms as teachers and students interact to jointly construct mathematical meaning.

Like Piaget, Vygotsky does recognise that biology indeed plays an important role in the development of mental ability. However, Vygotsky advocates that symbolic artifacts and cultural practices empower us to control our biological endowment (i.e. our brains) through *auxiliary means*, just as physical tools empower us to control and change the physical environment (Lantolf & Thorne, 2006, p. 27). In other words, what Vygotsky is saying is that the language used to teach mathematics helps to mediate the understanding of mathematical meanings unlike Piaget who believes that it is the learner's psychological maturity that helps mediate mathematical meanings. Coming back to the idea of the empowering auxiliary means, Ratner (2002) explains that they "arise as a consequence of *participation in* cultural activities (e.g. raising and educating children, playing, etc.) in which cultural artifacts (e.g. books, paper, eating utensils, toys, etc.) and cultural concepts (e.g. self, family, lay, religion, mind, etc.) interact in complex, dynamic ways with each other and with psychological phenomena" (p. 10). The key word is 'participation' and since the implementation of ETeMS, teachers in Malaysia, find themselves having to teach (*cultural activity*) mathematics (*cultural concepts*) in a new language of instruction (*cultural artifact*). While the cultural concept (mathematical content) remains the same, the effect of "the change" in the cultural artifact (English Language instead of Bahasa Melayu) on the cultural activity (teaching) and meaning making, which is beyond Vygotsky's observation remains to be investigated. If we were to look at Malaysian classrooms through Vygotsky's theory and his emphasis on the psychological tool, then meaning-making in the mathematics classroom in Malaysia would be best achieved via Bahasa Melayu.

In short, Vygotsky's sociocultural theory is based on the concept that human activities take place in cultural contexts and are mediated by language (or interaction) and other symbol systems. And as Wertsch (1985) further points out that human activity can best be understood when investigated in the context of their cultural historical development. This study thus seeks to investigate how the changed medium of instruction, proposed by the ETeMS policy, mediates the teaching and learning *of* mathematics *in* English in Malaysia. This study examines the *process* and *activity* of teaching and learning mathematics and how it is *mediated* in the linguistically altered classrooms in Malaysia by investigating talk and interaction between teachers and students in mathematics classrooms. This is supported by Lantolf & Thorne (2006):

> the only appropriate way of understanding and explaining higher, culturally organised, forms of human mental functioning, is by studying the process and not the outcome of development (p. 28).

The concept of *mediation* which is important in the *process* and *activity* of teaching and learning will be discussed in the following section.

2.4 Mediation

The philosophical foundations for Vygotsky's ideas are the theories of Marx, Engels and Lenin (Au, 2007). They were concerned with the economic foundations from which development, that is individual development and societal progress, arises. But the idea of mediation mainly arises from Engel's proposition, that the work done by humans is mediated by the tools they develop. Vygotsky extended the idea of physical tools as mediators to include mediation of cognitive processes by psychological tools – speech and semiotic tools. Mediation is the key concept of Vygotsky's sociocultural theory and also this study.

Expounding on Vygotsky's theory of mediated mind, Meacham (1996), Lantolf (2000) and Lantolf & Thorne (2006) explain that humans use physical tools and labour activity instead of acting directly on the physical world and this changes the world and the circumstances they live in. Similarly, humans use symbolic tools or signs (psychological tools) to regulate their relationships with others which in turn changes the nature of these relationships. In short, humans use both physical and symbolic artifacts to mediate the relationship between themselves and the world. This idea of mediation via tools is relevant in classrooms because teachers and students mediate teaching and learning via physical and symbolic tools. Harre & Gillett (1994) claim, there are no human actions that are not mediated:

> humans reside in two worlds: one comprised of signs and symbols, managed primarily through language, and the other of material objects, controlled primarily through our hands and brains (p. 100).

Teachers and students in Malaysia have had their familiar world of mathematics made unfamiliar with the implementation of ETeMS. The mathematics world of the teachers and students in Malaysia, that had been mediated via Bahasa Melayu, since ETeMS is being mediated via English.

Lantolf & Thorne (2006, p. 79), Kozulin et al (2003), Kozulin (1990) and Moll (1990, p. 11) have all explained that Vygotsky was concerned with how abilities are developed "to carry out socially formulated, goal-directed actions with the help of mediating devices" as Wertsch (1981, p. 32) puts it. In short, what Vygotsky emphasises is that *all* actions and activities are mediated. This idea is especially important in my study as it seeks to explore two mathematics teachers' role in mediating the teaching and learning *of* mathematics *in* English as they assist their students to negotiate learning.

Kozulin (1990) points out, mediation is the instrument of cognitive change. The source of mediation can be a material tool, a system of symbols or even the behaviour of another in social interactions. This means that mediation can take the form of a textbook, visual material, classroom discourse, instruction or any other kinds of teacher assistance and even gestures. As Malaysian classrooms grapple with the transition to a new medium of instruction, all forms of mediation must be investigated particularly classroom discourse and interaction as they play an active mediational role because of the centrality of language as a means of mediation. My study looks at the mathematical content that is being mediated, hence the focus on "teaching and learning *of* mathematics". This study, more importantly, looks at how the new medium of instruction mediates the learning of mathematics, thus the focus on "teaching and learning *in* English".

Gibbons (2003) who based her study on Vygotsky's notion that learning originates in the social mediation provided by interactions discusses how mediation involves communication between two different orders of discourse: (i) the current levels of students' knowledge and L2 abilities and

(ii) the broader knowledge and specialist language of the science community into which the students were being apprenticed. Her study showed how “science learning” and “language learning” are realised through a collaborative interactional process in which students begin to appropriate the language of interaction for their own purposes. My study looks at how the linguistically altered collaborative interaction mediates “mathematical content” and “mathematical English”.

An exact understanding of the language is essential to the comprehension of mathematics. In fact, research reveals that mathematics is not just a bunch of numbers. Mathematics has a unique register that students must ultimately learn (Kang & Pham, 1995). The language of mathematics is concise and precise and it is a hi-density language expressed with few redundancies (Halpern, Patkowski & Brooks, 1996). The lack of redundancy requires students to understand the material the first time. Allen (1993) echoes a similar notion, “the language of mathematics is a context-reduced language which is cognitively challenging” (p. 31). Leach & Bowling (2000, p. 26) gives us an example of how simple mathematical problems were confusing because the structure of the question was unfamiliar. The mathematics of this question is easy but ESOL students encountered difficulties:

Example: 10 – 7 =
1. What is ten minus seven?
2. Take seven from ten.
3. Ten take away seven.
4. Subtract seven from ten.
5. What number is seven less than ten?
6. What is left if seven is taken from ten?
7. What is the difference between seven and ten?
8. How many more is ten than seven?
9. How much bigger is ten than seven?

Based on what these researchers have pointed out, students in Malaysia would need “tight mediation” (Roessingh, 2005, p.129) or careful intervention for the mathematical English and mathematical content they will jointly construct with their teacher using English, the new medium of instruction.

According to Vygotsky (1962), the teacher in the mediational role engages in a joint effort with students mainly through interaction, to advance the students' cognitive development and knowledge construction. Vygotsky explains that at first, the speech children hear is in external form only and it becomes the child's private speech but eventually this private speech is internalised as inner speech. When it eventually transforms into inner speech, it sheds the linguistic elements of the originator and what remains is pure meaning. Vygotsky argues that inner speech is the final phase in the development of higher forms of human conscious activity. The speech students hear is important which means that the mathematics teachers' talk in the Malaysian classroom plays a very crucial role in bridging and mediating the new language of instruction with the knowledge and concept of mathematics. With the implementation of ETeMS, teachers who learnt mathematics in Bahasa Melayu and who were trained to teach mathematics in Bahasa Melayu now find themselves having to mediate the teaching and learning *of* mathematics *in* English. Adler's (2001) study in multilingual mathematics classrooms in Africa captured a similar dilemma where the opportunities for mathematical conversations (talking to learn and learning to talk mathematics) were further complicated when the teaching and learning of mathematics is carried out in a language which is neither the teachers' nor the students' main language (p. 7). My study, therefore, aims to investigate how teachers in Malaysia mediate the teaching and learning *of* mathematics *in* English. In the following section, I review the roles of tools and artifacts in mediation.

2.4.1 Mediational tools and artifacts

Tools and/or artifacts play important mediating roles in any teaching and learning process and activity. Vygotsky (1978, 1962) proposed that higher mental processes be considered as functions of mediated activity, mediated by artifacts or tools. In this study, the term "tool" is used interchangeably with "artifact" (see John-Steiner, 2000; Moll, 1989).

As has been discussed at length in the earlier section, all activities humans are involved in, social or cognitive in nature, are reliant on and shaped by the mediational tools/artifacts that are used. Researchers like Luria, Cole & Wertsch and Lantolf & Thorne point out the importance of meditational tools. One of the main tools invented by humans is language, and Vygotsky places a lot of importance on the role of language in the organisation and development of thought processes (Luria, 1979, p. 44). Cole & Wertsch (1996) state that "social interaction is not a direct, transparent, or unmediated process, but one that takes place in an artifact-saturated medium" (p. 263). And according to Lantolf & Thorne (2006),

> Within sociocultural theory, artifacts are simultaneously material and conceptual (or ideal) aspects of human goal-directed activity that are not only incorporated into an activity, but are constitutive of it. This is true of symbolic artifacts, such as language, or concrete artifacts, such as physical objects (p. 62).

Looking at the linguistically altered mathematics classroom from what Lantolf & Thorne say, although the focus of the teaching and learning of mathematics is on the mathematical content, it is still language that constitutes the content. As teaching and learning is a social activity, it is thus mediated through various artifacts and tools. This study mainly looks at how teaching and learning *of* mathematics in Malaysia, since ETeMS, is mediated via a modified tool/artifact that is English language instead of Bahasa Melayu.

Kozulin (1998) identifies three major classes of mediating agents: (i) material tools, (ii) symbolic psychological tools and (iii) human mediator (p. 62). Lantolf & Thorne (2006) call the material tools "concrete artifacts" or "physical objects". They are directed at processes in nature. These tools and/or artifacts have only an indirect influence on human psychological processes.

The symbolic aspect of the tool-mediated activity gives rise to a new and important class of mediators which Vygotsky called psychological tools (Kozulin, 1998). Psychological tools mediate the psychological processes of humans. Lantolf & Thorne (2006) refer to the psychological tools as symbolic artifacts. These higher-order symbolic mediators include natural and artificial languages as well as discourses and cultural symbolic systems (Kozulin, 1998, p. 63). In the mathematics classrooms in Malaysia, the important mediating tool of language has been altered since the implementation of ETeMS. In linguistically altered mathematics classrooms in Malaysia, teachers and their students now mediate the teaching and learning of mathematics in a second language.

Vygotsky placed importance on language and interaction as mediating tools because these tools radically reconstruct mental operations. Scollon (2001) explains that:

> Physical tools enhance our biological ability to act on the physical world while cultural artifacts amplify memory and increase the capacity to organise and communicate information and knowledge (p. 116).

It is the cultural artifact that Scollon identified that has undergone change in the mathematics classroom and how teachers organise and communicate information and knowledge in the linguistically altered mathematics classroom is of interest here as mathematics teachers in Malaysia mediate wor(l)ds (see section 1.1). It remains to be seen if the modified cultural artifact still plays the role Scollon identified in the mathematics classroom.

Besides the two mediating tools Vygotsky mentioned above, Kozulin (1998) identifies another tool – the human mediator. In a classroom, the teacher is seen as the main human mediator in the joint construction of meaning with the students. According to Kozulin, Vygotsky also focuses on the role of the "other individual" as a mediator of meaning (p. 64). Wertsch (1998) and Lantolf & Thorne (2006) also recognise the role of the human mediator in that for mediation through another individual was closely linked in Vygotsky's theory to the notion of symbolic function. The human mediator appeared first as a carrier of signs, symbols, and meanings. However, according to Kozulin (1998), Vygotsky made no attempt to elaborate the activities of human mediators beyond their function as vehicles of symbolic tools. The role of human mediators was further explored by Feuerstein (1990) through his work on mediated learning experience.

Mediated learning experience, according to Feuerstein, is broadly seen as the interaction between human being and their sociocultural environment. Feuerstein says that for mediated learning experience to occur, another human being (caregiver, parent, teacher, peer, etc.) interposes him or herself between the stimuli, for example, homework, test, assignment (or the students' response to the stimuli) and the student with the intention of mediating the stimuli or response to the student. He terms this intervention as mediation. The mediator, Feuerstein (1990) explains problematises the stimuli with the intention of bringing to the students' attention the teaching and learning aspect in the stimuli. Therefore, Feuerstein cautions, inadequate mediated learning experience leads to undeveloped or sometimes impaired cognitive functions.

It is evident that like Vygotsky, Feuerstein also views learning and development as being mediated; mediated by both material and psychological tools as well as by the human mediator (for a child, initially the mother or another nurturing parent figure and in this study, the teacher him/herself). Teachers regularly position themselves in between the content they are teaching and their students as they mediate teaching and learning in classrooms. Both Vygotsky and Feuerstein advocate that it is in their mediated interaction that their students move to higher mental development. Vygotsky's primary emphasis when examining mediation was on the sign systems used in human communication, in particular speech. But this study, thus, looks at how all three mediating agents: material tools, symbolic tools and human mediators (mathematics teachers in Malaysia) mediate the academic and social wor(l)ds of "the teaching and learning *of* mathematics *in* English".

2.5 Discourse and mediation in the academic wor(l)d of the classroom

Vygotsky's notion of mediation further elaborated by Feuerstein's notion of mediated learning experience shows that teacher talk and language use during classroom interaction play an important role in mediating learning. It is this teacher talk and language use that has been altered with the implementation of ETeMS and investigating the linguistically altered classroom discourse may reveal important insights. The importance of studying discourse has already been pointed out by several researchers. Marton & Tsui (2004) say that understanding how learning is linguistically constituted in the classroom, is best achieved through investigating classroom discourse. Gibbons (2003) and Gibbons (2000) also suggest that it is useful to explore the role of classroom discourse in mediating learning. She says that the sociocultural view of learning sees the development of cognition as a result of participation with others in goal-directed activity. Therefore, she says, if external dialogue is a major resource for the development of thinking, then the nature of the talk in which children are engaged in the classroom must be seriously considered.

That teacher talk and language use during classroom interaction play important mediating roles in the joint construction of meaning is supported by Mercer (1995) and Adler (2001). As Mercer eloquently puts it:

> The language practices of the classroom (educational discourse) must "scaffold" students' entry into mathematical [educated] discourse. We can think of each teacher as a discourse guide and each classroom as a discourse village. Teachers are expected to help their students develop ways of talking, writing and thinking which will enable them to travel on wider intellectual journeys . . . but they have to start from where students are, . . . and help them go back and forth across the bridge from "everyday" discourse into "educated discourse" (pp. 83-84).

Mercer has explained the importance and the role of the "language practices of the classroom". Looking at the linguistically altered mathematics classroom in Malaysia from Mercer's point of view, one does wonder if the linguistically altered discourse is able to bridge and scaffold the learning of the mathematical content in English. Barwell, Barton & Setati (2007) say that with increasing movement of populations across international borders, bilingualism and multilingualism in mathematics education is no longer extraordinary. More and more students are learning mathematics in a language that is not their main one because of the rise in migration. However, the Malaysian context differs in that globalization and not migration was one of the reasons for bilingualism in the mathematics classroom. The essence and nature of bilingualism in the mathematics classrooms in my study thus differs from the essence of bilingualism Barwell, Barton & Setati discuss although similar struggles in the teaching and learning of mathematical content and mathematical English may appear.

Adler (2001) also emphasises the communicative and cognitive function of "talk" in mathematical meaning-making. However, she cautions us of the risk of placing *too* much emphasis on teacher talk. From her research, she noticed that in explicit teaching of mathematical language, language itself and particularly, talk, became the focus in the mathematics class and a resource in the teaching and learning process. In her opinion, although this is beneficial, it is not necessarily always appropriate. She explains that there is a danger of too much focus on what and how something was said, which results in the mathematics under consideration getting lost. Based on what Mercer and Adler say, the linguistically altered discourse in the Malaysian mathematics classroom might help students make a wider intellectual journey or it might drown the mathematical content.

However, Khisty (2002), argues that pedagogic talk is still very important because, according to her, the most important model is the teacher. She says that, teacher's talk must be deliberate because teacher's speech serves two purposes: (i) to guide student's thinking and (ii) to provide a model that shows how to use second language for mathematics. Khisty & Chval (2002) explored issues of the role and nature of teacher's pedagogic discourse in the mathematics context. They argue that teachers' talk plays a much more important role in students' learning than is often considered – particularly in the learning of racially, ethnically, and linguistically diverse students because teaching and learning is jointly constructed by both teacher and students as they interact in the classroom. Vygotsky's concept of mediation emphasises the role played by human and symbolic intermediaries placed between the individual student and the material to be learned (Kozulin et al, 2003, p. 2). Similarly, Gibbons (2003), Khisty (2002), Khisty & Chval (2002), Marton & Tsui (2004) as well as Adler (2001) also emphasise that classroom discourse is an important site for cognitive development.

Sociocultural theory positions school mathematics as a social practice in which language is a resource for learning. Investigating classroom talk to understand teaching and learning processes has gained much prominence in classroom research. In Bishop's (1985) view, the purpose of communication in the mathematics classroom is to share mathematical meanings. "Meanings", he says, "must be exposed in order to be shared and, talk is one important vehicle for such exposure" (p. 27). It is thus important to provide detailed analytic account of the social construction of meaning through language. This means an investigation of spoken language practices is vital especially in the linguistically altered mathematics classrooms of Malaysia. Yackel et al (1990) believe that social interaction influences what is learned and how it is learned (p. 20). Similarly, Chapman (2003) says that it is important to consider how teachers and students use language in the social context of the mathematics classroom to make and negotiate meanings (p. 1). This suggests that talk is crucial to cognition because mathematical meanings are constructed within the language practices of classroom discourse.

Building upon Vygotsky's notion of language as an important mediating tool, classroom discourse or teacher talk plays an important function in the classroom. In fact, according to Mercer et al (1999), language plays three crucial and integrated functions in the cognitive development of a child: as a cognitive tool (which children come to use to process knowledge), as a social and cultural tool (for sharing knowledge amongst people) and as a pedagogic tool (which one person can use to provide intellectual guidance to another). They claim that the social experience of language use shapes individual cognition. In the teaching and learning contexts in Malaysia, language use, mostly in the form of teacher talk, occupies a large area of the discursive space in the classroom. Therefore "talk" could be seen to play all the three functions mentioned above in the cognitive development of a child. This, I find, is captured in Vygotsky's ZPD – the difference between what a student can do without help and what he or she can do with help. Learning occurs by "assisted performance" (Poole & Patthey-Chavez, 1994) in the context of joint activity. It is in this context of ZPD and "assisted performance" that talk functions as a cognitive tool, as a social and cultural tool and as a pedagogic tool.

2.5.1 Triadic dialogue

Sociocultural theories are primarily theories of learning, but in the reality of many classrooms with teacher-fronted approaches and features, the focus is mostly on teaching. With the focus on "teaching" as opposed to "learning", Haneda (2005, p. 314) observed that monologic discourse enacted through the Initiate-Respond-Evaluate (IRE) mode is a common feature of much classroom talk. This three-move exchange is sometimes called the "IRE or the default script" (Cazden, 1988; Lemke, 1990; Mehan, 1979; Sinclair & Coulthard, 1975). Teachers often initiate with some sort of question or elicitation, students make a response of some sort, and teachers have a third turn in which they evaluate the students' responses in some way. In the everyday reality of many teacher-fronted classrooms in Malaysia, whole-class interaction (triadic dialogue) is likely to occur more frequently than dyadic interaction.

Gutierrez (1993) says that the triadic dialogue seems to serve a gatekeeping function, that is, it enables the teacher to keep tight control of the classroom life especially over the content and participation. Despite this "gatekeeping" criticism, triadic dialogue still manages to enable learning to occur. Recent research into the triadic dialogue reveals new findings. As van Lier (1996) points out, triadic dialogue is not "an invariant and monolithic questioning procedure that has only one form and one function" (p. 152). That means, beside the function as "gatekeeper" keeping tight control of the classroom, triadic dialogue still functions in ways that enable learning to occur. It is thus vital to investigate the linguistically altered triadic dialogue in the Malaysian mathematics classroom to see if it enables learning.

Research has revealed that the third move in the triadic dialogue is seen to not merely evaluate the students' reply, but teachers use it to "follow-up on" their response by either elaborating on it or requesting further information (Lotman, 1988). Collins (1982) suggests that we need to look and see whether or not the teacher "takes up" or "follow-up on" students' answer. Similarly, Nystrand (1997) says we need to see whether or not the teacher validates particular students' ideas by incorporating their responses into "subsequent questions" or comments and elaborates on them by referring back to what students have said. And Haneda (2005) says that the third move in the triadic dialogue:

> can take a variety of forms: offering elaboration or comment; providing clarification; asking for elaboration, justification, explanation, or exemplification; and challenging students' views (p. 316).

It is important then to examine whether the third move in the linguistically altered triadic dialogue does all that Haneda observed. While it is still the teacher who controls the topic and flow of conversation, when the "take up" or "follow-up on" by the teacher occurs, students are encouraged to make contributions as "primary knower" (Berry, 1981). Berry explains that in most classrooms, the teacher acts as the "primary knower" who already knows the answer to the questions he or she asks and the students are the "secondary knower" whose ideas can only become legitimate in classroom conversation when the primary knower bestows that legitimacy. When this happens, that is when students make contributions and the teacher "takes up" or "follows-up on" their answers, Haneda (2004) says, students will feel encouraged to express their opinions and try out their developing ideas. Nassaji & Wells

(2000) also emphasise the variety of purposes that triadic dialogue can be made to serve in order to appropriately scaffold student learning. Therefore, examining the teacher-student dialogue in the linguistically altered mathematics classrooms in Malaysia would reveal two distinct insights: firstly if the teachers actually do "take up" their students' responses and how it enhances the teaching and learning of mathematics.

2.6 Discourse and mediation in the social wor(l)d of the classroom

Sociocultural theory proposes that cognitive development originates in social interaction. Thus learning is a social activity which is mediated by various tools and artifacts, the most important being language. That language is a vehicle for making meaning has also been emphasised by Hammond (2001). The importance of language and social interaction as mediating tools for cognitive development has already been discussed at length in the sections above. But, sociocultural theory also proposes that the affective dimension of development is also social in nature. The affective domain is also mediated by teachers and students through language and social interaction. That means the cognitive and the affective dimensions are jointly constructed in and through daily discursive and social practices between teachers and students.

While Vygotsky points out how language is important for learning and thinking which in my study would mean the ability to communicate mathematically, Setati (2008), who researches mathematics education in a multilingual setting, was more concerned with which language is best as the medium of instruction. Although learners' main language would be a better resource in the teaching and learning of mathematics, Setati found that teachers and parents argue for the use of English in the mathematics classroom because of its social and economic power. In her study, Setati captured the teachers' and learners' voices regarding the use of English as the medium of instruction which gave insight into the power and political nature of language in South Africa, not just at the macro-level of structures but also at the micro-level of classroom interactions. While her study reinforces the aims of the implementation of the ETeMS policy, my study is situated in a totally different context. While Setati researched the power and politics and influence on languge choice among teachers and learners, my study seeks to research the uneasy coexistence of the already complex academic and social wor(l)ds of the linguistically altered mathematics classrooms when ETeMS policy was imposed on them.

Sociolinguistic studies of classroom culture find that classrooms are complex communicative environments. They are social settings where teachers and students jointly construct everyday life together, form a common culture and "way of being" and have expectations as to accepted ways of doing things (Green, Kantor & Rogers, 1991). As teachers and students interact with each other, various messages are being signalled and interpreted simultaneously as classroom life is made up of not only academic interaction but also social interaction and interpersonal relationships. Erickson (1982) categorises these messages in terms of the demands made on students; "the academic task structure" and "the social participation structure". Thus, any classroom research should be viewed from both these angles; the academic wor(l)d and the social wor(l)d because the cognitive and affective domains in the classroom co-exist and are interrelated. These two dimensions influence each other in constructing the everyday life of the classroom.

Wertsch (1998) says that while traditional approaches to the study of mind and mental behaviours focus on the study of the individual *(the who)* and *what* the individual is doing, sociocultural theory incorporates three additional dimensions to this enterprise; *how* the person is acting (i.e., in consort with artifacts or other individuals), *where* the person is acting (e.g., the experimental laboratory, the classroom, the public domain, etc), and *why* the person is acting (i.e., the motives and goals underlying the activity). Lantolf and Pavlenko (2001, p. 144) add another dimension; *when* the activity occurs. This means a comprehensive study of the classroom is one that looks into the *who*, the *what*, the *how*, the *where*, the *why* and the *when* to get insights not only of the academic wor(l)d but also the social wor(l)d of the classroom.

Mousley & Marks (1991) who researched discourse in mathematics within a framework based on discourse theory stress the importance of the social setting and of classroom interaction, referring to them as “a complex multi-dimensional web of language use” (p. 11). While Mousley & Marks’ analyses of the discursive practices of mathematics classroom show how language influences learning, another important focus of their work, in which they draw upon the work of Foucault, is on how discourse establishes and maintains social organisation in the classroom. According to McBride (1989), “a discursive practice is a communicative speech act that embodies certain rules for knowledge” (p. 41). This means within this “complex multi-dimensional web of language use” in classrooms, the established rules for and knowledge of “ways of knowing” and “ways of being” (Heath, 1983) already exists. With the new medium of instruction since the implementation of ETeMS, the already complex practices have become even more complex. It is therefore insufficient to only look at the cognitive aspects of teaching and learning in the linguistically altered classroom. There is a strong need to look beyond them to look at the affective domains of classroom life.

2.6.1 Affect and emotions in the classroom

The wor(l)d of the classroom, as mentioned earlier, is actually made up of both the inter-related cognitive and affective domains or for the purposes of this study, the intertwined academic and social dimensions. Vygotsky (2004) also points out the interdependence of intellect and affect as he argues against the separation of the intellectual side of our consciousness from its affective side. Anyone who has been in a classroom, either as a student or a teacher, realises that classrooms are infused with intense emotional experiences. These emotional experiences direct interactions, affect learning and performance and influence personal growth in both students and teachers (Pekrun, Goetz, Titz & Perry, 2000). Meyer & Turner (2007) have observed that emotions help define classroom experiences, provide powerful rationales for engaging in and avoiding, even abandoning, teaching and learning opportunities (p. 243). It is crucial then to study the affective domains of the linguistically altered classroom in Malaysia.

The cognitive and affective dimensions of teaching and learning processes not only interact with but also affect each other in a classroom. For example, Haneda (2005) points out that it is necessary to attend to students' engagement in classroom talk on both the intellectual and affective dimensions. She says that these are inseparable aspects of the students' consciousness (p. 316). In her study Haneda found that the students were willing to participate in the teaching and learning activities not only because they were motivated to learn but also because of their agentive participation, that is their intellectual and affective engagement with the task, which had been established by their involvement in their classroom and by the "trusting" relationship they had established with their teacher. This shows that the students' "affective engagement" is very much related to "intellectual engagement". This holds true when we look not only from the students' perspective, but also from the teachers' perspective. DiPardo & Potter (2003) assert that teaching is emotionally charged, "At its best, teaching offers exhilaration, but frustration and sorrow can be constant companions as well" (p. 317). They point out:

> our emotions are intimately connected to our thoughts and actions and shaped in important ways by the institutional, cultural, and historic contexts in which we live and labor. We act on the basis of socially constructed thoughts and emotions, which, "gone inward," become what we tend to regard as our private sensibilities and understandings. If the setting in which such construction occurs is disturbed or unbalanced, our thoughts, emotions, and actions will bear the requisite marks (p. 337).

The institutional, cultural and historic contexts of the mathematics classroom in Malaysia which has all this while been tied to the world of Bahasa Melayu formed the basis of the emotional climate of the classroom. With the change in the medium of instruction in the mathematics classroom, it is important to examine whether the affective domain of the classroom is disturbed or unbalanced. With the implementation of ETeMS, teachers in Malaysia who themselves learnt mathematics in Bahasa Melayu, were trained to teach mathematics in Bahasa Melayu and have been teaching mathematics in Bahasa Melayu find themselves now having to teach mathematics in English. Although the setting and content has not been changed (still the teaching and learning *of* mathematics in Malaysian classrooms), the medium of instruction has. This study seeks to investigate the "requisite marks" on teachers' emotions and affect brought about by ETeMS.

2.6.1.1 Vocal and visuospatial aspects of classroom interaction

"Learning is nothing else than a special kind of social interaction", proposes Sfard (2001, p. 3). While studying this "special kind of social interaction" or classroom discourse as it is commonly known gives us much information into the cognitive aspects of teaching and learning, it also provide insights into the affective dimensions of teaching and learning. Hemmings et al (2000) explain that social behaviour is "constitutively interactive and irremediably situated" (p. 227) which in the context of the classroom means that the social behavior of the teachers and students, situated in an educational context, gives rise to various interpretations of their roles, their expected behavior and related interaction patterns. In fact, according to Hemmings et al, there are not, and cannot be, sociologically describable "situations" which are *not* predicated on interaction. They call for detailed investigation of just what kind of interaction is taking place and how it is being situationally accomplished. A similar point is also expressed by Schegloff (1982):

> Anyone who has lectured to a class knows that the (often salient) reactions of the audience – the wrinkling of brows at some point in its course, a few smiles or chuckles or nods, or their absence – can have a marked consequence for the talk which follows (p. 72).

Gestures and responses are manifestly "interactive" and are part of the social performance. Similarly, Stivers & Sidnell (2005) recommend examining talk from where it is situated vocally [sequentially, prosodically, syntactically] as well as visuospatially [eg body orientation, facial expression, accompanying gestures] (p. 2). They maintain that "the communicative work that is performed by one modality may be supported or extended by the work of another modality" (p. 6). Therefore, exploring the multimodal interaction between teachers and their students would provide valuable insights not only into the academic wor(l)d but equally important, into the social wor(l)ds being mediated as teaching and learning is carried out.

Upon implementation of the ETeMS policy, everything looked fine and calm on the surface. Teaching and learning continued as usual – from the distance. But beneath this calm facade of teaching, things were not all that smooth. I find Breen's (1986) metaphor of 'classroom as coral garden' very apt to describe the situation in the Malaysian mathematics classroom. Breen compares the complexity of the classroom life with the inter-related myriad life forms found in a coral reef. Holliday (1997) too expands on Breen's imagery:

> Little of this life can be seen on the surface of the reef; but beneath the surface, the complexity of life forms is immense. Similarly, what can be seen of classroom interaction constitutes "*epiphenomena*" – mere surface manifestations of far more complex things going on under the surface. All that we can so far understand of classroom reality is the "rim of social cognitive coral reef" (p. 31).

Holliday stresses that there is more going on in the classroom than the transfer of knowledge and skills between the members of the classroom group. I find that "classroom as coral garden" is a very fitting image because it depicts the richness, complexity, challenges and struggles of the linguistically altered interactions that happen in mathematics classrooms and also the forces affecting them, both from the inside and the outside. It creates the awareness and the need to investigate the social wor(l)d of the linguistically altered mathematics classroom.

Therefore in this study, I seek to explore both the social aspect and the academic aspect of the linguistically altered classrooms in Malaysia by investigating classroom practices and language of interaction in the mathematics classroom. Hall (1995) says that our language and our uses of language (re)create our social worlds, our relationships with others and our ideologies. The new language of instruction in the Malaysian mathematics classroom may also be (re)creating the social world of the classroom through the implementation of ETeMS. It is important to study this (re)created social world in the linguistically altered classroom. In the words of Wolff-Michael (2007),

> My ultimate search has been that for understanding human nature, not as explained in deterministic models of psychology or sociology, but as it is lived and experienced in everyday praxis (p. 70).

Thus understanding what happens among teachers and students in Malaysia as they live and experience their linguistically altered classroom life is very important.

2.7 Summary

In this chapter I have discussed two main ideas; the idea of mediation and the need to explore both the cognitive and affective dimensions of the classroom. Vygotsky's sociocultural theory of learning and development proposes that learning is a social activity which is mediated through social interaction. The process of teaching and learning is jointly constructed by both teachers and students using various mediational tools, the most vital one being language. I have discussed how classroom discourse mediates cognitive development based on Vygotsky's perspective. I have also discussed how interaction in the classroom also mediates the social world of the classroom life. I have discussed how classroom life is made up of both the domains of cognition and affect and how both these dimensions are inter-related. I propose that to get a better understanding of classroom life and the teaching/learning processes, both these angles must be explored.

My methodology to study the entwined academic and social wor(l)ds, i.e. the cognitive and affective dimensions will be explained in Chapter Three. These ideas will be further explored and developed in Chapters Four and Five. Chapter Four reports on mediating academic wor(l)d: stories of teaching and learning *of* mathematics *in* English while Chapter Five reports on mediating social wor(l)d: stories of teaching and learning in linguistically altered mathematics classrooms.

CHAPTER THREE

Investigating the Stories of ETeMS: Research Design and Methodology

3.1 Introduction

My study aims to tell the stories of two teachers situated within the policy of ETeMS. My case study consists of two intertwined investigations related to the teaching and learning of mathematics in two classrooms that have undergone a change in the medium of instruction. The first investigation is related to the academic wor(l)ds (cognitive dimension) of the classrooms that is the teaching and learning *of* mathematics *in* English. The second part is an investigation of the social wor(l)ds (affective dimension) of these two linguistically altered mathematics classrooms.

I begin with a discussion of the theoretical and methodological underpinnings of my study before presenting my research design. I then go on to explain how I addressed the issues of credibility and trustworthiness. This is followed by a brief description of the context of the study into which I situate my two participants and their classes and the lessons observed, which is related to the teaching and learning of the unit on length. I then explain the data collection and data analysis procedure.

3.2 Type of design

This study takes on an ontological perspective because its assumptions (Corbin & Strauss, 2008, p. 5) align with (i) the theoretical framework of my study – sociocultural theories of learning and sociolinguistic approach to the study of social interaction in classrooms, (ii) the methodological framework – interpretivism, symbolic interactionism specifically (Gray, 2009, p. 17), (iii) my data collection method – case study and (iv) my methodology for data analysis – discourse analysis drawing upon critical discourse analysis and conversation analysis. I will further elaborate in the following paragraphs.

Gray (2009) says that "ontology is the study of being, that is, the nature of existence" (p. 17). Similarly Corbin & Strauss (2008) ask, "What is the nature of this world that we wish to study?" (p. 4) before they go on to explain their assumptions (p. 5):

> Important to us are the great varieties of human action, interaction, and emotional responses that people have to the events and problems they encounter. The nature of human responses creates conditions that impact upon, restrict, limit, and contribute toward restructuring the variety of action/interaction that can be noted in societies. In turn, humans also shape their institutions, they create and change the world around them through action/interaction.

Ontological perspective, thus, calls for open-ended inquiry. This is echoed by Nisbet (1980) who says, "Go and live there and see what it is like" (p. 3). Nisbet's statement implicitly signifies the importance of context which aligns with Vygotsky's insights where human processes are "historically and socially determined" (Vygotsky, 1962, p. 23).

Blumer (1969) also says that human experience is mediated by interpretation. This fits with Bogdan & Biklen's (2007) view, "objects, people, situations, and events do not possess their own meaning; rather, meaning is conferred on them" (p. 27). They explain that people act, not on the basis of predetermined responses to predefined objects, but rather as interpreters, definers, signalers, and symbol and signal readers and that through interaction, the individual constructs meaning (p. 27) which is an important part of the symbolic interaction theory.

Symbolic interactionism developed in the 1930s from the work of Dewey and Mead who moved towards developing a way of conceptualizing human behavior that focused on people's practices and lived realities. Several central tenets of symbolic interactionism are: (i) people interpret the meaning of objects and actions in the world and then act upon those interpretations and (ii) meanings arise from the process of social interaction (Gray, 2009, p. 22). Gray proposes that human interaction with the world is mediated through the process of meaning-making and interpretation. This is the essence of interpretivism and symbolic interactionism which is parallel with Vygotsky's idea of learning and development. From Vygotsky's point of view, teaching and learning is jointly constructed by both teacher and students as they interact in the classroom, and pedagogy is tied closely to interactions between people in the classroom. The perspectives and frameworks discussed above inform my study which seeks to investigate what happens in the academic and social wor(l)ds of teachers and students in the classroom when the medium of instruction has changed.

This study takes on a qualitative design (Seliger & Shohamy, 1989) and uses case study approach. Malaysia has been grappling with the teaching and learning *of* English for quite some time now, but teaching and learning *in* English is a relatively new phenomenon. A qualitative research design can capture the voices and challenges of teachers and students as they manage daily teaching and learning *in* English. A qualitative research design using a case study approach enables me to study individuals in their natural setting. This involves going out to the setting or field of study, gaining access, and gathering materials that will be uniquely Malaysian yet relevant to any context with multilingual teachers and students.

Denzin & Lincoln (2000) define qualitative research as an inquiry process of understanding based on distinct methodological traditions of inquiry that explore a social or human problem. According to them, the researcher builds a complex, holistic picture, analyzes words, reports detailed views of informants, and conducts the study in a natural setting. Seliger & Shohamy (1989) state that "qualitative methods are concerned with studying human behaviour within the context in which that behaviour would occur naturally and in which the role of the researcher would not affect the normal behaviour of the subjects" (p. 118). Therefore, observing a mathematics classroom in action by adopting the qualitative research approach would enable me not only to understand the phenomena of teaching and learning *in*

English, but also to celebrate the linguistic achievements and successes besides examining the linguistic struggles and challenges in the mathematics classroom.

Seliger & Shohamy (1989) state that the case study approach is used where the investigator is interested in describing some aspect of the second language performance or development of one or more participants as individuals, because it is believed that individual group performance will be more revealing than studying large groups of participants (p. 125). According to Yin (1984), "a case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context …in which multiple sources of evidence are used" (p. 23). And Merriam (1988) says that the qualitative case study can be defined as an intensive, holistic description and analysis of a single entity, phenomenon, or social unit (p. 16). This shows that case study methods involve an in-depth examination of a single instance or event, in this case the teaching and learning *of* mathematics *in* English. Because the case study offers a method of learning about a complex instance through extensive description and contextual analysis, I, as the researcher, will be able to gain a sharpened understanding of the phenomena under study or in the words of Stake (1988), "an understanding of the particular case, in its idiosyncrasy, in its complexity"(p. 256).

Hence, employing a qualitative design via case-study approach emphasises my role, as the researcher, as an active student who can tell the stories from the participants' view rather than as an "expert" who passes judgment on participants.

3.3 Issues of credibility and trustworthiness

Although the qualitative case study approach has its advantages, I am fully aware of its disadvantages: i) data collection through observation is subject to bias; ii) data analysis is considered to be subjective and interpretative and iii) it lacks the credibility to make generalisations from its findings; iv) the presence of the researcher can lead to observer effect where those being researched might behave differently because they are "under the microscope" and v) the researcher's attachment and/or detachment to the study and setting may contribute to bias (Seliger & Shohamy, 1989; Denscombe, 2007). I discuss each of these disadvantages and how I tried to minimise them in the following paragraphs.

I tried to minimise the issue of subjectivity and bias by obtaining multiple data sources. The lessons were videotaped while I took down field notes of the classrooms under observation. The taped lessons were transcribed. As Frank (1999) suggests, "By making the language concrete, something we could see and touch, we were able to name and identify the strategies that we used" (p. 89). She also goes on to say that "By slowing down language and action of the classroom, with videotapes, audiotapes, and transcriptions, we can put what we do into concrete terms. We can chart our events and catalog our language to systematically examine practice from an insider perspective" (p. 90). While Frank talks about teachers recording themselves and analysing the recordings to gain insights into their own teaching and learning processes, I find it beneficial as a researcher to follow the same method to gain insights into the teaching and learning processes in linguistically altered classrooms. Excerpts of transcribed classroom talk and selected excerpts of video recordings were useful to get the teachers' thoughts and points of view. Data sources also include field notes of classroom observation, interviews with teachers and stimulated recall based on the video recordings and/or transcriptions. These varied sources facilitated data triangulation. For example, I cross-checked the insights I gained from analysing the transcripts of classroom talk with evidence from stimulated recall to examine practice from an insider perspective. This was then cross-checked and complemented with my observation of the teachers' practices from the field notes of classroom observation.

I pay close and careful attention to detail and rigour to ensure that my interpretations of the data are evidence based and consistent. While the data bears the weight of my interpretation, I continuously confront my opinions and prejudices with the data as advised by Bogdan & Biklen (2007, p. 37). They say that "the researchers" primary goal is to add knowledge, not to pass judgement. The worth of the study is the degree to which it generates theory, description or understanding (p. 38). Anyone who has been teaching soon realises that the classroom is already a complex setting. The linguistic alteration has added to this complexity. Therefore I attempt to portray the many dimensions of this complexity and not evaluate it as "good" or "bad". I also presented my findings at seminars and peer discussion groups to ensure examination of my research and its findings besides "checking alternative explanations for my findings" (Miles & Hubermann, 1994).

The case study approach allows the study of small samples in depth and does not claim to make generalisations. That means the findings from my case studies of Teacher M (TM) and Teacher R (TR) cannot be generalised to the entire population of mathematics teachers in Malaysia but they can be used to develop, extend and understand what happens in a linguistically altered mathematics classroom. I tried to achieve this by giving a "thick" description (Guba & Lincoln, 1981, p. 119), where I provide a detailed account of my field experiences and make explicit the patterns of cultural and social relationships within the context of the Malaysian classrooms I am researching, so that others can experience the phenomena under study through my eyes.

To minimise the observer effect, also called the "Heisenberg effect" (Bogdan & Biklen, 2007, p. 38), I tried to interact with my participants, the two teachers in my study in a natural, unobtrusive and nonthreatening manner. I assured them that the research would in no way affect their professional or personal lives but merely seek to study the policy as it plays out in the classroom. Having taught English as a subject for several years in the primary and secondary schools in Malaysia, I was able to relate to both my participants, the setting and find commonalities that put both me and my participants at ease.

Ely (1991) warns, "Here the issue about familiarity/unfamiliarity with what one wishes to study first comes into focus. We are too familiar when we "know" the answers ahead of time, or when we feel close, too distressed, too disinterested, or too biased to study the situation. We are too familiar when we cannot make the familiar unfamiliar (p. 16)." Having been a language teacher for over 15 years in Malaysia, I am well aware of the teaching and learning contexts in the language classroom, yet the context of the mathematics class *in* English is totally new. Firstly, the content is different from the language lessons. Secondly, the English used in this class is for academic purposes which differ from the purposes of the English used in the language classroom. Therefore I would be "sufficiently detached" (Ely, 1991) so as not to "endanger" my role as the non-participant observer. Besides, Ely does say that "it is increasingly important to study the familiar, but without the blinders that familiarity often attaches to us (p. 17)."

3.4 Ethics and selection of research participants and site

Ethical approval for this study was obtained from both the Human Ethics Committee of Victoria University and Educational Planning and Research Department (EPRD) of the Ministry of Education, Malaysia as well as the permit to conduct the research from the Prime Minister's Department, Malaysia (see Appendix E for the information sheets and consent forms). The names of the schools, the teachers and the students involved are referred to by initials and pseudonyms to protect the identity and maintain confidentiality. The two case study teachers are referred to with initials so as not to refer them to any particular ethnic group within Malaysia; Teacher M (TM) and Teacher R (TR). Thus, names of Indian, Chinese or Malay origin have been avoided. The students' names have also been changed and pseudonyms have been used. The schools are located in an urban area and the classes are selected to be typical of classrooms in urban areas in that they have mixed levels of English proficiency among students.

3.5 Context of the study

The context of this study was two Malaysian urban primary schools. Two teachers teaching mathematics to their Year 4 classes (ten-year olds) were studied. The data for this study was collected four and a half years after the implementation of the ETeMS policy.

3.5.1 Participants

This study seeks to illustrate how teachers' mediating role is played out and how teachers build linguistic bridges in the teaching and learning *of* mathematics *in* English. Pandian & Ramiah (2004) raised concerns about teachers of mathematics and science in Malaysia:

> we have teachers who themselves have proficiency problems with the new medium of instruction. . . . These teachers who are not language specialists will have to cope with the double demand of transmitting content as well as language. Will they be able to cover their subject area in an accurate and effective manner? (p. 2)

Lim et al (2009) also observed that among mathematics teachers, the overall confidence in their English language proficiency remains low enough for teaching in that language to appear threatening (p. 242). The mathematics teachers selected for this study are chosen from those who are moderately proficient in English, positive towards ETeMS policy and sufficiently confident to teach in English.

3.5.1.1 Teacher M (TM) and her class, 4M

Teacher M (TM) is in her late twenties. She has been teaching for six years now. She is a product of the Malaysian education system. She went through the six years of primary and five years of secondary schools and sat for all the required public examinations. In her forming years, she has been schooled in the "Malaysian" way of schooling, for example teacher-fronted classroom and the whole-class approach, and knows very well the "ways of knowing" (Heath,

1983) that are needed to survive in Malaysian schools. It must be noted that TM learnt everything in Bahasa Melayu except for English Language which was taught as a compulsory subject. It must also be noted that although it is compulsory to learn English, it is not compulsory to pass it in the public exam. One could still obtain a good overall grade even though one has failed the English paper in the public examination.

After schooling, TM pursued teacher training. She enrolled at a teacher training college for two and a half years and obtained a Certificate of Teacher Training that would enable her to teach in the primary school. At that time, being trained in a teacher training college was just an extension of primary and secondary school, for example teacher-fronted whole-class teaching. The language of instruction was Bahasa Melayu and TM was trained in Bahasa Melayu to teach mathematics in Bahasa Melayu. This was fine for TM who had learnt mathematics in Bahasa Melayu throughout her primary and secondary schooling days. She could draw on previous knowledge for the mathematics content and mathematical language.

With the change in policy in 2003, TM found herself in a strange situation. Nevertheless, from my interviews, I found that TM was very positive about the change and she felt that she could cope with teaching mathematics in English. She also felt that she spoke reasonably well in English – well enough to teach her ten-year old students. In fact, during the interview, she talked about the importance of English and it is good that her students will have an early start to learn in English. Here was a teacher who was not resistant to the change that was suddenly thrust upon her.

TM's class, 4M, consists of 38 ten-year-old girls. The students of class 4M have different mathematical and linguistic strengths. Altogether there are four Year 4 classes in this school. These classes are semi-streamed according to their exam achievement. At the end of their Year 3, the students would have sat for the End of Year Examination. They are then ranked according to their achievement. The last forty from this rank are grouped and put together in one class. The reason for this is to enable the teacher to do more remedial work. The rest of them from the rank are mixed up and divided into three classes. Hence, the semi-streaming and the difference in mathematical and linguistic strengths in 4M. There are a handful of students in 4M who are good in mathematics and proficient in English, particularly Charmaine and Monica.

The students of 4M have different teachers to teach them different subjects out of which one of the teachers will become the class teacher who then has to juggle teaching and administration work. Altogether they have ten teachers teaching them various subjects like Bahasa Melayu, English, mathematics, science, living skills, local geography/history, Islamic religious study or moral education, music, art, physical education. TM enters 4M to teach them mathematics four times a week, 70 minutes each time.

3.5.1.2 Teacher R (TR) and her class, 4R

Teacher R (TR), in her early forties, is the senior assistant in charge of student affairs in the school. She is also the mathematics teacher of 4R. Besides teaching the Year 4 (the ten-year-olds), she also teaches mathematics to the Year 5 and Year 6 (the 11 and 12-year-olds).

TR has been teaching for almost 18 years. However, it is only her third year teaching in a primary school. Most of her teaching years were spent teaching science and mathematics, in Bahasa Melayu, in the lower secondary schools (ages 13 to 15). TR took up a promotion as a senior assistant (in charge of students' welfare and discipline) in this primary school and juggles administration work, the task of setting up a new school and teaching mathematics *in* English in a primary school. It is only her third year teaching mathematics in English.

During one of our informal chats over coffee, TR told me that she is still not so used to teaching primary school children and teaching in English. According to her, she is still learning how to teach these young children and how to teach in English. In these 18 years of teaching, it has only been in the last three years that she has been teaching children so young and teaching in English. Like TM, she too was schooled in Bahasa Melayu. And like TM, she too was trained in the teacher training college as a teacher with Bahasa Melayu as the medium of instruction. While TM was trained to teach in primary schools (ages 7-12), TR was trained to teach lower secondary students (ages 13-15).

TR, like TM, is also positive towards the change in the medium of instruction. In fact she was chosen by the state education department to become an ETeMS trainer. The MOE and state education department conduct various in-service courses at various levels for mathematics and science teachers. TR is part of the team of trainers who go around conducting these ETeMS courses. MOE/state education department select content teachers (mathematics and science teachers with a certain level of English proficiency) and English language teachers to form the ETeMS trainers' team at the district and state level.

TR's class, 4R, consists of 25 ten-year old students. Altogether there are three Year 4 classes in this school and they too are streamed after the end of the Year 3 examination. The students of 4R are also made up of different mathematical and linguistic strengths like 4M.

Class 4R, like 4M, has different teachers for different subjects and TR teaches them mathematics. She too enters 4R four times a week, 70 minutes each time.

3.5.2 Physical arrangement of the classes

Like most classrooms in Malaysia, both 4M and 4R have the features of a traditional teacher-fronted classroom. The tables are arranged in rows facing the teacher and the blackboard.

Class 4M has an enrolment of 38 girls. Students' desks fill the classroom to its maximum capacity leaving a bit of space in front for a teacher's table. There are some display tables at the back of the class as well. However, students' desks reach almost to these display tables and there is hardly any space to walk.

This classroom does not belong only to 4M. Class 4M occupies this classroom in the afternoon only, from 1.10pm to 6.50pm. It is very common in Malaysia for two schools to share the same premises. One school would operate in the morning while the other would operate in the afternoon.

Half of the display at the tables and notice boards on the wall above the display tables at the back of the classroom belong to the class in the morning session school while the other half belongs to 4M in the afternoon session. Because the classroom is shared, the furniture in the classroom is never moved. If for some activity the desks are moved, they are rearranged by the end of the day so that it would not inconvenience the other class.

Although the desks do not move, I noticed the students of 4M moving whenever it was mathematics lesson. TM, their mathematics teacher, has rearranged their seating positions during her lesson. Instead of letting them sit with the friends of their choice as in other lessons with other teachers, she has got them to mingle. However, according to TM, students who are weak in mathematics and English sit in front of the class. Besides that she has also tried to ensure that students who are good in mathematics and English are distributed evenly around the class and not grouped together. According to her students, they are rearranged so that they will not be talking with their regular friends and it will also give them the opportunity to make new friends. According to TM, the good students will be able to help the weaker students. This means that although the physical structure of the class is hardly ever moved, the students in the class are always moving.

Besides this enforced movement by their teacher, I also saw some movement initiated by the students themselves and accepted by the teacher. For example, when TM copies notes on the board, I noticed the students who sit at the back of the class carry their chairs forward and share desks with others in front as they copy down the notes and listen to her explanation.

Class 4R has an enrolment of 25 students, a mixture of boys and girls. Because 4R is smaller in number than the regular size of classrooms in Malaysia, the class teacher had managed to set up a reading corner and a display corner. The rows of students' tables too were positioned in a slanting manner rather than the usual straight line although it still holds a strong teacher-fronted classroom. There is much more room to walk about in this class.

Class 4R is in a single session school, which means that it does not have to share its classroom with another class or another school. Despite that, the class teacher is the one with the authority over the layout of the class. The subject teachers do not disturb the physical structures of the classroom.

TR, being a subject teacher, teaching 4R mathematics, does not move the physical structure of the class. She maintains not only the physical layout, but also the seating arrangements of her students. The students in 4R complied with both the physical arrangement and the seating arrangements.

3.6 Data collection procedures

Data was collected through video recording of the class in progress, field notes of classroom observation, stimulated recollections based on video recordings and excerpts from the transcriptions of classroom discourse and interviews.

3.6.1 Video recording class in progress

The two classes were videotaped. The video recorder was placed at the back of the classroom to cover the teacher and as much of the class as possible. However the video recording mainly focused on the teacher so as to capture her talk in the classroom. Due to unavoidable circumstances such as the size of the classroom and the large number of students in each class, the noise level of the class under observation (4M and 4R) as well as the noise level of the neighbouring classes, the classroom interaction sometimes could not be adequately recorded. I video recorded the lessons myself while taking down field notes of the classroom observation. Therefore sometimes the video recording would capture only the voices of the teachers as the teacher would have moved out of the scope of the recording while I had been concentrating on writing my field notes.

3.6.2 Transcribing classroom discourse

The video recorded lessons were transcribed into lesson transcripts. As Frank (1999) suggests, "By slowing down language and action of the classroom, with videotapes, audiotapes, and transcriptions, we can put what we do into concrete terms. We can chart our events and catalog our language to systematically examine practice from an insider perspective" (p. 90). Selected excerpts were transcribed with detailed contextual clues like gesture, pause, pitch, etc. (see Appendix A for the key for transcript). Stivers & Sidnell (2005) recommend "much can be gained from examining a turn-at-talk for where it is situated vocally [sequentially, prosodically, syntactically] as well as visuospatially [e.g. body orientation, facial expression, accompanying gestures]" (p. 2). Therefore only excerpts where the video recording captures the speaker both visually and audibly were selected.

I transcribed the classroom interactions from each of the lessons observed from the beginning of the lesson till the end. These transcripts were then analysed and the excerpts chosen were further transcribed with additional details. Significant contextual references and descriptions of what the participants and other relevant details (see Appendix A for the key for transcript) were included in the transcripts as they play a vital role in the meaning making process during the teaching/learning event. The transcripts are labelled in the following manner: "teacher's initial: the lesson: excerpt number". Therefore R:1:1 refers to Excerpt *1* of Lesson *1* from *TR*'s lessons while M:3:1 refers to Excerpt *1* from Lesson *3* of *TM*'s lessons. However, M:1:B indicates the notes on the *b*oard that *TM* writes in Lesson *1*. These transcripts were further strengthened with other data sources such as field notes of classroom observation as well as notes from the stimulated recall and reflection.

<u>3.6.3 Stimulated recall with teachers based on video recordings/ transcriptions</u>

Stimulated recall is the technique of playing back video recordings to participants and asking them to report their behaviours. Nunan (1992) lists two advantages of this method. Firstly it produces insights into the teaching/learning processes and secondly it provides an avenue for the participants to voice their view and not be at the mercy of the researcher's view. By stimulated recall, I was able to seek explanation and clarification of the communication as well as the language teaching and learning strategies they employed while mediating "mathematical language" and "mathematical content/concept" in the linguistically changed mathematics classroom.

<u>3.6.4 Field notes of classroom observation</u>

The video taping was supported with my field notes of the classroom. Having only one video camera to record, I realised that I could not capture everything that happens in the classroom and some important detail of the classroom life might not fall within the scope of the recording. Thus, I tried to capture as much detail as possible – writing down my comments, questions to ask the teacher, matters that needed clarification and more explanation, my thoughts and initial interpretations. Despite the danger of the observer effect, by being there I could "get a *feel* for the atmosphere of the setting" (Zuengler, Ford & Fassnacht, 2005 p. 4). Zuengler et al say that it is important for the researcher to observe, listen, feel and interpret.

3.6.5 Interviews

I conducted two sets of interviews with TM and TR: at the beginning and at the end of my data collection phase. The initial interview, conducted prior the data collection, was to get an insight of the teachers' ideas and attitudes towards ETeMS and gauge their English Language proficiency and confidence. In striving to understand how these mathematics teachers deal with the double demand of transmitting content as well as language in the mathematics classroom, the initial interviews enabled me to get the teacher's perspective. This initial interview was a semi-structured one (Nunan 1992) where I had prepared some questions in advance. However, I was not constrained by these questions. In the course of the interview, I constructed further questions based on my participants' responses.

The interview at the end enabled me to discuss with the teachers and get their views on themes arising from my preliminary analyses of the classroom observation and stimulated recall data. It also enabled me to triangulate the data collected through the other means. This interview at the end was a balance between a semi-structured and structured one (Nunan 1992). I controlled the direction and goal of the interview and what it would cover by raising pre-formulated questions in a pre-fixed order as is the essence of the structured interview. However, in the course of the interview, I also constructed further questions based on my participant's responses which is the essence of semi-structured interview.

3.6.6 Informal Chats

Although I was familiar with Malaysian classrooms, the mathematics classroom was something unfamiliar. I held casual chats as I accompanied the teachers either to the class (before the lesson) or to the staffroom (after the lesson) regarding the academic and social wor(l)ds of the linguistically altered mathematics classroom that I had observed while they were teaching. Sometimes students also came up to me and chatted as I was setting up the video recorder at the back of the classroom if I was unable to accompany the teacher to the class as the teachers were sometimes teaching in another class before coming to the class under observation. Patton (2002, p. 342) identifies these informal chats as the "informal conversational interview" while Fontana & Frey (2000, p. 652) call it "unstructured interviewing". These informal chats enabled me to "go with the flow" (Patton, 2002, p. 343) and pursue information and clarification as insights into the participations' thought, opinions and feelings were revealed or as they emerged.

3.7 The lessons observed: The unit on length

The Malaysian Mathematics Curriculum for Year 4 consists of ten units. They are: (1) Whole Numbers, (2) Fractions, (3) Decimals, (4) Money, (5) Time, *(6) Length*, (7) Mass, (8) Volume of Liquid, (9) Shape and Space and (10) Data Handling.

I had the opportunity to observe TR and TM teach the entire unit on Length. They are governed by the ministry prescribed curriculum specifications (Appendix B) and the mandated textbook (Appendix C) and teacher's guidebook (Appendix D). Other than the prescribed textbook, the school chooses supplementary books to complement the textbook (Cho & Che, 2007a & 2007b - TR's school chosen supplementary book; Tan & Lavindran, 2007a & 2007b) - TM's school chosen supplementary book). This set of supplementary books reflects the public examination at the end of their primary schooling (Year 6), the Ujian Penilaian Sekolah Rendah (UPSR), which is the Primary School Assessment Test. TM's and TR's students will eventually sit for UPSR in two years time. But it is the practice of the yearly school prepared tests and state education department prepared examinations to mirror the format and structure of this UPSR exam although the content is kept to the prescribed syllabus for the level students are studying in. Table 1 gives an overview of (i) the curriculum specifications, (ii) the textbook and its breakdown of the unit as well as (iii) TR's and TM's teaching/learning structure of this unit. TR teaches this unit over seven lessons while TM stretches it over nine lessons.

I have chosen to focus on the second learning objective: Understand the relationship between units of length which consists of (i) State the relationship between units of length and (ii) Convert units of length. TR uses Lessons 1 and 2 focusing on these central concepts while TM spends Lessons 1 to 4. However these central concepts, "relationship between units of length" and "conversion of units", are repeated till the last lesson on Length. I find that these are central concepts in this unit on Length. Therefore by focusing on these two concepts, I can trace the classroom talk that surrounds the strand of "relationship between units" and "conversion of units" from the beginning till the end of the unit on Length. I can explore how the talk and language use that surrounds "relationship between units" and "conversion of units" vary and is sustained from the time they are introduced in the beginning till the end of the unit.

Table 1: Overview of the unit on Length

<table>
<tr><th>Curriculum Specifications</th><th>Textbook</th><th>TR</th><th>TM</th></tr>
<tr><td rowspan="2"><u>Learning Objective</u>:
Measure lengths using standard units

<u>Learning Outcomes</u>:
(i) Read measurement of length using units of mm
(ii) Write measurement of length to the nearest scales of
tenth division for :
○ cm
○ m
(iii) measure and record lengths of objects using units of
○ mm
○ cm and mm
○ m and cm
(iv) Estimate the lengths of objects in
○ mm
○ m and mm
○ cm and mm</td><td><u>Learning Area</u>:
Measuring Lengths

<u>Learning Outcomes</u>:
A. Measure the lengths and write the scales</td><td>Lesson 1</td><td>Lesson 2
Lesson 3</td></tr>
<tr><td>B. Estimate the lengths of objects</td><td>Lesson 1</td><td>- nil -</td></tr>
<tr><td rowspan="2"><u>Learning Objective</u>:
Understand the relationship between units of length

<u>Learning Outcomes</u>:
(i)State the relationship between cm and mm.
(ii) Convert units of length from:
○ mm to cm and vice versa
○ compound units to a single unit</td><td><u>Learning Area</u>:
Relationship between units of length

<u>Learning Outcomes</u>:
A. State the relationship between units of length</td><td>Lesson 1
Lesson 2</td><td>Lesson 1</td></tr>
<tr><td>B. Convert units of length</td><td>Lesson 2
Lesson 3</td><td>Lesson 1
Lesson 2
Lesson 3
Lesson 4</td></tr>
<tr><td rowspan="2"><u>Learning Objective</u>:
Add and subtract length
<u>Learning Outcomes</u>:
(i) Add units of length, involving conversion of units in
○ m
○ m and cm
○ cm and mm
(ii) Subtract units of length, involving conversion of units in
○ m
○ m and cm
○ cm and mm</td><td><u>Learning Area</u>:
Basic operations involving length

<u>Learning Outcomes</u>:
A. Add units of length</td><td>Lesson 3
Lesson 4</td><td rowspan="2">Lesson 4

Lesson 5</td></tr>
<tr><td>B. Subtract units of length</td><td>Lesson 4</td></tr>
<tr><td rowspan="3"><u>Learning Objective</u>:
Multiply and divide length
<u>Learning Outcomes</u>:
(i) Multiply units of length involving conversion of units by;
○ a one-digit number
○ 10, 100, 1000
(ii) Divide units of length involving conversion of units by;
○ A one-digit number
○ 10, 100, 1000
(iii) Solve problems involving basic operations on length</td><td>C. Multiply units of length</td><td>Lesson 5
Lesson 6</td><td rowspan="2">Lesson 6
Lesson 7</td></tr>
<tr><td>D. Divide units of length</td><td>Lesson 6</td></tr>
<tr><td>E. Solve problems involving lengths</td><td>Lesson 7</td><td>Lesson 8
Lesson 9</td></tr>
</table>

3.8 Data Sources

Since language is the medium in which teaching and learning takes place, discourse (both spoken and written) is a good source of data to analyse to understand how knowledge and meaning in the classroom is jointly constructed. A detailed description and analysis of the linguistically altered classroom discourse yields insights into the teaching and learning of mathematics in English.

3.8.1 Spoken discourse: Teacher-Student dialogue

As discussed in Chapter Two, the interaction that happens in the classroom constitutes teaching and learning processes. Pedagogical interactions between teachers and students were captured in the video recordings and transcribed. Selected excerpts of the transcriptions that highlighted critical teaching and learning events were then transcribed in further detail.

Table 2 below depicts a summary of the excerpts extracted, in a chronological order, from all the transcribed lessons that portrays the teaching/learning moments related to "relationship between units" and "conversion of units". In the teaching and learning of mathematics, Schwartz (2008) identifies and distinguishes the two types of knowledge mathematics instruction promotes: conceptual knowledge and procedural knowledge. Procedural knowledge enables students to find answers to problems according to set rules while students with conceptual knowledge understand the content and principles of mathematics and this understanding is transferable to other mathematical situations. Therefore, the extracted excerpts are separated into two categories; teaching and learning of (i) conceptual knowledge and (ii) procedural knowledge.

Table 2: Summary of excerpts related to the teaching and learning of "relationship between units" and "conversion of units"

Excerpt	Transcripts from TR's Lessons	Excerpt	Transcripts from TM's Lessons
Conceptual Knowledge			
R:1:1	TR informs students that 1cm=10mm	**M:1:B & M:2:B**	**M:1:B** **TM** writes, in Lesson **1**, on the **B**oard, formula and notes related to "relationship between units" and "conversion of units". **M:2:B** **TM** writes, in Lesson **2**, on the **B**oard, four tables for the measuring task around the school and conversion of units.
R:1:2	TR jointly constructs the 15cm=150mm relationship using the short ruler		
R:1:3	TR jointly constructs the 1cm=10mm relationship using the short ruler		
R:2:1	TR consolidates the concept of long(er)/short(er)		
R:2:4	TR jointly constructs, through Ribbon Activity, the 30cm=300mm relationship		
R:2:5	TR jointly constructs, through Ribbon Activity, the 20cm=200mm relationship		
R:2:6	TR jointly constructs, through Ribbon Activity, the 10cm=100mm relationship		
R:2:7	TR jointly constructs, through Ribbon Activity, the 5cm=50mm relationship		
R:2:8	TR jointly constructs the Conversion Formula for cm to mm		
R:2:9	TR tries out the cm to mm Conversion Formula		
R:2:10	TR *jointly constructs* the Conversion Formula for mm to cm		
R:2:11	TR *tries out* the mm to cm Conversion Formula		
R:2:12	Student tries out the conversion formula using long division		
R:2:13	*TR teaches* the Jumping Method as another student starts the long method		
R:2:14	TR sums up the relationship between units and the method of conversion		
R:2:15	TR final summing up of the relationship between units and conversion of units		
Procedural Knowledge			
R:3:1	TR's Jumping Method	**M:3:1**	TM's Bowl System
R:6:1	TR's Jumping Method	**M:3:2**	TM's Bowl System
R:6:2	TR's Jumping Method	**M:3:3**	TM's Bowl System
R:7:1	TR's Jumping Method	**M:4:1**	TM's Bowl System
		M:4:2	TM's Bowl System
		M:4:3	TM's Bowl System
		M:7:1	TM's Bowl System
		M:7:2	TM's Bowl System
		M:9:1	TM's Bowl System

Table 2 lists the excerpts of classroom interaction for the analysis of the first two investigations which relate to the academic wor(l)ds of the classroom: teaching and learning *in* English and the teaching and learning *of* mathematics. Table 3 below lists the scenarios that investigate the social wor(l)ds of the linguistically altered mathematics classrooms.

Table 3: Summary of scenarios related to the social wor(l)ds of the linguistically altered classroom

Scenario	Social Aspects		Excerpts
Scenario 1	**"Way of Being" in Malaysian Classrooms**	In TM's classroom	**TM:2:1[SW]**
		In TR's classroom	**TR:7:2[SW]**
Scenario 2	**Language Repair**	(i) In TM's classroom: during Lesson 2	**TM:2:1[SW]**
		(ii) In TM's classroom: during Lesson 3	**TM:3:4[SW]**
			TM:3:5[SW]
			TM:3:6[SW]
			TM:3:7[SW]
			TM:3:8[SW]
		(iii) In TR's classroom: during Lesson 1	**TR:1:4[SW]**
Scenario3	**Mathematics Repair**	(i) Marking at the blackboard	-
		(ii) Mathematics repair Other-Repair Absence of other-repair Self-Repair	-
Scenario 4	**Revealing Laughter & Loaded Silence**	Incident 1: TM joking with the term "operation"	**TM:4:1[SW]**
		Incident 2: Students teasing TM	**TM:9:2[SW]**
		Incident 3: TM teasing a student	**TM:9:3[SW]**
		Incident 4: Student teasing student	**TM:9:4[SW]**

3.8.2 Written discourse: On the blackboard and printed texts

Wherever necessary, the excerpt of the transcript is complemented with a depiction of the blackboard as the writing on the blackboard is also considered as important mediational tool. According to Ernest (1994), teacher-student dialogue (usually asymmetric in classroom forms) typically takes place at two levels: spoken and written. The written dialogue is taken into consideration because as Ernest says,

> In written 'dialogue' students submit texts (written work on set tasks) to the teacher, who responds in a stylised way to its content and form (ticks and crosses, marks awarded represented as fractions, crossings out, brief written comments, etc.). The primary aims of such conversation are that of ensuring that the student is appropriating collective mathematical knowledge and competencies, and not some partial or distorted version (p. 63).

While Ernest talks about students' written work in their exercise books, I have, using his suggestion, included the writing on the board as well because I find that in teacher-fronted classrooms like TR's and TM's, the writing on the board plays a very important role in the mediation of learning and in the joint construction of mathematical knowledge (content/concept) and mathematical English.

TM and TR are guided by (i) the prescribed Curriculum Specification, (ii) the official Teacher's Guidebook, (iii) the mandated textbook and the (iv) school chosen supplementary book(s). Their students, on the other hand, have the mandated textbook loaned to them for free by MOE which they return to the school at the end of the schooling year and the school chosen supplementary book(s) which they get to keep as they have to buy it. These four sets of texts are analysed as I investigate how they inform TM's and TR's teaching/learning of mathematics. The mathematical content in focus, that is "relationship between units" and "conversion of units" will be analysed, across the four texts as they too inform and complement TM's and TR's teaching/learning practices.

3.9 Data categorisation

According to Love & Suherdi (1996), interactional sociolinguistic approaches recognise the importance of the situated nature of classroom life, recognise the importance of the role of discourse in constructing that life, and focus on the patterned ways of interacting socially. Green & Weade (1985) say something similar: "as teachers and students interact during the events of classroom life, a variety of meanings are being constructed simultaneously." This means that at one level, the teacher and students are constructing the academic content of the lesson, often referred to as the "academic task" (Erickson, 1982). The focus of interactions at this level is on the overt academic information to be learned. At another level, the teacher and students are continually constructing the social aspect of their classroom life. The focus on interaction at this level makes visible the covert messages that are at play during these "social participation tasks" (Erickson, 1982). Although "academic task" and "social participation task" occur simultaneously, for analytical purposes, I analyze classroom discourse in two separate themes: (i) mediating academic wor(l)ds; that is teaching and learning *in* English as well as teaching and learning *of* mathematics and (ii) mediating social wor(l)ds in the linguistically altered classrooms. The term discourse used in the context of my study not only refers to "all spoken and written forms of language use as social practice" (Wood & Kroger, 2000, p. 19) but also discourse in the Foucauldian sense – which sees discourses as systems of language and power.

3.9.1 Analysing the mediation of the academic wor(l)d: The teaching and learning *of* mathematics *in* English

To analyse mediating academic wor(l)ds, I have adopted Wells (2002) macro and micro level analysis. Planning teaching at the macro level involves the overall design of the unit of work to achieve specific outcomes while micro level analysis of teaching refers to the moment by moment interactions within the lesson. To analyse this moment by moment classroom interaction or the spoken discourse, I have adapted Sinclair & Coulthard's (1975, p. 19) system of analysis.

Having realised that lessons were highly structured, Sinclair & Coulthard (1975) were interested in discovering how much of this structure was pedagogical and how much of it was linguistic. Their main aim was to discover the English used by teachers and students that is the linguistic structures of discourse (p. 10). Sinclair & Coulthard analysed the LESSON and broke it down into TRANSACTIONS, EXCHANGES, MOVES and ACTS. A LESSON is made up of one or more TRANSACTIONS that frame EXCHANGES. The EXCHANGES are further divided into BOUNDARY EXCHANGES and TEACHING EXCHANGES. The former are transitional exchanges while the latter are teaching and learning steps. The elements of structure in the BOUNDARY EXCHANGES are FRAME and FOCUS while the elements of structure in the TEACHING EXCHANGES are INITIATION, RESPONSE and FEEDBACK. They identified eleven types of *TEACHING EXCHANGE*S: teacher inform, teacher direct, teacher elicit, student elicit, student inform, teacher check, teacher reinitiate (i) when s/he gets no answer, teacher reinitiate (ii) when s/he gets wrong answer, teacher listing, teacher reinforce and teacher repeat. Next, they break down the EXCHANGES into MOVES. BOUNDARY EXCHANGES are made up of the FRAMING and FOCUSING MOVES to indicate the initiation of an interaction and the path the initiation takes. The TEACHING EXCHANGES are made of OPENING, ANSWERING, and FOLLOW-UP MOVES. They are then analysed based on their discourse ACTS; the ELICITATION ACT that requests a linguistic response, the DIRECTIVE ACT that requests a non-verbal response and the INFORMATIVE ACT where teachers or students can provide information relevant to the lesson. They have identified twenty-one ACTS altogether: marker (m), starter (s), elicitation (el), check (ch), directive (d), informative (i), prompt (p), clue (cl), cue (cu), bid (b), nomination (n), acknowledge (ack), reply (rep), react (rea), comment (com), accept (acc), evaluate (e), silent stress (^), meta-statement (ms), conclusion (con), loop (l) and aside (z). Table 4 depicts an example of Sinclair & Coulthard's matrix for the analysis of classroom interaction (1975, p. 66).

Table 4: An example of Sinclair & Coulthard's classroom discourse analysis matrix (Sinclair & Coulthard, 1975)

Exchange Type	Opening	Act	Answering	Act	Follow-Up	Act
Elicit	We haven't got them all in have we. What haven't we got?	s el	'i'	rep	'i' But we haven't got 'u'.	e com
Boundary	Right FRAME	m				
	So, that's the first quiz FOCUS and I think you got that all right	con com				
Boundary	Right FRAME	m				
	Here's the next quiz Then if you're ready FOCUS	ms				
Elicit	I want you to look at these I don't want you to write anything. But I just want you to look at them and see if you can tell me what these mean? NV Ann	s s s el b n	The first one's workmen.	rep		
Repeat	This one?	l	NV	rep	Yes.[1-]	acc

Sinclair & Coulthard's matrix for analysing classroom discourse presents a sociolinguistic proposal to study the language used by teachers and students as they jointly construct teaching and learning in an English classroom. My study, on the other hand, seeks to explore how English, the new medium of instruction, is used for the teaching and learning *of* the mathematical unit on Length. Using their detailed analysis of classroom interaction and the categories they have developed, I adapted it (Table 5) to investigate the teaching and learning *of* mathematics *in* English.

I have retained the first column from Sinclair & Coulthard's matrix, the "Exchange Types". This is because analysis of this first column with the fourth column (Classroom Interaction) reveals how teacher talk mediates the teaching and learning of mathematical content and mathematical English. Besides that, the first column also captures the various discursive practices made available to students for the joint construction of mathematical meaning in the classroom.

Where Sinclair & Coulthard have expanded the "Teaching Moves" and inserted into them the classroom interaction based on the three categories they developed; "Opening, Answering and Follow-Up" (columns 2, 4 & 6 of Table 4), I have retained "Speaker" and "Classroom Interaction" in separate columns (columns 3 and 4 in Table 5) and have instead indicated with a star the relevant "Teaching Move" (columns 6-8 of Table 5). I have opted for the linear representation of the classroom discourse instead of separating the teacher's and her students' classroom interaction into different columns. Data were collected from teacher-fronted, transmission modelled classrooms. In these classrooms, as revealed in my initial reflection on the transcriptions as well as numerous studies (see section 2.5.1), teachers' talk dominates classroom interaction. The separated columns of teachers' and students' merely highlight this expected dominance and defeat the purpose of making salient this feature. The aim of this study is to find out how teachers' talk in linguistically altered teacher-fronted classrooms in Malaysia mediates teaching and learning of mathematics. The linear representation of classroom discourse is considered sufficient because the first column (Exchange Types) identifies the kind of talk that occupies classroom interaction while the third column (Speaker) identifies who takes up most of the talking time in the class.

Classroom Interaction in the fourth column of Table 5 is also complemented with classroom observation such as contextual cues, raised pitch and intonation (see Appendix A for key for transcription). This is different from Sinclair & Coulthard's presentation of classroom discourse. The added information is considered vital because meaning is not only jointly constructed on *what* is said but *how* it is said (see section 2.6).

As this study also seeks to investigate "the teaching and learning *of* mathematics" besides "the teaching and learning *in* English", I have adapted and expanded Sinclair & Coulthard's matrix for the analysis of discourse in the English classroom to include the analysis of discourse in the mathematics classroom (column 10 of Table 5). This adapted and expanded matrix enables two levels of analysis of classroom discourse; (i) the study of language as a mediating tool and (ii) the study of the kinds of mathematical knowledge emphasised and the teaching/learning processes practiced by the teacher. Thus, the selected excerpts of classroom discourse will be analysed using the adapted and expanded matrix (Table 5) for the teaching/learning *of* mathematics *in* English: beginning with a focus on mediation which is sub-divided into (i) how teacher talk and language use mediate the teaching and learning *of* mathematical content and mathematical English, (ii) other mediational tools, besides teacher talk and language use, that mediate the teaching and learning *of* mathematical content and mathematical English, (iii) the discursive practices made available for the teaching and learning *of* mathematical content and mathematical English and (iv) the opportunities made available for the teaching and learning *of* mathematical content and mathematical English.

Table 5: The adapted and expanded discourse analysis matrix

Exchange Types	No.	Speaker	Classroom Interaction & Observation	Teaching Moves			Act	Teaching and Learning of Mathematics
				Feedback/ Opening	Response/ Answer	Feedback / Follow-up		
Tr. Inform	1.	TR	What we are going to learn is:	*			ms	
	2.		to measure length using standard units ...	*			ms	
	3.		OK	*			m	
Tr. Inform	4.		standard units involve ...	*			i	'standard unit' introduced
	5.		for millimetre or centimetre for shorter length [TR writes mm and cm on the board]	*			i	Units for shorter length introduced orally and in writing on the board
	6.		and then	*			m	
	7.		ok	*			m	
Tr. Inform	8.		For longer length you can use the units metre or kilometre [TR adds m and km beside it]	*			i	Units for longer length introduced orally and in writing on the board

3.9.2 Analysing the mediation of the social wor(l)d: Teaching and learning in linguistically altered mathematics classroom

To analyse mediating social wor(l)ds, which Gee (1999) termed as the *social* turn in language study, I draw upon principles from conversation analysis (CA) and critical discourse analysis (CDA) to study the social construction of subjectivity/identity and the power relations in classroom events. According to Have (2007), CA "works on detailed renderings of interactional activities and transcripts. Because of this, CA can take into consideration details and subtleties of human interaction that have proven to be important for participants" (p. 9). As CA studies oral language as actually used interactionally in "natural" situations I draw upon its principles as I explore the social wor(l)d of the linguistically altered mathematics classroom. Taking into account the social and political features of the implementation of ETeMS, I analyse the classroom discourse from a "critical" stance. Bloome et al (2005) state that, "what people do in interaction with each other is complex, ambiguous, and indeterminate, and it often involves issues of social identity, power relations and broad social and cultural processes" (p. xvi). Therefore the principles of CDA give me a lens to look at "people acting and reacting to each other as they create and (re)create the worlds in which they live" (Bloome et al, 2005, p. xvi) when the new medium of instruction was introduced.

3.10 Summary

The aim of my study is to find out how teachers mediate the teaching and learning *of* mathematics *in* English. To narrate these stories, a rich description and qualitative interpretation is required. My study is embedded within sociocultural and sociolinguistic theoretical and methodological frameworks for within them language and other semiotic tools are seen as significant mediators in the social construction of proximal zones for learning. Therefore, the linguistically changed classroom is explored because language is an important mediating tool. As my focus has been on classroom interaction, I used the discourse analysis tool to capture the academic wor(l)d of the classroom and a blend of both conversation analysis and critical discourse analysis tool to explain the social wor(l)d. By using a variety of methods of data collection and analysis, I will endeavour, in the following two chapters, to shed light on some aspects of the complexity of teaching and learning mathematics *in* English in Malaysia.

CHAPTER FOUR

Mediating Academic Wor(l)d:

Stories of the Teaching and Learning *of* Mathematics *in* English

4.1 Introduction

My main aim in this study is not only to narrate the stories of ETeMS but most importantly to get some insights into the issues pertinent to the teaching and learning *of* mathematics *in* English by exploring classroom interaction, through both spoken and written discourses. I apply sociocultural and sociolinguistic theoretical and methodological frameworks (see Chapters Two and Three) as I analyse the teaching and learning of mathematics using the new medium of instruction.

As I begin with the analysis of TR and her teaching and learning *of* mathematics *in* English in sections 4.2 and 4.3, I outline TR's classroom interaction (see Table 2) as it relates to conceptual knowledge and procedural knowledge in the teaching and learning of "relationships between units" and "conversion of units" in the unit on "Length". As the spoken discourse in the excerpts is analysed, the complementing written discourse, that is the writing on the blackboard is also analysed. In sections 4.4 and 4.5, I analyse TM and her classroom discourse in the same manner. The written discourse in several printed texts is then analysed in section 4.6. In section 4.7, I summarise my findings around my research questions related to the academic wor(l)d of the two linguistically altered classrooms in this study. In section 4.8, I situate these findings within some important ideas of sociocultural and sociolinguistic theories with the aim of understanding what happens within the academic wor(l)d of these two mathematics classrooms with the implementation of ETeMS.

4.2 TR and her teaching of "conceptual knowledge"

Fourteen excerpts have been selected from TR's lessons (see Table 2) and they have been categorised into six areas based on the focus of the teaching and learning event. As TR begins her unit on "Length", she constructs for her students the mathematical content (1cm=10mm) and mathematical English, "short and long" which is captured in R:1:1 and discussed in section 4.2.1. The role of the rulers as mediational tools for the joint construction of mathematical content and mathematical English is explored at length in section 4.2.2. Besides using rulers, mathematical content is also mediated through a ribbon activity (see section 4.2.3). Then TR and her students jointly construct the conversion formula (see section 4.2.4) and her students try out the jointly derived conversion formula (see section 4.2.5). Finally, TR sums up the jointly constructed "relationship between units" and conversion of units" (see section 4.2.6). After these teaching and learning events related to the "conceptual knowledge", TR begins to emphasise "procedural knowledge" that is considered vital for assessment purposes (see section 4.3).

4.2.1 Teaching of mathematical content and mathematical English by TR.

As TR begins her first lesson in the unit on "Length", she delivers the mathematical knowledge to her students. TR stands in front of the class and controls the content and the talk in the class. In excerpt R:1:1 (see p. 70), TR introduces the concept of "measuring length" using "standard units". In her talk, she expands on length as she distinguishes between "shorter length" and "longer length". She also expands on "standard units" as she lists the measurements orally and visually on the board, writing the abbreviations "mm, cm, m, km". Then, TR introduces the concept of relationship as she connects with an earlier lesson on "Time" before stating the relationship between centimetre and millimetre.

Excerpt R:1:1

No.	Speaker	Classroom Interaction	Observation
1.	**TR**	**What we are going to learn is:**	
2.		**to measure length using standard units …**	
3.		**OK**	
4.		**standard units involve …**	
5.		**for millimetre or centimetre for shorter length**	*TR writes mm and cm on the board*
6.		**and then**	
7.		**ok**	
8.		**for longer length you can use the units metre or kilometre**	*TR adds m and km beside it*
9.		**So these are called the standard units**	*TR underlines the units*
10.		**OK**	
11.		**and then you have to understand**	
12.		**the re:la:tion:ship: between units of length…**	
13.		**ok**	
14.		**like we learn time..**	
15.		**we learn: the ↑ re:la:tion:ship:**	
16.		**ok**	
17.		**So in THIS ↑ unit ↓**	
18.		**one centimetre**	
19.		**the relationship or**	
20.		**it is equivalent to …**	
21.		**TEN ↑ millimetre.**	*TR writes 1cm=10mm on the board*

Writing on the blackboard (during excerpt R:1:1)

<u>mm , cm , m, km</u> 1cm = 10 mm

In this excerpt TR's unpacks the mathematical knowledge (in lines 4, 5 and 8) that "mm, cm, m, km" are standard units. In the first page of the unit on "Length" in the textbook, the first objective stated is, "I will learn to: measure lengths using standard units" (Appendix C). Although "standard units" is mentioned, there is no explanation or connection made in the textbook as to what standard units are. Her talk also mediates the mathematical terms related to length, “short/shorter” and “long/longer” for her students. These mathematical terms have not been used in the textbook. If TR had not used these terms and explained what standard units are in her classroom talk, her students would have had no opportunity to learn about them.

Important mathematical terms “shorter” and “longer” are not stated on their own but connected to the relevant and respective standard units. TR begins writing on the board “mm, cm” when she states “shorter length”. Then she adds, on the board, “m, km” as she states “longer length”. Then she underlines “mm, cm, m, km” as she states “standard units”. She also writes the relationship between centimetre and millimetre on the board, 1cm=10mm.

Both orally and visually, TR begins with the smaller unit or the shorter length before moving on to bigger units or the longer lengths. A look at the blackboard during this excerpt reveals that TR does not write “mm” and “cm” and below them “m” and “km” but she writes them in a straight line, in an ascending order. As the students look at the board, they see the units, “mm, cm, m, km” getting bigger (in value) and longer (in length) as they read from left to right. Her spoken information is followed with the visual information on the board. They had the opportunity to hear the complete word and see the abbreviations for each unit on the board. Focusing her students’ attention by writing the standard units on the blackboard and reinforcing by underlining the written units on the board complements TR’s teacher talk as she mediates the teaching and learning of the mathematical content.

TR’s classroom talk also connects the mathematical content of “relationship” between the previous unit (“Time”) and the present unit (“Length”). To locate the concept of “relationship” in familiar grounds, TR draws on the already jointly constructed knowledge in the previous topic, “Time”, that also draws on the concept of relationship. TR pronounces the word “re:la:tion:ship:” in an elongated way twice (lines 3 & 6) which emphasises the teaching and learning content. As TR begins her lesson in the unit on "Length" and links with the previous unit on "Time", she reminds her students that they already have knowledge and skill about "relationship" and that they are going to draw on this understanding as they learn a new topic. Only after recalling this connection with the earlier topic on "relationship" in "Time" does TR proceed to give them the 1cm=10mm relationship. TR made available for them, orally and visually (writing on the blackboard), the relationship between centimetre and millimetre. It is her talk in the classroom, and not the textbook, that bridges the link between the previous and present unit.

Her discursive practice in R:1:1 may seem only one-way, in Sinclair & Coulthard's words only "teacher inform" but embedded in this one-way discursive practice, many teaching and learning steps are taking place: TR begins by (i) unpacking "measure length using standard units" (line 2) where she introduces mathematical English "shorter/longer" and states what standard units are, then (ii) tells them that they have to "understand" (line 11) the relationship between the units, (iii) activates their memory by connecting to previous experience and unit on "Time" – as though it is an extension of the concept on relationship they have learnt only now with new/different units and (iv) finally go on to give them the relationship between centimetre and millimetre. Her spoken and written discursive practice introduces the mathematical content and mathematical English.

4.2.2 Joint construction of mathematical content and mathematical English using rulers

In the next three excerpts (R:1:2, R:1:3 & R:2:1), TR jointly constructs the mathematical knowledge with her students using the students' short ruler and the teacher's long/one-metre ruler.

In excerpt R:1:2 below, TR does five things. First, she uses two additional mediational tools, the ruler and code-switching, besides her teacher talk and the writing on the backboard. Second, she involves her students in joint construction of the mathematical relationship between centimetre and millimetre, 15cm=150mm. Third, she introduces the concept of “same length”. Fourth, she reinforces the concept of units which she introduced in R:1:1 as standard units. Fifth, she gives a glimpse of the method to do conversion.

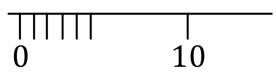
Excerpt R:1:2

No.	Speaker	Classroom Interaction	Observation
1.	TR	**Ok look carefully at your ruler…………**	
2.		**Ok look at the centi:metres =**	
3.		**= the one that.. written down. centimetre…**	*TR holds up the short ruler, with her left hand, just in front of her face and with her right hand points to the left end of the ruler*
4.		**So how↑many centimetres are there?**	
5.	Class	**15 =**	
6.	TR	**= 15 centimetres.**	
7.		**OK the other side =**	
8.		**= You turn around**	*TR turns the ruler around*
9.		**it is in . millimetre, isn’t it? ↑**	
10.	Class	**Yes**	
11.	TR	**How many millimetres are there?**	
12.	Class	**100 and**	
13.	TR	**100 and ↑**	
14.	Class	**50**	
15.	TR	**Ok**	
16.		**So: is: …**	
17.		**My question is =**	
18.		**= IS ..aaa .. 15↑centimetres the same: as**	*TR writes on the board, 15cm =*
19.		**100 millimetre? ↓**	*TR writes 150mm on the board although she says 100mm*
20.		**sama tak? [[same or not?]]**	
21.	Class	**Yes**	
22.	TR	**Awak tengok tadi-kan? [[You saw just now –right?]]**	
23.		**aaa . sini dalam [[Here in]]**	
24.		**centimetre**	

25.		**from zero: until 15**	
26.		**Right?↑**	
27.		**So: . we can measure until 15 … centimetre=**	
28.		**= Alibuddin**	
29.		**look at your ruler …**	
30.		**Ok↓**	
31.		**And then you turn …**	
32.		**a:round**	
33.		**Ok: it's written there millimetre =**	
34.		**= from zero: until 150 mili:metre**	
35.		**So milli↑metre and centi↑metre**	*TR underlines cm and mm on the board, 15<u>cm</u> = 150<u>mm</u>*
36.		**they are called units ..**	
37.		**kan? [[right?]] =**	
38.		**= cikgu dah sebut sebelum ini – unit kan? [[teacher has mentioned before this - unit right?]]**	
39.		**Ok …**	
40.		**So this one =**	*TR point to the cm and mm underlined on the board*
41.		**= they are units for length**	
42.		**ok .**	
43.		**So as you can see here: …**	
44.		**look at your ruler …**	
45.		**ten↑ centimetre =**	
46.		**= sorry 15 centimetre is equivalent to 150 millimetre =**	
47.		**= correct or not?**	
48.	Class	**Yes**	
49.	TR	**Correct**	
50.		**so that's: why this =**	
51.		**= you get =**	
52.		**= you get from this =**	
53.		**= the relationship …**	*TR underlines <u>1cm = 10mm</u> that was written on the board*
54.		**One↑centimetre is equal to ten↑millimetre**	
55.		**so 15 centimetre:**	*TR rubs off = 150mm from the board*
56.		**is equal to:**	
57.		**15 times by↑**	*TR writes on the board, = 15 x , and turns to the class*

58.	Class	**ten**	
59.	TR	**So you'll get 150 milli:metre**	*TR nods at the class. She writes x10 = 150mm*
60.	Class	**metre**	

Writing on the blackboard (during excerpts R:1:2 – R:1:3)



mm , cm , m, km

1cm = 10 mm
15cm = 150 mm

15 cm = 15 x 10
= 150 mm

In R:1:2, the writing on the board plays a rather important tool in mediating the correct mathematical content. As TR writes on the board, "15cm=150mm" (lines 18-19), she asks her students, "IS ..aaa .. 15↑centimetres the same: as 100 millimetre?↓" (TR writes 150mm on the board although she says 100mm). It is the writing on the blackboard and not the incorrect teacher talk (saying 100mm instead of 150mm) that mediates the correct mathematical content.

In R:1:1, TR told her students the relationship between centimetre and millimetre. In R:1:2, TR involves her students as they jointly construct the 1cm=10mm relationship. TR invites her students to look carefully at their ruler, specifically to look at the units (lines 1-2). She focuses their attention on the centimetre and millimetre markings on the ruler (line 4) and asks "how many millimetres are there?" (line 11). Instead of telling them the relationship as she did in R:1:1. She waits for her students' response.

TR's decision to repeat the "look at your ruler" task to notice the centimetres and millimetres afforded her students the opportunity to actually "look at the ruler" and see for themselves how long 15cm and 150mm actually are compared to merely being informed by TR as she did in R:1:1 for 1cm=10mm. Instead of rushing through the mediating process, TR repeats the steps: she begins in lines 1-21 and repeats in lines 22-34. Although her students reply, "yes" (line 21) to her question if 15cm is the same as 150mm (lines 18-20), TR repeats the whole process, beginning in Bahasa Melayu and slowly reverting to English (lines 22-34). Here her "repetition" seems to be a checking mechanism to enable students who might not have jointly constructed the 15cm=150mm relationship the first time in English to do so the second time in Bahasa Melayu. This way no one will be left out in the joint construction of mathematical knowledge related to "relationship between units" because of the new medium of instruction.

TR also appears to code-switch when she reinforces the units of length (lines 35-42). In R:1:1, TR used only English as she introduced the standard units, "mm, cm, m, km". But in R:1:2 TR switches to Bahasa Melayu as she checks and helps her students connect to the mathematical knowledge she had introduced in R:1:1, that is millimetre and centimetre are units of length (lines 35-36). By asking in Bahasa Melayu, TR is affording her students, especially the ones who are struggling with English, an opportunity to make meaning and jointly construct this mathematical content in a shared language they are comfortable in.

In R:1:1, TR made available for her students the content-related phrases, "the relationship or it is equivalent to" (lines 19-20). In R:1:2, TR makes available another content-related phrase, "the same as" (line 18). She in fact goes on to afford her students in Bahasa Melayu as well, "sama [[same]]" (line 20) besides writing the symbol "=" as she did in R:1:1. These content-related phrases are important to the concept of "relationship between units".

Students would need to use them when they appropriate talk on the relationship between units.

In short, TR uses three mediational tools to mediate the concept of "same length". First is her language use, in English and Bahasa Melayu, when she asks "Is 15cm the same as 150mm?" and "sama tak?" as it brings to her students' attention the concept of "same length". Second is her writing on the board, "15cm=150mm" and the use of the equal symbol, "=" which also helps mediate the concept of "same length". Third is the use of the ruler which actually enables them to "see" this concept of "same length".

Although TR's discursive practice is still teacher-centered, there is more student participation here compared to R:1:1. Her students may not seem to be contributing to the quantity of or turns in classroom talk, but following the teacher's instructions and responding appropriately to her questions can also be seen as active participation in teacher-fronted classrooms. In R:1:2, TR moves away from the "teacher inform" discursive practice of R:1:1 and indulges in some "teacher elicit" practice.

In excerpt R:1:3 below, TR does three things. First, she uses more Bahasa Melayu. Second, she translates the Bahasa Melayu term she uses to English. Third, she uses the students' ruler, drawing on the board and Ministry mandated textbook as she jointly constructs with her students the 1cm=10mm relationship.

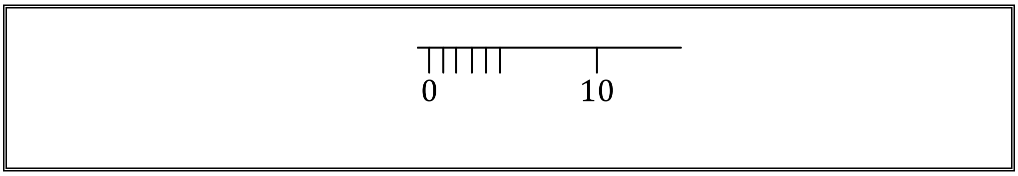
Excerpt R:1:3

No.	**Speaker**	**Classroom Interaction**	**Observation**
1.	TR	**Ok ..**	
2.		**look at the division ..**	
3.		**from zero: to TEN millimetre =**	
4.		**= how many↑ divisions are there? ...**	
5.		**Tengok kejap awak punya pembaris =**	

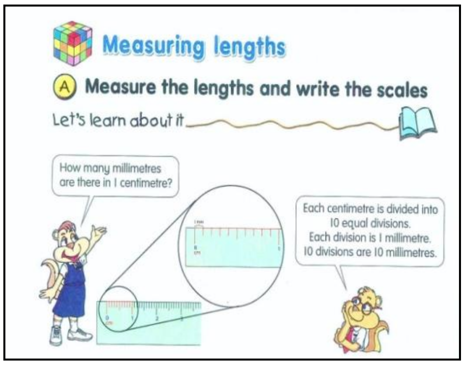
		[[Look, for a while, at your ruler]]	
6.		**= awak kira …….. [[you count]]**	*TR draws on the board a horizontal straight line. She then draws several short vertical lines and labels it 0 at the beginning, left end and 10 a little bit further.*
7.		**Nampak dari zero: sampai sepuluh =** **[[can you see from zero until ten]]**	
8.		**= Ok berapa ini ? = [[ok how many ?]]**	
9.		**= yang sekatan ini? = [[these divisions?]]**	
10.		**= we call that divisions …**	
11.		**how many divisions? =**	
12.		**= kira … [[count]]**	
13.		**from zero to ten …..**	
14.	Class	**Ten**	
15.	Class	**Nine**	
16.	TR	**Ten =**	
17.		**= should be ten ..**	
18.		**count again . from zero =**	
19.		**= One, two, three, four:, five**	
20.		**Ok at the centre is five =**	
21.		**= and then until ten**	
22.		**So: from zero to ten we have .. TEN . divisions**	
23.		**Ok ..**	
24.		**you can also refer to your textbook**	
25.		**Tengok dalam buku, dia dah besarkan [[look in your book, they have enlarged it]]**	
26.		**It has been enlarged for you**	
27.		**How many millimetre are there in ONE centimetre?**	
28.		**How many millimetres? ↑**	
29.		**Berapa millimetre?** **[[How many millimetre?]]=**	
30.		**= Berapa millimetre dalam SATU centimetre?** **[[How many millimetre in ONE centimetre?]]**	
31.	Class	**Ten**	
32.	TR	**Ten**	

33.	**Ten millimetres in one: centimetre**	*TR points to 1cm=10mm on the board*
34.	**ok.**	

TR's drawing on the blackboard (during excerpt R:1:3)



TR uses the divisions on the ruler to mediate the relationship between centimetre and millimetre. To mediate what "divisions" mean, she draws on the board and uses the Bahasa Melayu term "sekatan" (line 9). The students also had the opportunity to learn that divisions, or "sekatan" in Bahasa Melayu, reveal the relationship between two units. To help them "see" the ten divisions on the ruler, she tells her students to count the number of divisions. Some students answer "ten" (line 24) and some answer "nine" (line 15). Realising that the divisions on the ruler are rather small and her own drawing on the blackboard not so clear, TR suggests that they have a look at the textbook (line 24). She repeats the suggestion in Bahasa Melayu as well (line 25). Figure 2 below shows what the textbook has to offer:



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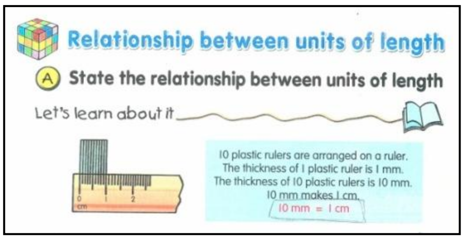

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Figure 2: Let's learn about it (Wan, Lee & Rabiyah, 2004a)

Obviously some students had counted the nine lines while some had counted the ten spaces in between the lines. It is clearly the textbook, especially page

130, that mediates the ten divisions as 10 millimetres as TR does not clarify the difference between nine lines and ten spaces for her students. She merely says, “Ten. Should be ten” (lines 16-17) and instructs them to “count again” (line 18) before asking them to refer to the textbook.

TR’s use of Bahasa Melayu increases from none in R:1:1 to a little in R:1:2, and to rather more in this R:1:3. Despite initially beginning in English and focusing on the ruler (lines 1-4), TR after only four lines, turns to Bahasa Melayu as she repeats her instruction in lines 2-4 and mediates the “seeing/discovering” of 10 millimetres. Even her instruction in R:1:2 to “look at your ruler” (lines 1, 29, 44) is switched to Bahasa Melayu in R:1:3, “tengok kejap awak punya pembaris [[look for a while, at your ruler]]” (line 5). TR code-switches because she takes into consideration her students’ needs and thus switches to Bahasa Melayu in this first lesson of the unit on “Length”.

However TR takes the trouble to translate the Bahasa Melayu she uses back to English. After mentioning, “dia dah besarkan [[they have enlarged it]]” (line 25), she repeats it in English, “It has been enlarged for you” (line 26). Usually she mediates the English she uses by translating it to Bahasa Melayu but in this instance she does the reverse especially to introduce the Bahasa Melayu term “besarkan” in English, “enlarged”.

TR is still using the one-way discursive practice. However, in R:1:3, she moves from the “teacher inform” to “teacher direct” at first and then to “teacher elicit”. This is the first time, she uses the questioning structure that seeks the relationship between two units in lines 27 & 30. She asks, “how many millimetres are there in one centimetre?” in both English and Bahasa Melayu. This question is important, not only to know the relationship between units, but also for conversion of units. By mediating this question and repeating it in both languages, TR helps them attend to it. And her repetition elicits a uniform answer “ten” (line 31) compared to earlier on (line 11) where her students responded, “ten” and “nine” (lines 14-15). TR repeats "ten" (line 32) and then expands her feedback, "ten millimetre in one centimetre" (line 33) while pointing to 1cm=10mm written on the board. TR's Lesson 1 ends soon after this excerpt.

TR begins her Lesson 2, in excerpt R:2:1 below, with the concept of short/long. While in R:1:1 TR linked "shorter/longer" with the relevant units "mm, cm/m, km" respectively, in this excerpt TR links the "short/long" concept with tangible objects such as the rulers (students'/teacher's) and teacher's table/students' textbook. Her questions also seem to shape her students' answers.

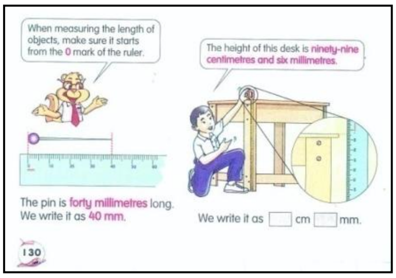
Excerpt R:2:1

No.	Speaker	Classroom Interaction	Observation
1.	TR	**Ok**	
2.		**one of the tools .. that can be used to measure length is: a ruler**	
3.		**Where is the ruler? =**	
4.		**= So usually as a student ..**	
5.		**you have ... the short ruler with you, isn't it?**	*TR picks up the short ruler from the student's table in the first row, in front of her*
6.	Class	**Yes**	
7.	TR	**Right**	
8.		**I also have .. a longer: ruler.**	*TR reaches for her long ruler from her table and holds it up in front of her*
9.		**It's called a one metre ruler**	
10.		**One metre =**	
11.		**= because the length of this ruler is↑ ..**	
12.	Class	**One metre**	
13.	TR	**ONE metre**	
14.		**Ok one metre ruler**	
15.		**So we use: the correct tools or the a suitable tools**	
16.		**to measure certain length of an objects.**	
17.		**ok**	
18.		**If I want to measure ..**	
19.		**the length of ..**	

20.		**this table …**	*TR points to her table.*
21.		**which one is more suitable?**	
22.		**The one metre ruler …**	*TR holds up the long ruler*
23.		**or the ruler that you have?**	*TR picks up a student's ruler*
24.	Class	**One metre ruler**	
25.	TR	**This one is more↑ .. suitable,**	*TR raises her long ruler slightly higher*
26.		**ok**	
27.		**If I want to measure ..**	
28.		**the thickness of …**	
29.		**the textbook =**	
30.		**= ok this is the thickness of the textbook ..**	*TR hold up the textbook and points out the thickness*
31.		**Ok, which ruler is more↑ suitable?**	
32.	Class	**My ruler**	
33.	TR	**The one metre ruler or this one?**	*TR holds up the long ruler and the short ruler*
34.	Class	**This one**	*Students holding up their short ruler*
35.	TR	**Ok,**	
36.		**the shorter ruler**	
37.		**right**	

In R:2:1, TR appears to complement her classroom talk with tangible objects instead of code-switching and the writing on the blackboard. She begins with identifying and distinguishing between the students' short ruler and teacher's long ruler (lines 4-14). To situate and reinforce this mathematical knowledge, she links it to the different objects to be measured – teacher's table and students' textbook (lines 15-37). By using the students' short ruler to measure the thickness of the textbook and her long/one-metre ruler to measure the length of the table, TR mediated for her students the mathematical concept of length. Besides that, by bringing to her students' attention to both the rulers, TR is enabling them to see how long one metre actually is. Holding out her long ruler and calling it the one-metre ruler, TR is making available, orally and visually, for her students the mathematical concept of one metre. Her students see for themselves that one metre (100cm) is much longer than their short ruler (which is only 15cm).

Although the textbook depicts short/long lengths, it is TR's talk in the classroom that mediates the words and the concept of "long" and "short". The Ministry mandated textbook, pages 130-131 (see Figure 3), shows a boy measuring the height of a desk using a measuring tape and a girl measuring the length of the Malaysian flag using the one-metre ruler. The task set at the end of page 131 reveals that the measuring task would require different tools to measure different objects. While tasks 1 and 2 could be answered using the students' short ruler, the long/one-metre ruler is required for question 3.



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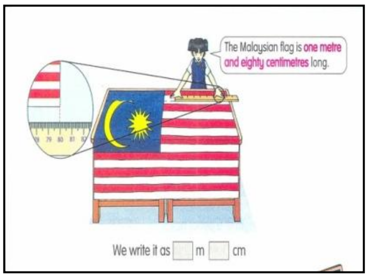

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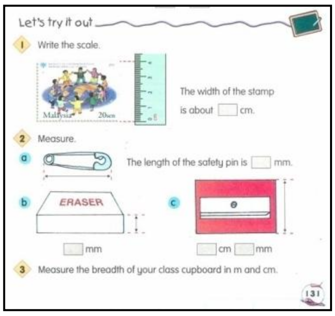

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Figure 3: Measuring lengths (Wan, Lee & Rabiyah, 2004a)

Her discursive practice of repeating "one metre" four times enables TR to create more opportunity for her students to attend to the mathematical concept of how long one metre actually is, both visually and orally. TR's students get to hear that her "longer ruler" (line 8) is actually "a one metre ruler" (lines 9, 10, 13, 14). It is through her discursive practice, specifically her repetition, that the length of the ruler is emphasised. TR refers to her ruler as "longer ruler" only once (line 8) but refers to it as "one metre" four times (lines 9, 10, 13, 14).

This excerpt also reveals insight into how TR's questions shape her students' responses. There are three instances (lines 10, 18 and 20) where her students respond to her questions. In line 10, her students pick on the clue from her question to answer. TR asks, "the *one metre ruler* or the ruler you have?" (lines 8 & 9). They answer, "*one metre ruler"* (line 10). When the students venture to answer differently such as in line 18, "My ruler" to TR's question, "Which ruler is more suitable?" (line 17) TR appears not to take up her students' answer. She rewords her question and in the process shapes her students' answer. TR prompts them with her question, "the one metre ruler or *this one*?" (line 19), they answer, "*this one*" (line 20), picking up the clue from TR's question.

Towards the end of Lesson 1, (see R:1:3), TR showed a heavy reliance on Bahasa Melayu to mediate mathematical knowledge. But in R:2:1, TR uses solely English. There is no evidence of code-switching.

4.2.3 Joint construction of mathematical content and mathematical English using ribbons

Having established the two basic relationships (1cm=10mm and 1m=100cm), TR further enhances the knowledge on "relationship between units" using her ribbon activity. TR divides the class into groups; there are five rows and the students in each row form a group. TR then passes each group a one-metre ruler. Then she passes each group a ribbon and instructs them to measure the ribbon either in centimetre or millimetre. The groups measure the assigned ribbon with the ruler. TR then goes around and writes the measurement on the ribbon using a marker pen. Then she gets her students to come forward with the ribbon (for example 30cm) while the other groups examine their ribbon to see if they have the same length (the other ribbon would be 300mm). The ribbons are held together and examined if they are of the same length and the relationship is then written on the blackboard. The next four excerpts (R:2:4 - R:2:7) highlight the mediating role these ribbons play in the joint construction of the "relationships between units" besides revisiting the concept of "same length" that was introduced in Lesson 1 (R:1:2). While the ribbons play an important mediating role, TR moves away from only using this physical object (R:2:4) to using both; ribbons and her questions to mediate (R:2:5) the mathematical content and mathematical English. Her questions play a bigger mediating role in R:2:6 and finally TR leaves out the ribbons altogether (R:2:7). This will be discussed after each of the four excerpts.

This ribbon activity is also important firstly because it involves more student participation in the joint construction of mathematical knowledge and secondly because TR's students come to the front of the class and participate in the activity. With the students physically entering the teacher's space, there seems to be more sharing of the discursive space among TR and her students. This particular insight will be discussed after the all the four excerpts and not after each excerpt to enable a better comparison and succinct discussion.

In excerpt R:2:4 below, TR re-visits the concept of "same length" she had introduced in R:1:2 as she jointly constructs with her students the 30cm=300mm relationship. The ribbons TR holds play an important mediating role from the beginning till the end of the excerpt. In this excerpt, TR invites her students to come to the front of the class, into her teacher space.

Excerpt R:2:4

No.	Speaker	Classroom Interaction	Observation
1.	TR	**Alright**	
2.		**Now boys and girls look here ….**	
3.		**Now I have two ribbons here with me**	
4.		**Ok**	
5.		**One: has been measured ..**	
6.		**and it is 30 centi . metre =**	

7.		**= ok Iris come here …**	
8.		**come in front**	
9.		**and hold this for the class to see ….**	*Iris comes to the front and holds the ribbon given to her by TR*
10.		**because =**	
11.		**= because you are good girl today …**	
12.		**30 centimetre**	
13.	Ad	**Teacher me**	
14.		**Teacher me**	
15.	TR	**Ok next one**	
16.		**Adriana**	*Adriana comes to the front and holds the other ribbon given to her by TR*
17.		**ok this one also has been measured =**	
18.		**= and: it is how many millimetre class? ↑**	
19.	Class	**300**	
20.	TR	**300 Ok**	
21.		**Are they the same? =**	
22.		**= do they have the same length?**	
23.	Class	**Yes**	
24.	TR	**Now compare …**	
25.		**Which one is longer?**	
26.		**30 centimetre or 300 millimetre is longer?**	
27.	Class	**The same**	
28.		**The same**	
29.	TR	**Ok Aisa,**	
30.		**what do you think?**	
31.	Class	**It's the same**	
32.	TR	**It's the same**	
33.		**Ok, let's see**	*TR takes the ribbon the two girls were holding.*
34.		**We'll hold both**	*TR holds both the ribbons together, one on top of the other.*
35.	Ind Ss	**No!**	
36.	Class	**Yesssssss ↑**	
37.	TR	**Ok another relationship here**	
38.		**that is: ……**	
39.	Class	**30 centimetre equal to**	
40.	TR	**30 centimetre is equal to 300 ..**	*TR writes 30cm = 300mm on*

		millimetre	*the board*
41.		**Alright?**	
42.	Class	**Yes**	
43.	TR	**Ok sit down**	
44.		**Thank you**	

After stating the measurement of both the ribbons, TR asks the class, "Are they the same? Do they have the same length?" (lines 21-22). Even though her students answer, "Yes" (line 23), TR changes the structure of the question while the content remains the same and asks the class, "Which one is longer? 30cm or 300mm is longer?"(lines 25-26). Then she goes on to ask an individual student, Aisa before making visible (by holding the two ribbons together) the similarity in length.

The ribbons in R:2:4 play a mediating role. TR's repeated questions elicits from her students that 30cm is the same as 300mm. Although the class as a whole and Aisa, individually have answered that the two ribbons, which means the two measurements, are the same, TR makes visible this fact. She holds both the ribbons together for the class to see. By doing that, TR mediates and makes tangible the relationships between the two units. In the next excerpt, it is TR's student and not TR holding the ribbon. TR now incorporates her questions besides using the ribbon as a mediating tool.

In excerpt R:2:5 below, TR re-visits the concept of "same length" she had introduced in R:1:2 as she jointly constructs with her students the 20cm=200mm relationship. Unlike R:2:4 where TR holds the ribbons and makes tangible the concept of "same length", in R:2:5 the students do it. TR moves from using only the ribbons to using her questioning strategy to mediate this mathematical content. She also literally "lets go" of the ribbons and this mediating tool is now in the hands of her students.

Excerpt R:2:5

No.	Speaker	Classroom Interaction	Observation
1.	TR	**Next one:**	*TR points to Aishah sitting in the first seat at the first row. Aishah stands up holding her ribbon.*
2.		**Alright, now, listen.**	
3.		**Faik↑ ... duduk [[sit]]**	
4.		**What is the length of your ribbon?**	*TR asks Aishah, now standing in front of her as she looks at the ribbon the girl holds up.*
5.	Ais	**20 centimetre**	
6.		**Now ...**	
7.		**who has the same: length of ribbon?**	
8.		**Which group have the same: length of ribbon .....**	
9.		**with Aishah**	
10.	Ind Ss	**How much is the ribbon?**	
11.	TR	**with Aishah =**	
12.		**= Aishah has a ribbon that .. measure 20 centimetre =**	
13.		**= which group?**	*Tali and her group raise their hands*
14.		**Ok Tali come here**	
15.	Tali		*Tali stands up at her desk*
16.	TR	**Hurry up Tali:**	
17.		**Adilah↑ move in front a bit**	
18.		**Ok ..**	
19.		**what is the measurement of your ribbon =**	
20.		**= Tali say out loud to the class**	
21.	Tali	**200 millimetre**	
22.	TR	**200 millimetre**	
23.		**Are they the same?**	
24.	Class	**Yes**	
25.	TR	**Ok, check**	*TR asks Tali and Aishah to check.*
26.		**Compare**	*The two girls turn to each other and hold out their ribbon against each other's ribbon.*
27.		**Need to make sure, isn't it?**	
28.	Ta & Ais	**Yes**	

29.	TR	**Yes: ok:**	
30.		**So another ..**	
31.		**how many centimetre? =**	
32.		**= 20 centimetre is equal to .. 200 milli↑metre**	*TR writes on the board 20cm=200mm below 30cm=300mm*

While in R:2:4, TR gave both the lengths first, that is 30cm and 300mm, before asking if they were the same (lines 21-22) or which one was longer (lines 25-26), in R:2:5 TR states one length first, "20cm" (line 5) and asks, "who has the same length of ribbon?" (line 7). TR's question cannot be answered with just a "Yes/No/It's the same" response as the students did in R:2:4. TR's students now have to think and check their ribbons to see if they have the correct ribbon. Tali and her group seated at their desk raise their hands. TR invites Tali to come to the front and hold her ribbon up. Compared to Adrianna in R:2:4 who merely holds up the ribbon TR passes to her, Tali has more contribution towards the joint construction of the 20cm=200mm relationship for she and her group first had to decide if their ribbon was the correct one before Tali raised her hand. TR gets Tali to state the measurement of her ribbon, "200mm" (line 21) and gets Tali and Aishah to hold the ribbons together and compare them (line 26) instead of doing so herself as she did in R:2:4. The sense making and joint construction of the relationship between units appears to change when TR changes the structure of her question/elicitation.

In R:2:5, TR is no longer holding any ribbon. It is Aishah, a student, who stands in front holding a ribbon 20cm long. TR does not identify the ribbon she is looking for, that is the ribbon that measures 200cm as she did in R:2:4. But her questions (lines 5-9) mediate the task for her students. TR slowly changes her mediating tool, from using solely the ribbon to using questions to mediate the relationship between 20cm and 200millimetre. However she does not quickly remove the mediating tool – she makes Aishah and Tali check by comparing the two ribbons.

In excerpt R:2:6 below, TR re-visits the concept of "same length" she had introduced in R:1:2 as she jointly constructs with her students the 10cm=100mm relationship. TR's ribbons now play a lesser mediating role and her questions play a bigger mediating role.

Excerpt R:2:6

No.	**Speaker**	**Classroom Interaction**	**Observation**
1.	TR	**Alright**	
2.		**Hafiz group,**	
3.		**where's your ribbon?**	
4.	Ha	**Here**	
5.	TR	**Come**	
6.		**Ok: ..**	
7.		**What is the length of your ribbon?**	*TR asks Hafiz who is now standing in front of her.*
8.	Ha	**100 millimetre**	
9.	TR	**So: who ..**	
10.		**who has the same length …**	
11.		**as … Hafiz's ribbon? =**	
12.		**= 100 milli . metre? ↑ …**	
13.		**who knows =**	
14.		**= 100 millimetre is the same as how many centimetre?**	
15.	Class	**ten**	
16.	TR	**ten centimetre ribbon**	
17.		**Ok**	
18.		**Siapa ada [[Who has?]] ..**	*TR takes the ribbon from Hafiz and holds it up*
19.		**Who got ten centimetre ribbon?**	
20.	Ind Ss	**Me** **m e** **me**	
21.	TR	**Where?**	
22.		**Huh! Denda! [[punishment!]]**	*TR takes the ribbon another girl hands to her and holds both them on top of each other.*
23.		**Siapa hilangkan angka huh ? [[who rubbed off the measurement huh?]]**	
24.		**Alright**	
25.		**ten centimetre is also equal to ..**	
26.	Class	**One <u>hundred</u>**	
27.	TR	**<u>One</u> hundred milli↑metre**	
28.		**Ok**	*TR writes on the board 10cm=100mm above 30cm=300mm.*

In R:2:6 both TR and her students state together the jointly constructed 10cm=100mm relationship; "10cm is equal to…" (TR in line 25) her class responds in line 26, "one hundred" and TR completes it "one hundred millimetre" (line 27). In R:2:4, as the students were stating the relationship "30cm equal to" (line 39), TR interrupted and completed the statement, "30cm is equal to 300mm" (line 40). In R:2:5, TR made the statement herself, "20cm is equal to 200mm" (line 32). But in R:2:6, both she and her students make the statement together (line 25-27).

TR's questions changes in R:2:6. She asks Hafiz, "What is the length of your ribbon?" (line 7) then turns to the class and asks, "Who has the same length as Hafiz's ribbon, 100 millimetre?" (line 10-11) This is the kind of structure she has been using in the ribbon activity. Then she modifies her question to "who knows 100 millimetre is the same as how many centimetres?" (line 13-14). Her question now is not directed to the specific group that holds the other ribbon, but encompasses the whole class. The class responds, "ten" (line 15). TR modifies her question again, "Who got ten centimetre ribbon?" (line 19) and even before the 10cm ribbon is brought to the front, TR very quickly takes the 100mm ribbon from Hafiz who is standing in front of the class and the 10cm ribbon from the group who is still seated at their desks, holds them up and writes the relationship on the board. TR's ribbons seem to play a lesser mediational role and her questions play a bigger mediating role.

In excerpt R:2:7 below, TR re-visits the concept of "same length" she had introduced in R:1:2 and in this ribbon activity as she jointly constructs with her students the 5cm=50mm relationship. But she no longer refers to the ribbons.

Excerpt R:2:7

No.	Speaker	Classroom Interaction	Observation
1.	TR	**Ok**	
2.		**who has five ..aaa.. centimetre?**	
3.		**Ok =**	
4.		**= five centimetre ribbon?**	
5.		**so five centimetre is equal to how↑many millimetre? =**	
6.		**= who knows?**	
7.	Class	**50 millimetre**	
8.	TR	**Five centimetre is equal to .. 50 milli.metre right?**	TR writes on the board 5cm=50mm above 10cm=100mm.
9.	Class	**Yes**	
10.	TR	**Ok**	
11.		**Any question? ↑**	
12.		**Mark?**	
13.		**Faiz ok?**	

In R:2:7, TR's question is more direct, "who has five centimetre ribbon?" (lines 2-4). As the student passes her the ribbon, TR asks, "So 5cm is equal to how many millimetre?" (line 5). This elicitation structure is the same structure TR uses in R:2:6, "100mm is the same as how many centimetre?" (line 14). Her students respond, "50mm" (line 7) and TR goes on to state the relationship (line 8) but adds a tag behind, "right?"(line 8). With the tag, "right?", TR appears to include and acknowledge her students in the joint construction of the relationship between 5cm and 50mm and not solely occupy the role of constructing the knowledge as she did in R:1:1. The mediating tool, the ribbon, is entirely left out although TR asks, "who has five centimetre ribbon?" It is not even held together to be checked if they are of same length.

Despite making available to her students the complete way of answering questions that require measurement, TR's students seem to omit the unit when they answer. It seems as though they have not attended to it despite it being made available. Every time her students answer as a class, they only seem to give the numerical value and TR repeats their answer with the unit. For example the students answer, "ten" and TR repeats their answer but expands it, "ten millimetre" (R:1:3, line 33), "ten centimetre" (R:2:6, line 16). However, there are instances where the complete answer is given, for example "100 millimetre" (line 8, R:2:6). This appeared when the question was directed to individual student. However, TR's students seem to have finally attended to TR's practice of answering with the unit in R:2:7 (line 7). They answer, not just "50", but complete with the unit, "50mm".

4.2.3.1 Ribbons and the discursive space

In the above four excerpts related to the ribbon activity (R:2:4 – R:2:7), TR invites her students to the front of the class. Her students not only enter physically into the teacher's space, but also seem to share the discursive space with TR as both teacher and students jointly construct mathematical knowledge. In the beginning of R:2:4, TR holds the discursive space longer when she is in the "teacher inform" mode. However she shares the floor when she calls Iris and Adriana forward. With the students physically sharing the teacher space in front of the class, TR seems to relinquish the "teacher inform" mode and adopt the "teacher elicit" mode. When she does that, there appears to be more student participation. In her attempt to mediate the fact that 30cm is equal to 300mm, TR immediately rephrases her questions to make it clearer for her student: "Are they the same?" (line 21) and immediately after that in line 22, she asks, "Do they have the same length?" Another instance where she does the same is found in line 25, TR asks, "Which one is longer?" and in the next line, "30cm or 300mm is longer?" (line 26). With her "teacher inform and elicit" discursive practices, TR enables her students to attend to the mathematical knowledge.

Again in the beginning of the R:2:5, TR seems to hold longer the discursive space despite Aishah sharing the front of the classroom with her. So far, the students have only responded to TR's elicitation. And now a student in her class asks, “How much is the ribbon?” (line 10). TR responds to the student’s question. There is more student participation where one asks question and another two holding the two ribbons together to check instead of TR checking as she did in R:2:4. TR seems to slowly relinquish her “teacher inform” discursive practice of transmitting knowledge and adopt a practice that enables her students to jointly construct the mathematical knowledge.

In R:2:6 TR once again shares the discursive space with her students. She invites Hafiz to the front, elicits the length from him and poses the question to the class. She asks, “who has the same length as Hafiz’s ribbon?” (line 10-11) and “who knows 100mm is the same as how many centimetre?” (line 14). TR seems to have abandoned her “teacher inform” discursive practice and is using, in this excerpt, “teacher elicit”. With the “teacher elicit” practice, TR is passing to her students the responsibility to jointly construct the mathematical knowledge. When TR tries to take on the “teacher inform” discursive practice to state the 10cm=100mm relationship, she is not “allowed” to by her students who join in, as they now share the discursive turn and space by stating the relationship (lines 25-27). TR merely repeats their answer.

In R:2:7, despite the short interaction, TR acknowledges the shared discursive space when she asks, “5cm is equal to 50mm, right?” (line 8). The tag, “right” reveals that TR has abandoned her “teacher inform” practice and now shares the knowledge constructing role with her students as they jointly construct the 5cm=50mm relationship.

In short, TR has so far told her students the 1cm=10mm relationship between units (see section 4.2.1). Then TR consolidates the 1cm=10mm relationship between units with some examples; measuring the thickness of the book and the length of the table (see section 4.2.2). Using the ribbons, TR jointly constructs four other relationships between units beginning with her ribbons and later moving on to her questioning strategy (see section 4.2.3).

Using the four jointly constructed relationships between units from the ribbon activity, TR now jointly constructs the conversion formula. This will be discussed in the following section 4.2.4.

4.2.4 Joint construction of the conversion formula

In the next two excerpts (R:2:8 - R:2:9) in this section, TR jointly constructs the conversion formula with her students while drawing on the knowledge on relationship between units she and her students had jointly constructed through her ruler activity (section 4.2.2) and ribbon activity (section 4.2.3).

Writing on the blackboard (during ribbon activity, excerpts R:2:4-R:2:7)

1 m = 100 cm	5 cm = 50 mm
$\boxed{\text{1 cm = 10 mm}}$	10 cm = 100 mm
	30 cm = 300 mm
	20 cm = 200 mm

In excerpt R:2:8, TR draws on the relationships she had jointly constructed with her students during the ribbon activity, 1cm=10mm (from the ruler activity, in the box on the blackboard) and 5cm=50mm (from the ribbon activity, at the right end of the blackboard) to jointly derive the conversion formula for centimetre to millimetre. Above is the writing on the blackboard as TR begins her teaching in R:2:8:

Excerpt R:2:8

No.	Speaker	Classroom Interaction	Observation
1.	TR	**alright**	
2.		**now as you can see here**	
3.		**boys and girls ...**	
4.	Ind Ss	**Boys and girls**	
5.	TR	**Ok .... so these are the relationship**	
6.		**ok**	

7.		**that you can build up ..**	
8.		**but the most important thing is =**	*TR points to the notes she has written on the board, 1m=100cm and 1cm=10mm*
9.		**= you just remember one ...**	*TR draws a box around 1cm=10mm*
10.		**One centimetre is equal to ten millimetre**	
11.		**So from there we can convert ..**	
12.		**Ok to any ....**	
13.		**to any .. measurement that is expected =**	
14.		**= ok, centimetre to milli↑metre**	
15.		**Now let's look ...**	
16.		**One centimetre is equal to ten millimetre**	*TR writes 1cm=10mm in the middle of the board*
17.		**Without doing any measurement or without using your ruler ↑**	
18.	Class	**ya**	
19.	TR	**Ok,**	*TR peeps at the relationships she had written from the Ribbon Activity, on the right side of the blackboard*
20.		**five centimetre is equal to how many millimetres?**	*TR writes on the board 5cm=__mm*
21.	Ind Ss	**50**	
22.	Class	**50**	
23.	TR	**How do you get the 50?**	
24.	Class	**[incoherent]**	
25.	TR	**No you cannot say to add zero.**	
26.		**What is the ..aaa.. operation that we can use?**	
27.		**Can you please keep all that**	*in softer tones*
28.		**before I take it away**	*in softer tones*
29.		**Ok, five centimetre is equal to .. how many millimetres just now you said? ↑**	
30.	Class	**50**	
31.	TR	**Ok, Betul [[Right]]**	
32.		**Ya [[Yes]] Correct**	*TR fills in the blank, 5cm=50mm*
33.		**But how do you get 50?**	
34.	As	**Because one centimetre is ten millimetre.**	

35.	TR	**Yes, Aswa ..**	
36.		**one centimetre is equal to ten millimetre**	
37.		**So five centimetre …**	
38.		**five times by ↑**	*TR writes 5 x 10 below 5cm=50mm*
39.	Class	**ten**	
40.	TR	**Ok .. this one ..**	*TR underlines x 10, 5 <u>x 10</u>*
41.		**because the relationship here**	
42.		**one centimetre equal to ten millimetre**	
43.		**So whenever you want to convert from: centimetre to millimetre ..**	
44.		**you multiply by ↑**	*TR draws a box around <u>x 10</u>,* $\boxed{\text{X 10}}$
45.	Class	**ten**	
46.	TR	**Ok, you multiply by ↑**	
47.		**ten**	
48.	Class	**Ten**	
49.	TR	**ok**	

Writing on the blackboard (during excerpts R:2:8 – R:2:9)

1 cm = 10 mm 5 cm = <u>50</u> mm 5 $\boxed{\underline{\text{x 10}}}$ 6 cm = 6 <u>x 10</u> mm = 60 mm	1 m = 100 cm $\boxed{\text{1 cm = 10 mm}}$	5 cm = 50 mm 10 cm = 100 mm 30 cm = 300 mm 20 cm = 200 mm

It must be noted that in R:1:2, TR had briefly introduced the conversion method, but the emphasis in that particular excerpt was on making her students see if 15cm was the same as 150mm and deriving from it the 1cm=10mm relationship. In R:1:2, TR does not make summary statement as she does in R:2:8, "when you want to convert from centimetre to millimetre, you multiply by ten" (lines 43-45).

In R:2:8 TR connects her earlier two activities (using rulers and ribbons) and the relationships she had jointly constructed to jointly construct new knowledge – the conversion formula. The relationship 5cm=50mm TR and her students had jointly constructed during the ribbon activity now becomes a tool for the joint construction of the conversion formula. This conversion formula which TR jointly constructs with her students is not in the Ministry mandated textbook.

The way TR positions her writing on the board also plays an important mediating role. Even though the relationship 1cm=10mm is on the board in a box, with an extra box drawn around it, TR writes it once more in the centre of the board. Just below it she writes her question "5cm =__mm". By positioning her question right below the 1cm=10mm, TR's writing helps her students make an "informed guess" that the conversion formula is "x10".

TR begins by stating the "most important" (line 8) one they have to "just remember" (line 9) is "one centimetre is ten millimetre" (line 10). She then gets them to deduce from the given example (5cm=50mm) how to arrive at the 50cm answer. TR appears to actively involve her students with her prompts. When she asks them, "Five centimetre is equal to how many millimetres?" (line 20) they may have replied "add zero" because TR says, "No, you cannot say to add zero." (line 25). TR did not provide them the answer, but instead continues to prompt, "What is the operation that we can use?" (line 26). Aswa repeats TR's earlier reminder (lines 8-10) about the most important relationship they have to remember, "Because one centimetre is ten millimetre" (line 34). TR acknowledges Aswa's answer and provides them, not the answer, but more prompts, "So five centimetre…. Five times by ↑ ?" (line 38) to which her students' reply, "ten" (line 39) indicating that her discursive practice of prompting and asking for justification help her students jointly construct the conversion formula. After jointly constructing the formula, TR repeats it twice (lines 44-48). But even as she repeats it, she does not state the formula but elicits it from her students, "you multiply by" (lines 44, 46) and her students reply, “ten” (lines 45, 47). It is TR’s classroom talk and repetition that mediates this formula for the students as this jointly constructed method of conversion is not available in the textbook. Although it is available in the school chosen supplementary book, throughout the unit on “Length”, TR never once used or referred to the school chosen supplementary book.

Having jointly constructed the conversion formula, TR tests the conversion formula with her students in R:2:9. While the joint construction of the conversion formula was a lengthier process, the testing of the already jointly constructed conversion formula was a much shorter process. In this excerpt TR gives her students the opportunity to attend to the newly derived conversion formula and “test” this derived formula together to see if it can be used.

Excerpt R:2:9

No.	Speaker	Classroom Interaction	Observation
1.	TR	**Ok**	
2.		**six centimetre will be↑ how many millimetres? ↑**	
3.	Ind Ss	**600**	
4.	Class	**60**	
5.	TR	**60**	
6.		**60, isn’t it?**	
7.		**Six times by ↑**	
8.	Class	**Ten**	
9.	TR	**Ok , you’ll get 60 mili↑**	
10.	Class	**metre**	
11.	TR	**and so on …**	
12.		**Alright …**	
13.		**Ok =**	
14.		**= Any question before I proceed**	
15.	Class	**No**	

The conversion formula on the blackboard now becomes the mediational tool. In R:2:8, TR had written the conversion formula, “x10”, and she mentions it thrice (lines 38, 44, 46) and underlines it (line 40) and draws a box around it (line 44). Her students seem to have attended to all three mediational means when TR gives them another example in R:2:9, 6cm=__mm, they draw upon the already mediated conversion formula and immediately call out the answer. They do so without much prompting or direction from the teacher.

TR appears to confirm the conversion formula (line 6) with her students with the use of the tag, “isn’t it?”. The conversion formula has once again been made available when TR checks, “six times by?” (line 7) and her students reply, “ten” (line 8). But her students answering, “60” (line 4) even before the operation/method is requested indicates they have attended to the jointly constructed conversion formula.

Compared to R:2:8, in R:2:9 both TR and her students solve the conversion of 6cm to 60mm rather fast. Having mediated the process in R:2:8, TR and her students draw on the shared knowledge to find the solution in a shorter time. There is no seeking any elaboration or justification for why it must be multiplied by 10 and no stating the basic relationship, 1cm=10mm. However the writing on the blackboard plays a mediating role. Because this question is a follow up to the earlier steps, the “relationship between units” and “conversion formula” are still on the board. Having done the conversion of 5cm, this second time with 6cm was much faster.

In excerpt R:2:10 below, we see TR jointly constructing with her learners the conversion formula from millimetre to centimetre using 30mm= __cm from the ribbon activity.

Writing on the blackboard (during excerpt R:2:10 - R:2:11)

		5 cm = 50 mm
1 cm = 10 mm	30mm = 3cm	10 cm = 100 mm
5 cm = 50 mm	30 $\boxed{\div 10}$	30 cm = 300 mm
$\boxed{\text{X 10}}$		20 cm = 200 mm
6 cm = 6 x 10 mm	50mm = 5 cm	
= 60 mm	50 ÷ 10	

Excerpt R:2:10

No.	Speaker	Classroom Interaction	Observation
1.	**TR**	**What about if: …**	
2.		**you measured something in centimetre**	
3.		**ok**	
4.		**but you have to give the answer in: millimetre**	
5.	**Ind Ss**	**convert**	
6.	**TR**	**ok**	
7.		**you still use the .. relationship**	
8.		**that is one centimetre equals to↑ ten millimetre**	
9.		**Ok but now …**	
10.		**just now =**	
11.		**= alright let me see**	
12.		**300 millimetre** [TR writes 300mm on the board]	
13.		**ok I use the simple one first**	
14.		**30 millimetre .. equals to how many centimetre?** [TR changes 300mm to 30mm]	
15.	**C**	**three**	
16.		**three centimetre**	
17.	**TR**	**Yes we know that it is three**	
18.		**but how do you get three?**	
19.	**C**	[incoherent]	
20.	**TR**	**30 divide by↑**	
21.	**C**	**ten**	
22.	**TR**	**Ok, so 300 divide by** [TR writes on the board 300÷10 and draws a box around ÷10]	
23.	**C**	**ten**	
24.	**TR**	**Ok divide by ten you'll get**	
25.	**C**	**30**	
26.	**TR**	**sorry 30** [TR rubs off one of the zero at 300÷10, making it 30÷10]	
27.	**C**	**three**	
28.	**TR**	**Ok three** [TR fills in the blank, 30mm=<u>3</u>cm]	
29.		**three centimetre ..**	
30.		**ok**	

TR asks, "thirty centimetre equals to how many centimetre?" (line 14). This is the same structure TR used in R:2:8, "five centimetre is equal to how many millimetres?" (line 20). And just like in R:2:8 (line 22), TR learners responded with the correct answer, “three centimetre” (line 15-16). And again just like in R:2:8 (line 33), TR asks, “how do you get three?” (line 18). With her questions, just like she did in R:2:8, TR helps her learners derive the conversion formula from millimetre to centimetre, divide by ten. This conversion formula from millimetre to centimetre is not evident in the school mandated textbook. Thus, it is TR’s talk that helps her learners jointly construct this formula. However unlike R:2:8, TR does not summarise the conversion formula after she had co-constructed it. In R:2:8, TR summarised, “So whenever you want to convert from centimetre to millimetre, you multiply by↑ ten” (lines 43-45).

It looks like the previous conversion task, centimetre to millimetre (x10), has helped mediate the present conversion task, millimetre to centimetre (÷10). TR writes on the board, 30mm=__cm. If we look at the board, we notice that the conversion task that is on the board, from R:2:8 and R:2:9, is from centimetre to millimetre and the method TR had highlighted by drawing a box around it is “x 10”. When students see the board in R:2:10, they now see that the conversion task (30mm=__cm) is just the opposite, because it is from millimetre to centimetre. From the units in this question, they know that they cannot use “multiplication” and make an informed decision to “divide”. Even though they did not mention verbally “divide”, their answer, “three centimetre” (line 16) shows that they did mentally. It was, thus, made available by omission.

Although her learners have given the right answer, TR still wants them to explain and justify. She is still interested in the “how”. Just like in R:2:8, TR asks them to justify their answer with her question, “how do you get three?” (line 18) and her rising intonation, “30 divide by ↑” (line 20). Her discursive practice of pushing her learners to explain and justify is very important for the acquisition of mathematical skill. With her question and rising intonation, TR models for her learners an important mathematical skill – give reason/justify answer.

The learners seem to have attended to answering in full form that is with the units. Instead of just stopping at "three", they go on to repeat their answer in full form, "three centimetre".

In excerpt R:2:11 below, having derived the conversion formula from millimetre to centimetre, TR tries it out with her students using one of the examples she derived from the ribbon activity, 50mm=__cm.

Excerpt R:2:11

No.	Speaker	Classroom Interaction	Observation
1.	**TR**	**50 millimetre?**	
2.	**C**	**Divide by ten**	
3.	**TR**	**equals to how many centimetre?**	
4.	**C**	**five**	
5.	**TR**	**divide by ↑**	
6.	**C**	**Five**	
7.		**Five**	
8.		**five**	
9.	**TR**	**So ... another tip for you is**	
10.		**to convert millimetre to centimetre**	
11.		**we divide by ↑**	
12.	**C**	**ten**	
13.	**TR**	**divide by**	
14.	**C**	**ten**	
15.	**TR**	**ten**	
16.		**alright**	

Just like in R:2:9, TR sets to "test" the newly co-constructed conversion formula with her learners. A look at the excerpt reveals that even though TR initiates the interaction, it is clearly controlled by the learners. Only as TR summarises the conversion formula does she have a bit more control where she initiated the turn and her learners complete it, "to convert millimetre to centimetre, we divide by↑" (line 10-11), "ten" (line 12).

The sample on the board (30mm=3cm) and conversion operation in a box, $\boxed{\div 10}$ play a big mediating role. Just like the testing out of the conversion formula in R:2:9, this one, R:2:11 is also much shorter than the joint construction of the conversion formula (R:2:8 and R:2:10). This is because, besides teacher talk, the writing on blackboard – sample question, underlines as well as the boxes – plays important mediating roles.

The learners seem to have attended to the conversion formula so TR's discursive practice is rather short or minimal in R:2:11. Even before TR could end her question (line 3), they were already calling out the method, "divide by ten" and just as she finishes the question (line 3), they called out the answer, "five" (line 4). Even when TR requests the conversion method (line 5) her learners seem to ignore her and confidently keep calling out the answer (lines 6-8).

TR then summarises (lines 9-15) the conversion formula from millimetre to centimetre. TR's learners seem to have attended to the basic 1cm=10mm relationship because TR does not seem to request it. With her learners answering "divide by ten" (line 2) even before TR prompts them indicates that the 1cm=10mm relationship has successfully been mediated.

Although TR is summarising the conversion formula because her learners have already given the correct answer for her conversion task, she does so, jointly, with her learners asking, "divide by" and her learners reply, "ten". TR has also discarded the 'teacher inform' role and shares the discourse space with her learners in the joint construction of the conversion formula.

4.2.5 Student trying out the conversion formula

Having quite closely guided her students from discovering the relationships and deriving the conversion formula, in the next two excerpts TR removes her close guidance as she gets her students to try out the conversion of units. She calls two students, Arissa (R:2:12) and Faiz (R:2:13) to try out the formula they and their classmates have jointly constructed with her. While Arissa does the conversion using long division, she whispers to her teacher that she knows another method as she returns to her seat. When Faiz comes to solve the conversion task and begins to do so using the long method, TR stops him and gets him to use the "jumping method" (see section 4.7.2.4).

In excerpt R:2:12 below, TR nominates a student, Arissa, to do a conversion task. Arissa comes forward and does the conversion task using the long division method in the first column of the blackboard. While Arissa is doing the working on the blackboard, TR carries on her teacher talk, sometimes addressing Arissa and other times directing her talk to the class.

Excerpt R:2:12

No.	**Speaker**	**Classroom Interaction**	**Observation**
1.	TR	**Right ..**	
2.		**who knows another way ..**	
3.		**to convert↑ millimetre to centimetre =**	
4.		**= without doing all: these steps?**	
5.	Ind Ss	**Divide**	
6.	TR	**I have one, two**	
7.	Ind Ss	**Divide**	
8.	TR	**<u>three</u>**	
9.	Class	**<u>Divide:</u>**	
10.	TR	**Alright**	
11.		**Arissa**	
12.		**Ok =**	
13.		**= come in front ....**	
14.		**I know you all smart student↑ ....**	
15.		**but sometimes quite naughty ...**	
16.		**Ok now =**	
17.		**= how you're going to do it? =**	
18.		**= One hundred millimetre↓ ....**	*TR says 100mm but writes on the board 110mm*
19.		**ok**	
20.		**you have to convert it into centimetre =**	
21.		**= I just taught you just now, isn't it? ↑**	

22.		**how to do it?**	
23.		**How are you going to do?**	
24.		**Millimetre to centimetre**	
25.		**what must we do?**	
26.		**divide or: multiply?**	
27.	Class		*silence*
28.	TR	**Huh? Class?**	
29.	Ind Ss	**Divide**	
30.	TR	**You only use**	
31.		**use two operation**	
32.	Ind Ss	**Divide**	*faintly*
33.	TR	**division or: multiplication?**	
34.	Ind ss	**Division**	
35.	Class	**Divide**	
36.	TR	**So you divide by? ↑ ...**	
37.	Class		*silence*
38.	TR	**By?↑**	
39.	Class	**ten**	
40.	TR	**Yes:**	
41.		**You must go back to the basic: ...**	
42.		**1 c-m is equal to 10 m-m ...**	
43.		**Ok ..**	
44.		**the basic here**	
45.		**We use the basic here**	
46.	Ar		*student completes the working on the board using the long method of division*
47.	TR	**Very: good**	
48.		**Ok give a clap to Arissa**	
49.	Class		*Students clap. As Arissa returns to her desk, she whispers something to her teacher.*
50.	TR	**Ok**	
51.		**Arissa say she has another way of doing it.**	
52.		**The first way**	
53.		**we do =**	
54.		**= we use↑**	
55.		**addition ..**	
56.		**Ok ...**	
57.		**the second .. method is**	
58.		**by use =**	
59.		**= by using ↑**	
60.	Class	**Divide**	

61.	TR	**<u>Division</u>**
62.		**divide**
63.		**100 millimetre divide by 10**
64.		**Why↑ you divide by 10? =**
65.		**= You go back to the basic relationship**
66.	Class	**1 c-m equal 10 m-m**
67.	TR	**Yes**
68.		**I can hear you very clearly**
69.		**One centimetre is equal to TEN millimetre**
70.		**Ok**
71.		**when you want to CHANGE from millimetre to centimetre**
72.		**we divide↑ .. by ten**
73.		**TETAP bahagi sepuluh [[CONSTANTLY divide by ten]]**
74.		**Aswa faham? [[understand?]]**
75.	As	**Faham [[understand]]**

Writing on the blackboard (during excerpt R:2:12)

110mm = <u>11</u> cm 11 10 ⟌ 110 mm <u>10</u> 10 <u>10</u>	<u>110</u>mm = ___cm 110mm = 100mm + 10mm = 10 cm + 1 cm = <u>11 cm</u>	1cm = 10 mm

The only tool available at this juncture is the “basic relationship” that is written in a box at the right corner of the blackboard. All Arissa and the rest of the class know from this “basic relationship” is that they either have to multiply or divide by ten. The writing on the board did *not* play a mediating role for which operation they were to use to do the conversion task. It was all the jointly constructed and shared knowledge (as shown in the earlier excerpts) as well as TR’s classroom talk that played the mediating role for Arissa and the rest of the class.

While Arissa is solving the conversion task on the board, TR addresses the class. When she asks the class (lines 17-26) they remain silent. TR has been trying to involve her students, through talk, in the sense making process while Arissa is engaged in the same process but in writing as she does the long division on the board. It is TR's talk here that keeps the rest of the class involved in the mathematical knowledge while Arissa is doing the task on the board.

In R:2:12, TR uses "teacher elicit" and "teacher direct" discursive practices and not so much "teacher inform". She prompts them, "huh? Class?" (line 28) and refrains from giving them the answer (line 30 & 31) until they respond. An individual student replies, "divide" and the class also replies, "divide" (line 35). TR prompts them further, "So you divide by ↑" (line 36 & 38) till she gets a response, "ten" (line 39). Using raised intonation (lines 36 & 38, 59) and asking them to justify (line 64), TR gets her students to respond. It is her discursive practice that ensures that her students participate. In this excerpt, TR uses the term "change" (line 71) besides the term "convert". This is the first time TR has used ordinary, everyday language, "change" to replace the mathematical term, "convert". With an increased volume, "CHANGE" TR brings to their attention this common language.

TR code-switches, but only at the end, "tetap bahagi sepuluh [[constantly divide by ten]]" (line 73) to reinforce that "when you want to change from millimetre to centimetre, we divide by ten" (lines 71-72). She seems to use Bahasa Melayu to reinforce her point.

In excerpt R:2:13 below, TR introduces for the first time her "jumping method" (see section 4.7.2.4) of conversion after Arissa had hinted (in R:2:12, lines 49-51) she knows another way besides the long division method to do the conversion task.

Excerpt R:2:13

No.	Speaker	Classroom Interaction	Observation
1.	TR	**…aaa… Faiz ……..**	
2.		**ok**	
3.		**Faiz will show us how to use multiplication↑ .. in changing**	
4.	Fa		*Faiz walks up to the board*
5.	TR	**Seven ..**	
6.		**just write down**	
7.		**= 7.5 …….. times by ten:**	
8.	Fa		*Faiz writes down 7.5 and below it x10. Then he draws a line across, indicating he is going to multiply using the longer version.*
9.	TR	**Do you want the longer version or the shorter version?**	
10.	Class	**Longer version**	
11.	TR	**Short one-lah**	*TR rubs off what Faiz had written on the board*
12.		**7.5**	
13.		**write down 7.5 ……**	
14.		**point five =**	
15.		**= times by**	
16.		**no no**	*Faiz was going to write x10 below 7.5 again*
17.		**Just beside**	
18.		**times by 10**	
19.		**ok.**	
20.		**Hey: I've taught you how to use this, isn't it?↑**	
21.	Class	**Yes**	
22.	TR	**How to**	
23.		**just jump: ..**	
24.		**Jump ..**	
25.		**or bring forward the decimal point ..**	
26.		**When you multiply by ten↑**	
27.		**10 has one: zero, isn't it? ↑**	
28.		**So you bring .. jump *only* once ..**	
29.		**ok**	
30.		**So this one becomes seventy .. five**	
31.		**ok**	
32.		**Aaa… dah lupa dah** **[[you have forgotten already]]**	

33.		**you forgot already**
34.	Class	**No**
35.	TR	**Ok**
36.		**If I multiply by *one hundred***
37.		**how many times must I jump or bring the decimal point:**
38.	Class	**Two?**
39.	TR	**Two**
40.		**Ok**

Writing on the blackboard (during excerpt R:2:13)

7.5 cm = 75 mm	7.5 cm = ___ mm	$\boxed{\text{1cm = 10 mm}}$
	= 7 cm + 0.5 cm	
7.5 x 10 = 75	= 70 mm + 5 mm	
	= 75 mm	

The only tool available at this juncture, as in R:2:12, is the "basic relationship" that is written in a box at the right corner of the blackboard. Just as in R:2:12, all Faiz and the rest of the class know from this "basic relationship" is that they either have to multiply or divide by ten. The writing on the board did *not* play a mediating role for which operation they were to use.

Faiz seems to have forgotten how to convert using the "jumping method". Although Faiz had forgotten, TR does not take over and demonstrate on the board the "jumping method". In fact she talks Faiz through the steps (lines 12-18 and 23-28). It is TR's talk that helped mediate the "jumping method" for Faiz and the rest of the class. There is no mention of the "jumping method" in the Ministry mandated textbook and only a small glimpse of it in one of TR's school chosen supplementary book. Although TR had taught them the "jumping method" in an earlier topic on "Decimals", it has not been introduced to them in this unit on "Length". *Nothing* on the board mediated this "jumping method" of conversion. It is TR's talk that enables her students to (re)learn this "jumping method".

TR stands beside Faiz and directs him as he writes on the board. She does not write for him but guides him with her talk, “just beside”. She indicates the direction the decimal point should “move”, “jump or bring forward the decimal point”. She also mediates why it should “jump only once” because “ten has one zero”. Her discursive practice in this excerpt is more of “teacher direct”. She also provides the necessary linguistic prompts, “bring forward” and “jump only once” (see section 4.5 regarding the issue of “moving” the decimal point).

<u>4.2.6 TR summing up “relationship between units” and “conversion of units”</u>

In excerpts R:2:14 and R:2:15 below, TR sums up the second learning objective from the curriculum specifications: “relationship between units” and “conversion of units”. The summary in R:2:14 is after TR had given some homework for her class to do. She walks around checking her students’ work and then walks over to the board and does a quick summary. After the summary in R:2:14, her students continue their work and TR moves around checking her students’ work. The summary in R:2:15 is just before this Lesson 2 ends.

Excerpt R:2:14

No.	**Speaker**	**Classroom Interaction**	**Observation**
1.	TR	**Right**	
2.		**take this down**	*TR has written on the board 1cm=10mm, with the arrows moving to the right and left,*
3.		**so that you can remember**	
4.		**Ok, one centimetre is equal to TEN millimetre: ↑**	
5.		**Ok: …**	
6.		**if you want to change centimetre to millimetre**	
7.		**you multiply by ten ……**	*TR points at the board using her long ruler*
8.		**Ok =**	
9.		**= and if you want to change:**	

		millimetre into centimetre	
10.		**you divide by ten**	*TR points at the board using her long ruler*
11.		**Ok**	
12.		**the other relationship is meter and: …. centimetre**	
13.		**At the beginning of the lesson =**	
14.		**= class**	
15.		**dengar sini semua [[listen here everyone]]**	
16.		**Tadi [[Just now]] at the beginning of the lesson**	
17.		**cikgu tunjuk ini-kan [[teacher showed you this – right?]]**	*TR moves to the centre of the class and holds the long ruler horizontally at both ends*
18.		**the ruler**	
19.	Class	**Yes**	
20.	TR	**The one metre rule**	
21.		**One metre rule is also equal to one hundred …**	
22.		**One hundred centi ↑**	
23.	Class	**metre**	
24.	Ind Ss	**teacher**	
25.	TR	**wait =**	
26.		**= can you please just hold on**	
27.		**Ok so**	
28.		**one metre is equal to one hundred↑ .. centimetre**	
29.		**If you want to convert from metre to centimetre**	
30.		**you must multiply by↑**	
31.		**a hundred**	
32.		**And: if you want to convert centimetre to … metre**	
33.		**you divide by↑**	
34.		**a hundred =**	
35.		**= That's all you have to remember**	
36.	Class	**Teacher**	
37.	TR	**Write that down**	*TR walks to the girl who keeps calling her*

In R:2:14, TR states the relationship first before stating the operation to be used for each of the conversion task. She states, "one centimetre is equal to ten millimetre" (line 4), then goes on to state, "if you want to change centimetre to millimetre, you multiply by ten" (lines 6-7) and "and if you want to change millimetre into centimetre, you divide by ten" (lines 9-10). She does the same for the conversion of units from metre to centimetre and vice versa in lines 28-34. This whole structure is repeated in R:2:15 in lines 20-25 and lines 28-33. But in R:2:15 (lines 13-14), TR again connects to the previous topic on "Time" as she did in R:1:1. Her intention of doing so is perhaps to activate the shared knowledge of the concept of "relationship". The conversion formula that TR and her students jointly constructed in Lessons 1 and 2 and summarised in R:2:14 and R:2:15 is used throughout the whole unit on "Length". The Ministry prescribed textbook does not have any evidence of this but the school chosen supplementary book has hints of this method of conversion.

Excerpt R:2:15

No.	**Speaker**	**Classroom Interaction**	**Observation**
1.	TR	**Alright**	
2.		**now class**	*TR stands at the centre of the class with the long ruler in her hand*
3.		**before I end my lesson**	
4.		**semua letak pensil [[Everyone put your pencils down]]**	
5.		**put down your pencil**	
6.		**sit up straight …**	
7.		**put down your books …**	
8.		**Aswa …………**	
9.		**Ok**	
10.		**for units**	*TR walks to the board*
11.		**ok**	
12.		**for length**	
13.		**we have learnt time-kan? [[right?]]**	
14.		**conversion**	
15.		**nak tukar [[to convert]]**	
16.		**you have =**	

17.		**= first you have to:**	*TR points to the board with her long ruler*
18.		**memorise or know the relationship ….**	
19.		**so now I want you to copy this one**	
20.		**One centimetre equal to ten millimetre**	
21.		**and then the arrow showing that: ..**	
22.		**from centimetre to millimetre**	
23.		**you multiply by ten …**	
24.		**From millimetre into centimetre**	
25.		**you divide by ten …**	
26.		**So if you … still confused**	
27.		**you just refer to this one**	
28.		**And then for units metre and centimetre**	
29.		**One metre is equal to 100 centimetre**	
30.		**Ok, change …any values of metre into centimetre**	
31.		**you multiply by a 100 …**	
32.		**And: from centimetre to metre**	
33.		**you divide by a 100 …**	
34.		**As long as you remember this one …**	
35.		**you won't have any problem ..**	
36.		**Can you do that?**	
37.	Class	**Yes**	

Writing on the blackboard (during excerpt R:2:14 – R:2:15)

<u>Pg 137 M 2</u> Convert these units of length a → p	X 10 1 cm = 10 mm ÷ 10 X 100 1 m = 100 cm ÷ 100

The writing on the blackboard during both R:2:14 and R:2:15 is the same. TR had written some notes on the board which consists of (i) the relationship, (ii) the arrows moving from left to right and vice versa as well as (iii) the method of conversion, symbols of multiplication and division. Having checked half of the class as they were doing their homework, TR saw that some students were still having difficulty in doing the conversion task she had set. Picking up her long ruler and walking to the backboard, TR mediates (in R:2:14) the notes on the board as she explains them. In both R:2:14 and R:2:15, TR uses her long ruler to point to the board as she explains her notes. Having the arrows on the board moving to the left and right, TR uses neither her hands nor the ruler held in her hand to gesture the moving to the left or right despite stating, "the arrow showing that" (line 21 in R:2:15). The notes in the visual form on the board, that is the arrows, mediate whether they multiply or divide when they convert units of length and not the direction the decimal point should "jump". Her "notes" on the board do not have any reference to her "jumping method" way of converting units of length she introduced just before these summaries in R:2:13.

TR, in R:2:14, states the relationship first (e.g. one centimetre is equal to ten millimetre). And then she states the conversion task (e.g. if you want to change centimetre to millimetre) followed by the operation that is required to carry out the conversion task (e.g. you multiply by ten). A quick look at the excerpt reveals that TR is back in her "teacher inform" discursive practice. She does not even allow a student to interrupt her as she "informs" the class (lines 24-26). TR dominates the classroom talk as she summarises. In R:2:15, TR again states the relationship first (e.g. one centimetre equal to ten millimetre). And then she states the conversion task (e.g. from centimetre to millimetre) but she seems to have dropped off "if you want to convert/change". After stating the conversion task, she follows it by stating the operation that is required to carry out the conversion task (e.g. you multiply by ten). TR is still in her "teacher inform" discursive practice and dominates the classroom talk.

TR again uses “change” (lines 6 & 9, R:2:14) as she did in R:2:12 (line 71) besides using “convert” (lines 29 & 32, R:2:14). And for the first time TR uses the Bahasa Melayu equivalent to it, “tukar” in her final summary in Lesson 2 (line 15, R:2:15). She had not given them “tukar” but used the common term “change” besides the mathematical term “convert” till the end of the lesson. Just to ensure that all her students understand “convert” she code-switches to “tukar”. She seems to use their shared first language as she did in R:2:12 (line 73) to reinforce as this is still the beginning of the unit on “Length”.

4.3 TR and her teaching of “procedural knowledge” related to “conversion of units”

Schwartz (2008) explains that procedural knowledge helps learners find answers according to set procedures or rules (see section 3.8.1). In the next four excerpts TR teaches her students the “jumping method” to convert units. The term “jumping method” has been coined by TR to help her students remember her shorter method of converting units of length (see section 4.7.2.4 for further details). TR’s “jumping method” is not evident in the Ministry mandated textbook. There is a small reference to it (the curved arrows moving thrice to the right) in one of TR’s school chosen supplementary book which is shown in Figure 4 below. However a close look at the evidence in the supplementary book reveals that the “moved” arrows are for the regular division task (9.8mm***x1000***=9800mm) and not for the conversion task (9800***mm***÷10=980***cm***). This is the only reference TR’s students have of the “jumping method” other than what is made available to them by TR.

Calculate the following.
(a) 9.8 mm × 1 000 = ______ cm
(b) 47 m 85 cm ÷ 5 = ______ m ______ cm

Solution

(a) 9.8 mm × 1 000 = 9 800 mm
= (9 800 ÷ 10) cm
= 980 cm

Figure 4: “Jumping Method” in TR’s school chosen supplementary book B (Cho & Che, 2007, p. 14)

In R:2:13, TR taught them how to "jump" or bring forward one time the decimal point when 7.5cm is multiplied by ten, 7.5 **x10**=75mm. TR had, rather briefly, introduced the three aspects of the "jumping method": (i) the operation to be used (multiplication), (ii) the direction the decimal point should "move" (jump/bring forward) and (iii) the number of times the decimal point should be "moved" (once). See section 4.5 for the issue of "moving" the decimal point. With the focus on "procedural knowledge" related to "conversion of units", these aspects of the "jumping method" fill the classroom talk. The evidence is seen in the four excerpts that follow (R:3:1, R:6:1, R:6:2 and R:7:1).

In excerpt R:3:1, TR comes back to the "jumping method", her approach to teaching conversion, she had introduced in R:2:13. TR once again touches on all the three aspects related to her method of converting units of length: (i) the operation to be used, (ii) the direction the decimal point should "move" and (iii) the number of times the decimal point should be "moved".

Excerpt R:3:1

No.	Speaker	Classroom Interaction	Observation
1.	TR	**so answer in centimetre is↑ ……**	
2.		**28.5 centi↑**	
3.	Class	**28.5**	
4.	TR	**metre**	
5.		**but I want you to: ..**	
6.		**change it into**	
7.		**metre**	
8.	Class	**metre**	
9.	TR	**So centimetre to metre,**	
10.		**what must you do? ..**	
11.		**Divide . by . a↑**	
12.	Ind Ss	**Ten**	
13.	TR	**Hun↑ dred**	
14.	Class	**dred**	
15.	TR	**Tak ingat huh!** **[[Don't remember huh!]]**	
16.		**ok**	
17.		**25**	

18.		**Eh**	
19.		**28.5 divide by a↑**	
20.		**hundred ..**	*TR writes in the form of a fraction, 28.5/100*
21.		**So**	
22.		**this is the decimal point ...**	
23.		**I have *two* zeros here ..**	*TR points to the two zeros in the hundred on the board*
24.		**So I jump how many times?**	
25.	Class	**Two**	
26.	TR	**Two times**	
27.		**To the right**	*TR lifts her right hand and waves*
28.		**or to the left**	*TR lifts her left hand and waves*
29.	Class	**Left**	
30.	TR	**One**	
31.		**two**	
32.		**So now**	
33.		**the decimal point is there**	
34.		**so now**	
35.		**the answer is 0.285**	

Writing on the blackboard (during excerpt R:3:1)

		$\begin{array}{r} 21.2\text{ cm} \\ +\;\;7.3\text{ cm} \\ \hline 28.5\text{ cm} \\ \hline \end{array}$ $\dfrac{28.5}{100} = 0.285\text{m}$

It is interesting to notice TR's curved line(s) in her "jumping method" as seen on the board. Her curved lines arch above the numbers as it "jumps" twice to the left and it has no arrow at the end of its jump. However before TR demonstrates on the board the curved lined "jumping" twice to the left, TR mediates the direction with gestures. As she asks, "to the right or to the left?" (line 27-28), TR accompanies her elicitation by waving her right hand to the right and waving her left hand to the left. She made available this "left/right" term (i) orally in her elicitation, (ii) gesturally by waving her hands and (iii) visually on the board when she demonstrated the "jumping method".

As TR begins with the conversion task she asks, "So centimetre to metre, what must you do?" (lines 9-10). After a short pause, she continues with her half-way prompt, "Divide by a ↑" (line 11). She gave them some wait time, getting no response she prompts them to respond. Getting an incorrect response, "ten" (line 12) TR expands her prompt, "Hun↑.." (line 13) and both she and her students complete it together, "..dred" (lines 13-14). Despite her summary in Lesson 2 (R:2:14 and R:2:15), TR realises her students cannot remember. Her two prompts in line 11 (which operation to use; divide or multiply) and line 13 (she hints at 100 as she begins with a raised intonation, "hun") help mediate the conversion formula for her students.

Having established the conversion formula (from centimetre to metre), which is dividing by 100, TR writes her talk above on the blackboard. She writes 28.5 divide by 100 in the form of a fraction (lines 19-20). Then she mediates the "jumping method" (lines 22-31). It must be noted that TR had introduced this "jumping method" in the previous lesson via Faiz (R:2:13). This is then the second time her students are encountering the "jumping method" in this unit on "Length". TR then points out and stresses that there are two zeros (line 23) and only then proceeds to ask, "So I jump how many times?" (line 24). Her stressed pronunciation and pointing to the zeros on the blackboard in her classroom talk that mediated the "jumping method" related to conversion of units. The students replied, "two" (line 25).

Having built the knowledge for conversion, that is "divide by a hundred" and "jump two times", TR elicits from them the knowledge of the third part of the "jumping method", "to the right or to the left?" (lines 27-28). Her students reply correctly, "left" (line 29) and TR goes on to demonstrate on the board the curved lines "moving" twice to the left from the decimal point at 28.5 as shown on the board. It is her question that mediates the direction the decimal point should "move".

Looking at TR's discursive practice in this excerpt, she uses "repetition" where her elicitation is general in the beginning and then becomes specific to the question at hand. She begins by asking generally, "So centimetre to metre, what must you do?" (lines 9, 10). She then becomes specific as she repeats, "28.5 divide by a ↑ hundred" (lines 19-20). Her repetition enables them to attend to the operation that is required (either multiplication or division) for the conversion of units.

TR also seems to build up her students' knowledge first before posing them a question. After she had written 28.5/100 in the form of a fraction on the board, she points to the two zeros and informs the class, "I have two zeros here" (line 23) before asking, "so I jump how many times?" (line 24). The oral and visual information gave her students the clue/knowledge to answer, "two" (line 25) which TR validates with her repetition, "two times" (line 26). It is through her discursive practice of providing information and followed by question that her students could attend to the number of times the decimal point "jumps" in this excerpt.

In excerpt R:6:1 below, TR's classroom talk is still around the three aspects of the "jumping method": (i) the operation to be used, (ii) the direction the decimal point should "move" and (iii) the number of times the decimal point should be "moved". In fact, she touches upon all these three aspects every time she wants her students to use her "jumping method" to convert units of length. The excerpt below is from TR's Lesson 6. A look at TR's classroom talk in Lesson 3 (R:3:1) reveals that she has done the same, that is touching on all the three aspects of her "jumping method". Her repetition helps her students attend to and reinforces her "jumping method" of conversion.

Excerpt R:6:1

No.	**Speaker**	**Classroom Interaction**	**Observation**
1.	TR	**250**	
2.		**you divide by a 100 ..**	
3.		**One**	
4.		**Two ...**	*TR draws the arched curved lines*
5.		**Ok**	
6.		**So:**	
7.		**jump to the left .**	
8.		**Twice ..**	
9.		**Becomes .. 2.5**	
10.		**2.5 metre**	
11.		**ok**	

In R:6:1, TR's talk is minimal. Despite that, she touches on all the three vital aspects of the conversion formula. She states (i) the operation to be used, "you divide by a 100" (line 2), (ii) the number of times the decimal point should be "moved", "one, two" (lines 3-4) and "twice" (line 8) as well as (iii) the direction it should "move", "jump to the left" (line 7). However she does not involve any student as she is only "testing" the conversion formula for her students to see – almost like a summary with example.

Writing on the blackboard (during excerpt R:6:1)

x 1 cm = 10 mm 1 m = 100 cm ÷	2 5 0 cm = <u>2.5</u> m

Besides the succinct teacher talk above, the students had the arched lines on the board to help them understand the task. Unlike the two earlier excerpts, TR does not write the task in the form of a fraction and neither does she use the symbol, "÷". She does however have the curved lines arched above the numbers to portray the conversion task that is the "movement" of the decimal places. The students did not have gestures to accompany the teacher talk unlike what was seen in R:3:1.

TR appears to be in her "teacher inform" mode. Her talk is direct and she does not indulge in teacher elicitation talk. TR's demonstration precedes her teacher talk. Usually, TR explains first and follows it up with her demonstration on the board. In lines 3-4, she draws the arched lines "jumping" above the numbers twice to the left and as she draws she counts, "one, two". Only after she has demonstrated the decimal point moving two times to the left, TR repeats in words, "jump to the left twice" (lines 7-8). Her repetition enables her students to attend to the "jumping method". TR use of the cardinal numbers to count, "one, two" (lines 3-4) and the adverb, "twice" made available for her students that "jumping two times" in this excerpt (lines 3-4) and in R:3:1 (line26) is the same as "jumping twice" (line 8) in this excerpt.

In excerpt R:6:2, TR's classroom talk is again around the three aspects of the "jumping method": (i) the operation to be used, (ii) the direction the decimal point should "move" and (iii) the number of times the decimal point should be "moved". Although this excerpt is similar to R:6:1 in terms of the focus of classroom interaction on the "jumping method", in this excerpt TR seems to include her students in the process of converting units of length with her use of "we".

Excerpt R:6:2

No.	**Speaker**	**Classroom Interaction**	**Observation**
1.	TR	**So**	
2.		**centimetre convert to metre**	
3.		**we have to divide**	
4.		**nine, one, nine divide by a↑.. 100**	*TR writes 919/100 and moves the arrow*
5.	Class	**100**	
6.	TR	**Ok**	
7.		**so**	
8.		**just .. move .. backwards**	*TR draws the arrow moving*

twice to the left

9. **ok**
10. **two times**
11. **So**
12. **9.1 9↑ metre ..**
13. **correct**
14. **very good**

Just as in R:3:1 (line 9), TR begins with the same structure, "So centimetre convert to metre" but instead of going on to elicit, "what must you do" (R:3:1, line 10), in R:6:2 TR states, "we have to divide" (line 3) as well as goes on to elaborate, "divide by a ↑" (line 4) and both she and her students complete the statement with "hundred" (line 4/5). In the two earlier excerpts (R:3:1 & R:6:1) TR uses "you" when she was eliciting a response from her students. But in this excerpt TR uses "we" instead of "you" and instead of asking a question, "what must you do?" she gives a statement, "we have to divide". With the change in the pronoun ("you" to "we") as well as the change in her teacher talk (question to statement), TR moves from informing her students of the "jumping method" to jointly constructing the knowledge *with* her students despite the excerpt showing her still in control.

Writing on the blackboard (during excerpt R:6:2)

1) 72 cm ÷6 = __mm	2) 3676 cm ÷4 = 9.19 m	3) 580 m ÷ 10 = __cm	4) 7800 cm ÷ 100 = ___ m
	9 1 9 cm 4 | 3 6 7 6 - 3 6 7 - 4 3 6 - 3 6 9 .1 9 $\frac{9\,1\,9}{1\,0\,0}$		

Although the nominated student has solved the mathematical task correctly, TR goes over the "jumping method" once again. But in this excerpt, she uses the "teacher check" and not "teacher inform/direct" discursive practice. She recreates the division in the form of a fraction and demonstrates as well as visually makes available the "jumping method". This is the first time she uses the arched curved arrows and not just arched curved lines. By using the curved arrow, TR demonstrates where the decimal point ends. The nominated student had only drawn curved lines as TR had demonstrated previously (R:2:13). The students now had both the visual form (curved lines and curved arrows) made available for them to see on the board. However TR does not show the direction the decimal point "moves" in gestures. In this excerpt, TR also seems to expand her statement. In line 3, TR states "we have to divide" and goes on to expand on her statement, "divide by a hundred" (line 4).

TR also changes her instruction from "just jump" (R:2:13, line 23) to "just move" (R:2:14, line 8). This is the first time she uses the term "move" and she uses this term as she demonstrates the "movement" of the curved arrows (also used for the first time) on the board. TR makes available another term, "move backwards" (line 8), that describes the direction of the "movement". Other than the first time TR introduced the "jumping method" in R:2:13 where she uses the term, "bring forward" (line 25), she has constantly been using "to the left/right" in all other instances thus far. In R:6:1, TR states, "jump to the left twice" (lines 7-8) and in R:6:2 she states, "move backwards" (line 8) "two times" (line 10). So far three ways have been made available to the students to attend to the number of times the decimal points have to "move": (i) one, two (ii) two times and (iii) twice.

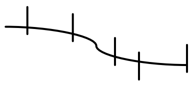
In excerpt R:7:1, the classroom talk is around a "problem solving" question. TR only touches on two of the three aspects of the "jumping method": (i) the operation to be used. She does not mention the second aspect (ii) the direction the decimal point should "move". But TR does mention the third aspect, (iii) the number of times the decimal point should "move".

Excerpt R:7:1

No.	**Speaker**	**Classroom Interaction**	**Observation**
1.	TR	**so**	
2.		**from metre to convert into centimetre**	
3.		**what must we do? ↑**	*TR waves her right hand from left to right*
4.	Class	**Times**	
5.	TR	**With a ↑**	
6.	Class	**100**	
7.	TR	**Ok ….**	
8.		**Right …**	
9.		**standard variation**	*TR talking, in softer tones, to Aril who is in front of the board*
10.		**or you just want to jump**	
11.		**never mind**	
12.		**whichever**	
13.		**whichever method you**	*TR talking, in louder voice while still looking at Aril*
14.		**you are …**	
15.		**you want to do =**	
16.		**= it doesn't matter**	
17.		**as long got the right answer: ..**	
18.		**Ok ……**	
19.		**so**	
20.		**Aril prefers to do long multiplication**	*TR is talking to the class*
21.		**doesn't matter**	
22.		**as long as**	
23.		**he got the right answer**	
24.	Class	**0.5**	
25.	TR	**Ha!**	
26.		**0.5**	
27.	Aril		*the student, Aril, writes 50centimetre*
28.		**right or not?**	
29.	Class	**Yes**	
30.	TR	**Ok**	
31.		**0.5 times by a 100↑**	
32.		**ok**	
33.		**so I'll just move**	
34.		**one**	
35.	Ind Ss	**<u>two</u>**	
36.	TR	**<u>two</u>**	

37.		**so**
38.		**50 centi↑**
39.	Class	**metre.**

Writing on the blackboard (during excerpt R:7:1)

	5m ÷ 10 = <u>50</u> cm 0 . 5 **0** x 100	0 . 5 m 10) 5 m 0 5 0 5 0 . .	0 . 5 X 1 0 0 0 0 0 0 0 5 5 0. 0

Looking at the board, at the task of converting 0.5metres to centimetres, Aril has made available the long method (4th column, the long multiplication) and TR has made available her short method (2nd column, the "jumping method"). Aril opted for the long multiplication method despite TR making available the direction the decimal point should "move" by gestures – waving her right hand from left to right (line 3) and the class making available the number of times it should "move" (lines 4-6).

Just as in R:3:1 (line 9), in this excerpt TR begins with the same structure, "So from metre to convert into centimetre" (lines 1-2) but instead of going on to elicit, "what must you do" (R:3:1, line 10), TR asks, "what must we do?" (line 3). Just as in R:6:2, TR uses the inclusive "we". With the change in the pronoun ("you" to "we") TR appears to invite her students to draw on the jointly constructed mathematical knowledge related to the "jumping method".

Just as in R:2:13 (lines 9-11), in R:7:1 (lines 9-10) TR also hints to her student to use the "jumping method". While in R:2:13 TR forced Faiz to use the shorter method (the "jumping method"), in R:7:1, she leaves the choice to Aril. But in both these excerpts, her teacher talk was directed to the individual student and not the whole class. After Aril had converted 0.5m to 50.0cm using the long multiplication method, TR demonstrates using her "jumping method" to the whole class.

Although initially in this excerpt TR begins with "teacher elicitation" discursive practice (lines 1-6), she goes on to "teacher inform" (lines 31-36) as she demonstrates the "jumping method". While Aril quietly moves from the 4th column of the blackboard to the 2nd column and writes the answer, "50cm" (line 27), TR announces her answer as she elicits, "so, 50 centi↑" (line38) and her students reply, "metre" (line 39). Although she says, "it doesn't matter" (line 16), TR's action (demonstrating the "jumping method") and announcement (stating loudly the answer) as well as quickly getting the answer (that is in a short time after she had initiated the "jumping method" compared to the length of time Aril took with his long multiplication) tells her student otherwise!

In short, TR uses various discursive practices as she mediates her teaching and learning of mathematics in English. Beginning with "teacher inform", TR moves into other practices such as "elicit, repeat, prompt, direct and check" besides revoicing students' response and code-switching. TR ends up emphasising her "jumping method" for converting units of length. Despite having briefly introduced the "partition method" (see writing on the blackboard during R:2:12) suggested in the Ministry mandated textbook, TR promotes her "jumping method", the procedural knowledge to convert units of length. Similarly, TM the second participant in this study, also emphasises this procedural knowledge to convert units of length through her "bowl system" (see section 4.5) and only very briefly spends time on "conceptual knowledge" related to "relationship between units" and "conversion of units" (see section 4.4). In the following two sections I discuss TM's teaching of "conceptual knowledge" and "procedural knowledge" related to "relationship between units" and "conversion of units".

4.4 TM and her teaching of "conceptual knowledge"

TM focuses only briefly on conceptual knowledge related to "relationship between units" and "conversion of units", and this focus is concentrated in Lessons 1 and 2. TM writes on the board some notes/formulas (M:1:B) and four tables for the measuring task (M:2:B). There was hardly any teacher talk other than the regular classroom talk related to routine, procedure and discipline.

Lesson 1

TM had started off this first lesson after completing the previous topic on "Time". She had just sufficient time to copy the notes and formula on the board before the bell rang indicating the end of the lesson. Therefore TM's Lesson 1 is mostly written notes on the board which is captured below. Lesson 1 shows TM giving her students some "formula" and "notes" related to "Length". TM divides her blackboard into 6 columns. She refers to the first two columns as "formula" and the next four columns as "notes". Below is TM's "formula" and "notes" on the board. TM writes a set of rules/procedures to follow when they are going to do conversion of units (Column 3). And she writes in brackets the method to do the conversion; (x10, x100, ÷10, ÷100). Beside each method, TM draws curved arrows moving to the right when it is multiplication and moving to the left when it is division. This is her "bowl system" (see section 4.7.2.4). TM gets her students to copy all the notes and formulae into their exercise book.

According to TM, in her stimulated recall, notes are important because students tend to forget what they have learnt after some time. Having the notes means that they could always refer to it in time of need. They would not have to depend on her to remind them but have it at their disposal when they get stuck. For TM, her notes play a mediating role.

M:1:B Writing on the blackboard

Wednesday
LENGTH

11 July 2007

Formula 1) 1cm=10mm 2) 1m=100cm 3) 1km=1000m 4) ½cm=5mm 5) ¼cm=2.5mm 6) ¾cm=7.5mm	7) ½m=50cm 8) ¼m=25cm 9) ¾m=75cm 10) ½km=500cm 11) ¼km=250cm 12) ¾km=750cm	A. Measuring Length ➢ Length is the distance from one side or end to the other ➢ The units of length are millimetre (mm), centimetre (cm) and metre (mm) a) m cm (x 100) b) cm mm (x 10) c) cm m (÷ 100) d) mm cm (÷ 10)	Example B. Convert the following to mm a) 6 cm b) 17 cm Solution 1cm=10m a) 6 x 10mm = 60mm or 6 **0** = 60mm b) 17 x 10mm =170mm or 17 **0** = 170mm	C. Convert the following to m a) 410cm b) 737cm c) 18m 11cm Solution a) 4 1 0 (÷ 100) = 4.1m b) 7 3 7 (÷ 100) = 7.37m	c) 18m 11cm No need to change = 18m + 0 . 1 1 = 18m + 0.11m = 18 . 00 + 00 . 11 18 . 11m

TM writes on the board, "*Length is the distance from one side or end to the other*" and "*The units of length are millimetre (mm), centimetre (cm) and metre (mm)* (see column 3 of M:1:B) A look at the textbook (Appendix C) reveals that there is no definition of length given in the form of a statement. However there are visuals that show the length of an object where the measurement for each object is given and students have to make their own connection that the given measurement refers to length. This would mean that her definition of length and what the units of length are can be seen to play a mediating role. They provide her students mathematical knowledge related to this unit. From her notes, her students know that to measure length they have to start at one end and go to the other end. They also know that there are three units of length they should learn and the abbreviations for each of the units. Her notes, the first two columns, also reveal the relationship between the units.

She also reminds her students to draw the arrows of her "bowl system" in blue using their blue colour pencils. The curved arrows of her "bowl system" are also mediational tools for the conversion of units. In fact, the blue colour pencil, which TM reminds her students to use, can also be seen as a mediational tool.

TM has made available for her students, in written form on the board, (i) different relationships between units (in columns 1 and 2), (ii) the definition of length and the units of length as well as their abbreviated form (column 3), (iii) the conversion formula – both the operation, either multiplication or division, and her "bowl system" (column 4) and (iv) sample conversion tasks using the "bowl system" (columns 5 and 6). It must be noted that the curved arrow(s) of the "bowl system", moving to the right/left is found in TM's school chosen supplementary book (Tan & Lavindran, 2007a & 2007b) and not in the Ministry mandated textbook (Appendix C).

Her students had the opportunity to see and write down the mathematical knowledge and mathematical English related to the unit of "Length". However, as there was no teacher talk to accompany these notes, the only opportunity presented to them was in the written form. There is no evidence that the students engaged with the mathematical knowledge or mathematical English at this stage of the lesson.

<u>Lesson 2</u>

TM's Lesson 2 is mostly written tasks on the board which is captured below. TM has set them a task, which is to fill the tables with objects they will be measuring as she takes them round the school.

As students copy the four tables into their exercise book, TM again reminds them to use their blue colour pencil to draw the arrows of her "bowl system". TM has again made available to her students the curved arrow(s), her "bowl system", moving to the right/left that is found in the school chosen supplementary books. She, in fact, emphasises it by asking them to use their blue colour pencil to draw their arrows even in her second lesson.

M:2:B Writing on the blackboard

Monday (Maths 2) 16 July 2007

A. Find 5 things/objects in millimetre (mm)

Objects/Things	Millimetre (mm)	Convert to centimetre (cm)
1. Example: a) Pencil	75mm	= 7 . 5 = 7.5cm

B. Find 5 things/objects in centimetre (cm)

Objects/Things	Centimetre (cm)	Convert to metre (m)
1. Example: a) Door	377cm	= 3 . 7 7 (÷ 100) = 3.77m

C. Find 5 things/objects in cm

Objects/Things	Centimetre (cm)	Convert to millimetre (mm)
1. Example: a) Eraser	14cm	= 14 (x 10) = 140mm

D. Find 5 things/objects in m

Objects/Things	Metre (m)	Convert to centimetre (cm)
1. Example: a) Bench	2m	= 2 (x 100) = 200 cm

TM's four tables in M:2:B seem to mediate the fact that certain objects are better measured using the smaller units while other objects are better measured with bigger units. TM's tables reveal that objects to be measured in millimetre and centimetre and converted into centimetre and millimetre respectively are smaller objects: pencil (table A) and eraser (table C). Objects to be measured in centimetres and metres and converted into metre and centimetre were larger objects: door (table B) and bench (table D).

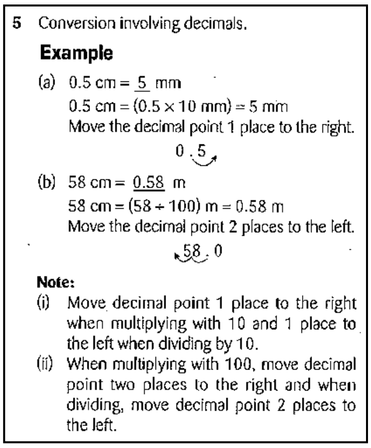
After the students had copied these four tables into their books, TM breaks them into groups and they leave the class to measure objects around the school. TM reminds them to stay around the canteen only, a covered area, as it was raining very heavily that day. When we reached the canteen, it was crowded with students from Years One, Two and Three (7,8,9-year-olds), about 450-480 students, as it was their break time. They were all crowded together in the canteen because of the rain. TM and her students tried measuring some objects but it was just too chaotic, noisy and crowded. Besides, it was also almost the end of the lesson. TM gets everyone to return to class. She then tells them that they can measure any object they like at home, follow the example and do the conversion. The bell rings indicating the end of this period and the beginning of another period with another teacher.

Although the four tables indirectly mediate the distinction between smaller/bigger object and shorter/longer length, it is not known if her students attended to it because, as has been mentioned earlier, there was no classroom discourse around the task set. We probably could have seen if they had attended to this distinction by the objects they choose to measure. But due to the heavy rain, this task was abandoned.

From Lessons 1 and 2, TM's examples on the board mediated some conceptual knowledge related to the unit on "Length" although there was generally an emphasis on the "bowl system". From Lesson 3 onwards, the emphasis on procedural knowledge through her "bowl system" becomes even more evident. This is discussed in the following section.

4.5 TM and her teaching of "procedural knowledge"

I look at the classroom interaction that surrounds conversion of units using TM's "bowl system" as TM seems to place a lot of emphasis on this method of conversion. The content-related words in the language of conversion and the visuals made available to TM and her students in their school chosen supplementary books (which is different from TR's school chosen supplementary book) are (i) "move", (ii) to the right/left, (iii) 1 place/2 places and (iv) the curved arrow(s) , , , . In their supplementary book, the sentence structure made available is "move decimal point 1 place/2 places to the right/left". I specifically focus on these four elements in TM's classroom discourse as they have been made available to her and her students in the school chosen supplementary book as shown in Figure 5 below.



5 Conversion involving decimals.

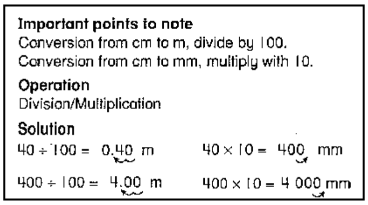
Example

(a) 0.5 cm = 5 mm
0.5 cm = (0.5 × 10 mm) = 5 mm
Move the decimal point 1 place to the right.
0.5

(b) 58 cm = 0.58 m
58 cm = (58 ÷ 100) m = 0.58 m
Move the decimal point 2 places to the left.
58.0

Note:
(i) Move decimal point 1 place to the right when multiplying with 10 and 1 place to the left when dividing by 10.
(ii) When multiplying with 100, move decimal point two places to the right and when dividing, move decimal point 2 places to the left.

Book A (p. 74)



Important points to note
Conversion from cm to m, divide by 100.
Conversion from cm to mm, multiply with 10.
Operation
Division/Multiplication
Solution
40 ÷ 100 = 0.40 m   40 × 10 = 400 mm
400 ÷ 100 = 4.00 m   400 × 10 = 4 000 mm

Book B (p. 29)

Figure 5: "Bowl System" in TM's school chosen supplementary book (Tan & Lavindran, 2007)

TM's "bowl system" and TR's "jumping method", where the decimal points are "moved" to the right or left depending on the conversion task, is probably not found in the ministry mandated textbook because, as Zevenbergen, Dole & Wright (2004) explain, it is mathematically wrong:

> "Observation of the movement of digits across the places upon multiplication and division by 10 provides students with an alternative to the commonly held belief that the decimal point moves. It is the digits that move – to the left upon multiplication by 10 or powers of 10 and to the right upon division by 10 or powers of 10." (p. 213)

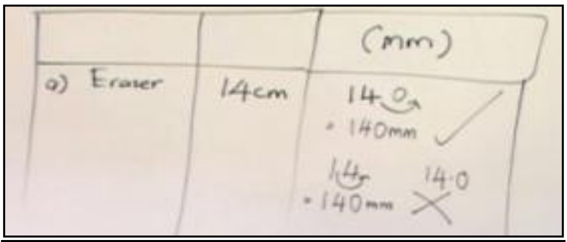
Neither TR nor TM explained this to their students.

In the following nine excerpts, I trace TM's classroom interaction related to "relationship between units" and "conversion of units" using her "bowl system" as she had placed much emphasis on it. In the first excerpt below, TM gives her students some time to complete the conversion task of objects they had measured in their homes. While the students are completing their work, TM moves around the class and randomly checks her students' exercise books. In the midst of doing that, she discovers that many of them had wrongly copied the information in table C in Lesson 2 (see M:2:B). She picks on this and makes it a teaching event. Furthermore, this error was made by Charmaine, one of the "good" mathematics students in class.

Excerpt M:3:1

No.	**Speaker**	**Classroom Interaction**	**Observation**
1.	TM	**Ok class → . . .**	
2.		**Ok**	
3.		**look at your Table ↑ C ↓ . . . . .**	
4.		**Look at your Table C ↓ . . . .**	
5.		**This one is your table, isn't it? ↓ . . . . . .**	
6.	Ch	**Ya →**	
7.	TM	**Ok "a"↓ . . .**	
8.		**eraser ↓ . .**	
9.		**correct? ↑ . .**	
10.		**after eraser is centimetre = →**	
11.		**= that means 14 centi .. metre →**	
12.		**When you're going to convert → to millimetre ↑ . . . . the arrow is moving from ↑**	
13.		**to millimetre ↑ . . . .**	
14.		**the arrow is moving from ↑**	
15.	Ch	**<u>four</u> →**	
16.	Mo	**<u>left to right</u> → . . . .**	
17.	TM	**four ↑ . . .**	
18.		**or after four ↓**	
19.	Mo	**after four →**	
20.	TM	**AFTER ↑**	
21.	Class	**four ↓**	
22.	TM	**copy the wrong one or not? ↑**	
23.	Class	**No ↓**	
24.	TM	**You must move from here ↓ .**	*TM draws a curved arrow moving, to the right, away from the digit "4"at number "14"*
25.		**How many times? ↑**	
26.	Class	**one →**	
27.	TM	**one time ↓**	
28.		**Zero →**	*TM adds a zero just above the curved arrow.*
29.		**The answer is 140 ↑. .**	
30.		**milli .. metre ↓**	

Writing on the blackboard (during excerpt M:3:1)



TM gets her students to recall the previous lesson, table C specifically, and focuses their attention on the example task she had given. She then explains the example and the conversion task. TM does not just show the conversion part that is wrong, but recreates the whole table so as to connect back to the original source of the teaching and learning. Although TM starts off by explaining the correct one, she does not just stop there. She goes on to problematise the error and explain what had gone wrong in the conversion. At the end of her explanation, she validates it by putting a tick beside the sum that is correct and drawing a big cross beside the one that is not. So her students do not just get to "hear" what is right and wrong, but they get to see it as well.

After a few turns of interaction, TM finally gives them the answer, "you must move from here" (line 24) to the question she initiated earlier, "when you're going to convert to millimetre, the arrow is moving from?" (lines 12-14). TM does not straightaway provide them the answer. She elicits the answer from her students as she talks about and around the task of conversion.

In this excerpt, the lack of teacher validation and the impact of this on a student's response are seen. In this excerpt, both Charmaine and Monica answer without nomination. But Monica modifies her more appropriate answer from "left to right" (line 16) to "after four" (line 19) after receiving no validation from her teacher. By following up on Charmaine's answer, "four" (line 15), TM seems to be validating it compared to Monica's answer. Seeing her teacher follow up on Charmaine's response, Monica felt that her answer was not what her teacher wanted and modifies her answer to suit her teacher's question even though her answer was actually correct. Even though TM validates Charmaine's answer by following up on it, Charmaine remains silent probably because she has become more aware of her own mistake. TM probably did not follow up on Monica's answer for several reasons. Firstly, it was Charmaine who had committed the error and TM was making Charmaine's error as the teaching and learning event. Perhaps TM followed up on Charmaine's answer to engage her and help her focus on her mistake – the mathematical content. Besides that, it must also be noted that Charmaine sits in the second row at the front right end corner of the room. TM is standing at the middle of the class in front of the board while Monica, on the other hand, is seated in the last row at the back left corner of the classroom. Perhaps TM did not hear Monica's answer as Monica was further at the back.

After Monica modifies her answer to "after four" (line 19), TM asks again with emphasis and raised voice, "after" (line 20) to which the class replies together "four" (line 21). TM's emphasis and raised voice might have been to get a reply from Charmaine because Charmaine did not follow up on TM's prompting to be clearer with her response. It could also have been to get her class to pay attention because many of them had also copied wrongly as Charmaine did. It might have also been to get the class to participate as well because it has only been Monica and Charmaine responding to her questions.

Having established the direction the decimal point must "move", TM deals with the number of places the decimal point must "move". Again TM elicits the answer from her class, "how many times?" (line 25). The class replies, "one" (line 26) and TM revoices their answer, "one time" (line 27) and continues with her explanation and demonstration on the board (lines 28-30). TM's response of revoicing, "one time", shows that she accepts her students' answer and validates it.

After she has written the numerals, 140 (line 29), TM elicits the unit "milli .." (line 30) and when she gets no reply from her students, she completes her elicitation, ".. metre" (line 30). TM's elicitation at line 30 is to indirectly emphasise that it is not enough just getting the number correct, but the unit must also be written down. TM directly emphasises the importance of writing the unit after their answer in later excerpts as well.

While TM seems to be having a whole-class interaction, in the midst of it, TM finds space for individual attention. Her question, "copy wrong one or not?" (line 22) is directed to Charmaine for copying wrongly into her exercise book and also to regain Charmaine's attention as Charmaine did not respond when TM followed up on her response with "four or after four?" (line 17 & 18). However, it was not Charmaine who answers but the class, "no" (line 23).

Other than using the content-related word "move" (see section 4.5) in lines 14 and 24, TM does not use the others. Although Monica offered the second content-related word "left to right" (line 16), TM takes up Charmaine's answer "four" (lines 15 & 17) and Monica follows suit, "after four" (line 19). TM also does not use the third content-related word "1 place/2 places". Instead TM uses "one time, two time" (lines 26 & 27) when she asks "how many times" (line 25) the decimal point is to be "moved". TM made available orally the content-related word "move" and visually her "bowl system", the arrow moving one decimal place to the right.

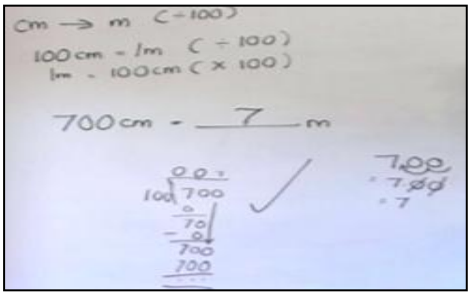
In the second excerpt, excerpt M:3:2 below, TM demonstrates her "bowl system". Hidayah comes forward and solves the conversion task using the long division method. TM accepts her answer, puts a big tick beside Hidayah's mathematics working and gets the class to applaud Hidayah for doing it correctly as Hidayah returns to her desk. Once the sound of clapping dies down, TM introduces her "bowl system". Clapping is a usual part of classroom life in TM's class. In this excerpt, TM makes obvious her preference for the "bowl system" way of converting units of length instead of the long division.

Excerpt M:3:2

No.	Speaker	Classroom Interaction	Observation
1.	TM	**Ok,**	
2.		**this one is the normal… ↑** **method = ↓**	
3.		**= that means using … division… →**	
4.		**One more is …. ↑**	
5.		**Using your bowl ↑**	
6.	Class	**system ↓**	
7.	TM	**bowl system →**	
8.		**Ok**	
9.		**move how many times? ↑**	
10.	Class	**two →**	
11.	TM	**why ↑ two time? ↑**	
12.	Class	**because one hundred got two** **zeros. →**	
13.	TM	**Syafikah, why .. two times? ↑**	
14.	Class	**Teacher me… ↑** **teacher me…. ↑**	
15.	TM	**shhhh…. Syafikah →**	*TM looks at the class*
16.		**Syafikah ↑**	*TM looks at Syafikah*
17.	Sy	**One hundred has two ↑ zeros →**	
18.	TM	**One time… →** **two time…. →**	*TM draws the curved arrows moving twice to the left from the end of 700*
19.		**Answer is 7.00 →**	

TM writes on the board the question, 700cm=___m and calls a student, Hidayah, to come forward and solve it at the board after she has briefly explained to the class "conversion of units". Just above the question, TM had written some notes (÷100 or x100) on the board as she was giving her brief explanation. However, TM did not mention her "bowl system" or draw the curved arrows on the board. That means no spoken or written dialogue related to her "bowl system" was made available to Hidayah or the class when TM was giving her explanation. But her note "cm → m (÷100)" is taken up by Hidayah, for she does divide by 100.

Writing on the board (during excerpt M:3:2)



Although TM had validated Hidayah's answer by putting a tick by the side of her working using the long division method and getting the class to applaud Hidayah, TM's action of solving the same problem using "bowl system" says otherwise. TM actions seem to be saying that Hidayah's method is acceptable but her "bowl system" is better. This message comes out loud and clear because the next three students she calls out to solve the math problem did not try to use the "long method" but used TM's "bowl system". It is not the teacher talk that mediates the message that the "bowl system" is better, but TM's working beside the long division on the board that does it.

Although TM does not use the other two content-related words (see section 4.5) "to the right/left" and "1 place/2 places", TM demonstrates on the board the decimal point moving 2 places to the right as she counts aloud "one time, two time" (line 18). She made available for her students, visually, that is the arrow moving twice to the left.

While TM seems to be having a whole-class interaction, in the midst of it, TM finds space for individual attention. She calls on Syafikah, repeats the same question she had asked the class as a whole and gets the same reply the class had given as a whole. In this interactional move (lines 13-17), TM seems to be using the mathematical interaction to get Syafikah's attention. It seems more like an act of disciplining Syafikah to see if she was paying attention to what was going on in class. The class answered as a whole without nomination. But teacher control is seen when TM nominates Syafikah (lines 13 & 16) and when she chides the class, “shhh… Syafikah” (line 15) as they bid to get her attention, “teacher me, teacher me” (line 14).

In the third excerpt, excerpt M:3:3 below, Shu Yen is nominated by TM to come forward to solve the problem, conversion from metre to centimetre, 7.377m = ___cm. After having three students come to the front and solve questions on the board related to conversion of units from centimetre to metre, Shu Yen seemed a bit lost. TM steps in to help her. This excerpt reveals how teacher talk alone was insufficient to enable the student to solve the conversion task set to her. When teacher talk was complemented with notes on the blackboard, it helped mediate the conversion task for the student. In this excerpt, TM adopts student’s voice and asks questions to mediate the mathematical content she is trying to emphasise.

Excerpt M:3:3

No.	Speaker	Classroom Interaction	Observation
1.	TM	**ok now ↓**	
2.		**Next going to be →**	
3.	Class	**teacher me… ↑**	
4.	TM	**Now metre ↑ to centimetre ↓**	
5.		**Shu Yen ↑**	
6.	SY		*Shu Yen comes forward to the board*
7.	TM	**Just now centimetre to metre →**	
8.		**Now metre to centimetre →**	
9.		**Metre ↓ to centimetre ↑**	
10.		**look properly →**	
11.		**Metre to centimetre ↓**	
12.		**You don’t look ↑ to the other exercise**	
13.		**because that one is↑centimetre to metre↓**	
14.		**This one metre to centimetre ↓**	
15.		**Just now is divide →**	
16.		**This one is: ↑ times ↑**	
17.	Ch	**hundred**	
18.	TM	**So: your =**	

19.		**= bowl system . .**	
20.		**is going like this ↑ or like this ↑**	
21.	Class	**right →**	*Some students answer while some show the gesture of moving to the left, with their fingers*
22.	TM	**do →**	
23.		**Just write ↓**	
24.	SY		*Shu Yen writes/draws curved arrows on the board*
25.	TM	**correct ! →**	
26.		**So ↑ this decimal point: ↓**	
27.		**Will move here ↓and then here ↓**	
28.		**Your decimal point will be: here ↓**	
29.		**Put your decimal point →**	
30.		**Ok write your answer →**	
31.		**where's your symbol? ↑**	
32.		**Where's your unit? ↑**	
33.		**Where's your unit? ↑**	
34.		**kilogram? ↑**	
35.		**Your unit is kilogram? ↑**	
36.		**Why so scared? : ↑**	
37.		**Confident ! ↑**	
38.		**correct? ↑**	
39.	Class	**yes →**	
40.	Class	**no →**	
41.	TM	**correct or not? ↑**	
42.	Class	**yes →**	
43.	TM	**correct or not? ↑**	
44.	Class	**yes →**	
45.	TM	**Teacher why suddenly ↑**	*TM's voices changes slightly – taking on a childlike tone and style and is slightly softer than usual*
46.		**Why she put in the middle? ↑**	
47.		**Why she move the →**	
48.	Class	**because it's times →**	
49.	TM	**Monica? ↑**	
50.	Mo	**because the decimal point is there ↓**	
51.	TM	**yes ↓**	
52.		**Because the decimal point is there ↑**	

53. If number ↓
54. Ok, for example =
55. = Look here
56. If the numbers is without the decimal point↓
57. You must ↑ move your bowl system →
58. From the back ↓
59. If got decimal point ↑
60. you must move from the ↑
61. decimal point ↓
62. Clear? ↑
63. Class yes →
64. TM ok →

Writing on the board (during excerpt M:3:3)

cm → m (÷100) 100cm=1m (÷ 100) 1m=100cm (x 100) a) 700cm = __m 007 100⟌7 0 0 - 0 70 - 0 700 - 700 ... 7.0 0 = 7.0 0 =7	b) 8773cm = __m 8 7 7.3 cm = 87m 73cm = 87.73 m	c) 974799cm = __m a)write in metres and centimetres b) Write in metres 9 7 4 7 . 9 9 = 9747.99m = 9747m 99cm	(x) (÷) m → cm (x100) d) 7.377m=__cm 7. 3 7 7 = 737.7cm

TM tries to orient Shu Yen to the task in lines 7-14. At this moment, TM's talk is directed towards Shu Yen only. Despite TM's promptings Shu Yen could not make the connection to TM's explanation and the notes on the board, 100cm = 1m (÷100) and 1m = 100cm (x100). TM becomes more specific and gives Shu Yen more clues. TM says, "just now divide" and "this one is times" (lines 15 & 16). Charmaine adds, "hundred" (lines 17) making the clue even more specific. Shu Yen keeps looking at the other three columns where the mathematical tasks dealt with the conversion of units from centimetre to millimetre. TM, standing beside her, comments, "just now centimetre to metre. Now metre to centimetre" (lines 7 & 8). She repeats it thrice (lines 9, 11, 14). TM tells Shu Yen to "look properly. You don't look to the other exercises because that one is centimetre to metre. This one is metre to centimetre. Just now is divide. This one is times" (lines 10-16). TM goes on to write above the question m → cm. Then she adds (x100) beside it. Shu Yen still was not able to proceed.

TM then draws the curved arrow on top of each other; one moving to the right and one moving to the left, . As TM draws the curved arrows on the board, she asks Shu Yen, "So your bowl system is going like this or like this?" (lines 18-20). Then TM adds the symbols "x" and "÷" beside the arrows, (x) and (÷). Shu Yen waits. TM then puts a tick beside the correct "bowl system" operation, " ✓ (x) ". Only then could Shu Yen proceed. Shu Yen "moved" the decimal point correctly using the "bowl system" as TM guides her (lines 27-29). With further promptings from TM, Shu Yen draws the curved arrows moving to the right, writes the unit and returns to her seat. It is these notes and the arrows that helped Shu Yen attend to the method of conversion. In this excerpt TM concentrates on helping Shu Yen determine the direction the "bowl system" should "move". She did not ask how many times the decimal point should "move", in this case two times, and why it should "move" twice. This is probably because she had provided these clues in the written form on the board. This shows that TM makes use of both the spoken and written dialogue as she and Shu Yen construct shared understanding around the conversion of units.

TM emphasises the importance of writing the units after the answer in this excerpt (lines 31-35) as she did in M:3:1. TM prompts Shu Yen, "Where's your symbol?, Where's your unit? Where's your unit?". This is different from M:3:1 where TM begins with the unit, "milli..." waiting for her students to complete it with "...metre". When her students did not respond, she completes her utterance as she writes the unit on the board. In M:3:3, TM directly elicits a specific response and when she does not get it, she gives other example – unit to measure mass, kilograms. Her student, Shu Yen, finally writes the correct unit, metre and then returns to her desk.

TM has modelled for her students the way to clarify which operation they are to use to convert the units. From general promptings, "Just now centimetre to metre. Now metre to centimetre.", TM becomes more specific, "Just now is divide. This one is times." Following TM's discourse practice of becoming specific, Charmaine models it and becomes even more specific. Charmaine completes TM's informative statement with "hundred" (line 17), that is times with hundred when you convert metre to centimetre. TM accepts Charmaine's answer and takes that up. She goes on to ask, "bowl system is going like this or like this". This time it is not Charmaine who had the last turn in the interaction and neither is it Shu Yen who is standing beside TM in front of the board who responds to TM's question. It is the class who answers orally and by using gestures (line 21). Although the promptings were directed to Shu Yen, Charmaine and the class had no qualms responding and TM herself did not chide them as she did in M:3:2, "shhhh…. Syafikah" (line 15). Perhaps TM chiding the class and focusing on Syafikah was not so much to elicit an answer as the class had already called out the answer and Syafikah repeated the same answer, it might have been to call on her to pay attention. In M:3:3, TM accepts the intrusive response as she is concentrating on the mathematical task and not engaged in a disciplining task as in M:3:2.

In this Lesson 3 (see M:3:3), TM had four students come forward and solve four questions she had written on the board: (i) 700cm = __m, (ii) 8773cm = __m, (iii) 974799cm = __m = __m __cm and (iv) 7.377m = __cm. Using TM's "bowl system" to convert units of length involves the moving of the decimal point. Up until the third question, the examples of moving her "bowl system" had been using whole numbers and the question Shu Yen worked on was the fourth question and it was the first instance of using decimal number. To highlight this fact to her students, TM alters her voice and takes on "student voice" as she points to Shu Yen's working on the board and asks, "teacher why suddenly, why suddenly she put in the middle?" (lines 45 & 46). TM then resumes her teacher voice and asks, "why she move the …" (line 47). The class answers "because it's times" (line 48) which is similar to what TM had been saying earlier, "this one is times" (line 16). TM remains silent and does not follow up on that answer. Not getting the answer she wanted, TM calls upon Monica who answers, "because the decimal point is there" (line 50). TM takes up Monica's answer, repeats it and goes on to elaborate on it (lines 56-61). She explains the difference between moving the decimal point of whole number and decimal numbers (lines 56-61). By modelling "student questioning" (lines 45 & 46), TM is also making available for her students the discursive practice of questioning.

TM draws on the board the "movement" of the arrows to the left and the right on the board. TM did not say aloud the content-related word (see section 4.5) "to the right/left" but she made it available on her board. In line 21, it appears that the students understood that the decimal point should move to the right. The students did take up the content-related word made available to them. Some of them said aloud "right" while others used their fingers to show the gesture of moving to the right. This shows that the students did take up the content-related word even though TM did not use the content-related word as she helped Shu Yen with the conversion task. Although TM does not use the content-related word "1 place/2 places", she reinforces the "movement" of the decimal point, by demonstrating the "movement" on the board while explaining in lines 26 and 27, "so this decimal point will move here and then here".

In the fourth excerpt below, TM follows up on students' answers and pushes them to elaborate. TM revoices her students answer and for the first time uses a more mathematically appropriate term for the direction the decimal point should "move".

Excerpt M:4:1

No.	Speaker	Classroom Interaction	Observation
1.	TM	**Ok,**	
2.		**centimetre to millimetre**	
3.		**There are two methods.**	
4.		**One is bowl system,**	
5.		**One is ↑**	
6.	Class	**times**	
7.	TM	**times**	
8.		**Times with? ↑**	
9.	Class	**ten**	
10.	TM	**bowl system? ↑**	
11.	Class	**front... front...**	*Some students move their index finger to the right*
12.	TM	**goes to right side or left side?**	*TM waves her hand to the right first, then to the left in a semicircle motion*
13.	Class	**right**	
14.	TM	**right**	
15.		**How many times?**	
16.	Class	**one**	
17.	TM	**One**	

In this excerpt TM jointly constructs the notes on the board *with* her students. This is different than in R:3:2 and R:3:3 where TM wrote the notes on the board *for* her students. The talk in this excerpt is thus centred around the notes that are being jointly constructed. Her students as a whole, not only Charmaine and Monica, join in the joint construction of the two methods of conversion.

Writing on the board (during excerpt M:4:1)

cm → mm

X 10

TM calls on Izatul and gives her a math problem, 1.7cm = __ mm. Izatul was not able to do the conversion. TM then revisits her notes and formulaes, but focusing on the particular task she had set. She writes on the board, cm mm and informs her students, "There are two methods" (line 3), "one is bowl system" (line 4) and asks in a raised voice "one is?" (line 5). The students reply "times" (line 6). TM writes "x10". Then she asks her students again, "bowl system?" to which some students answers "front… front" (line 11) while some students showed the gesture of moving right with their fingers. TM did not use the content-related word "move" but her students seem to know that she is requesting the direction the decimal point must "move". Her students had called out "front… front…" (line 11). TM seeks further clarification, "goes to right side or left side" (line 12) while waving her hands first to the right and then to the left to which her students reply, "right… right…" (lines 13 & 14).

TM's discursive practice of asking them to elaborate (line 8) is to jointly construct the knowledge that to convert centimetre to millimetre, they must times with ten. Having had that sorted out, TM then elicits the shared knowledge for conversion using the "bowl system". She asks "bowl system?" (line 10) and the students reply, "front, front" (line 11). TM does not accept the answer but neither does she reject it. Instead she provides them a mathematically and linguistically more appropriate term as she (re)voices their answer in the form of a question, "goes to right side or left side?" (line 12). The students use the term made available to them by TM and call out, "right" (line 13).

In this next excerpt, TM for the first time uses the content-related word "to the left/right" made available to her in the school chosen supplementary book and in her students' response. From Lesson 1 until now, TM has not made available, orally or in writing, for her students the content-related word "to the right/left" although visually she has done so numerous times. Her students have on their own used the content-related term twice: Monica had used "left to right" (M:3:1, line 16) and the class as a whole had called out "right" (M:3:3, line 21). However some students did take up her visual rendering of the content-related term where in line 21 of M:3:3, they put up their fingers and show the gesture of moving to the left/right.

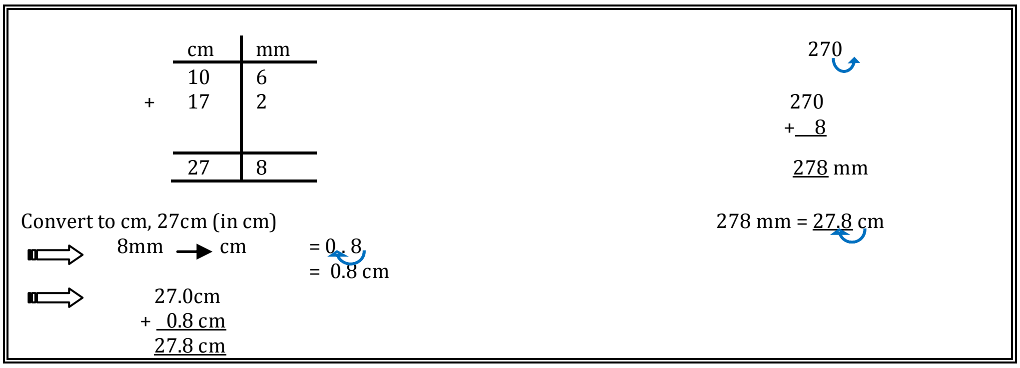
In excerpt M:4:2 below, TM's students for the first time initiate the "bowl system". All this while, it has been TM who initiates the bowl system. The interaction is around the math problem: 10cm 6mm + 17cm 2mm. TM explains to them step by step until they arrive at the answer 27.8cm. Then she changes the question and asks them to give the answer in millimetre instead of centimetre. This is what is captured in the excerpt below.

Excerpt M:4:2

No.	Speaker	Classroom Interaction	Observation
1.	TM	**Just now is convert to centimetre, isn't it?↑**	
2.		**Now I change the question**	
3.		**You must convert to millimetre**	
4.	Class	**change 27 centimetre to millimetre**	
5.	TM	**Why Kavita… cannot change 8 millimetre to 8 millimetre again?**	
6.	Kavita	**because it's already in millimetre**	
7.	TM	**because 8 millimetre**	
8.		**They ask millimetre means**	
9.		**It already in millimetre**	
10.		**This 27 centimetre**	
11.		**You must change to millimetre**	
12.		**27…. how to change to millimetre**	*TM writes 27 on the board*
13.	Class	**move**	*Some students move their index finger from right to left*
14.		**Move front**	
15.	TM	**move front?**	*TM moves the arrow from behind the digit 7 to between 2 and 7 in the digit 27,* 27
16.	Class	**no**	
17.	TM	**after the 7**	
18.		**Move back or front?**	
19.	Class	**back**	
20.		**front**	
21.		**front…front….front**	

22.	TM		*TM looks at them*
23.	Ch	**after the seven**	
24.		**You move one time**	*TM draws the arrow moving to the right from the digit 27, 27 0*
25.	TM	**27**	
26.		**Zero**	
27.		**270 milli ↑..**	
28.	Class	**metre**	
29.	TM	**so plus with 8**	
30.		**278 milli…metre**	
31.		**Change this 278 millimetre to centimetre**	
32.		**Move One time**	
33.		**Two seven point eight**	
34.		**27.8 centimetre**	
35.		**You see**	
36.		**You go that side or you go this side**	*TM moves her arms to the right and then to the left*
37.		**Anywhere**	
38.		**You come to the same answer**	
39.		**Correct or not?**	
40.	Class	**yes**	
41.	TM	**clear about this?**	
42.	Class	**Yes**	

Writing on the board (during excerpt M:4:2)



TM points to 27cm and asks, "27…. How to change to millimetre" (line 12). The students respond both orally, "move, move front" and using gestures, "index fingers pointing forward and moving from right to left" (line 13-14). TM did not use her usual clues, such as "bowl system", "move" or "arrow", in her talk to elicit a response from her students as to where the decimal point should "move". In fact it is her students who initiate the "bowl system" (lines

13-14) revealing that they have attended to her "bowl system" way of converting units of length.

Taking up their response, TM asks them, "Move front? Move back or front?" (lines 15 & 18). When the class responded by giving mixed answers, Charmaine speaks loudly and says, "after the seven, move one time" (line 23-24). Charmaine calls upon the jointly constructed knowledge and adds into her answer the number of times the decimal points should "move" although it was not what TM was asking. TM validates Charmaine's response and demonstrates, in words and action, on the board the arrow moving one time to the right after the seven.

Neither TM nor Charmaine brought up the reason why the decimal point should "move" once. While earlier on in the lesson TM had introduced the mathematically more appropriate term, "right/left" (M:4:1, line 12), she uses "front/back" in this excerpt (line 15 & 17) as she follows up on her students' response. TM did the same thing in M:3:1, line 17-18 when she followed up on Charmaine's response with, "four or after four".

TM waves her arms to the right and left (lines 36-38) as she says, "you go that side or you go this side, anywhere, you come to the same answer". She is referring to the two methods of conversion she has just demonstrated. The first one she converts 8mm to 0.8cm and adds it with 27cm to arrive at the answer 27.8cm. The arrow in this method "moves" one decimal place from right to left. In the second method, she converts 27cm to 270mm. The arrow "moves" one decimal place from left to right. She then adds 8mm to get 278mm. She then converts 278mm to 27.8cm and the arrow now "moves" one decimal place from left to right. It is the writing/working on the board that helps mediate TM's statement in lines 36-38.

As TM writes 270 on the board, she elicits the unit that must be written, "270 milli…" (line 27) and the students complete, "…metre" (line 28). Compared to

Lesson 3 in M:3:1 (line 30) where the students remained silent and TM had to complete her own prompt as she was emphasising the importance of writing the unit, in this excerpt her students seem to have attended to it because they completed her prompt.

The content-related word (see section 4.5) “move” is used by the students for the first time. In response to TM’s elicitation, “how to change to millimetre?” (line 12), some of her students call out “move” (line 13), “move front” (line 14) while some use their fingers and show the gesture of moving from left to right. Further on in this same excerpt, TM goes back to the 278mm and converts that to centimetre. Instead of using “front” and “back” (lines 18-20), TM says “you go that side or you go this side” (line 36). TM uses content-related word “move” and “go” interchangeably.

In excerpt M:4:3 below, TM does not prompt them as she usually does with clue words such as “bowl system”, “move” or “arrow”. In M:4:2, TM asked, “how to change to millimetre?” (line 12) where the “how” helped her students to focus on giving the direction the decimal point should “move”. But in this excerpt, there is no clue whatsoever that TM is asking for the direction the decimal point must “move”, yet her students respond appropriately. Because TM and her students already have this jointly constructed knowledge of her “bowl system”, TM’s students know what to respond.

Excerpt M:4:3

No.	**Speaker**	**Classroom Interaction**	**Observation**
1.	TM	**For example**	
2.		**They want you answer in metre**	
3.		**They want you answer in only metre**	
4.		**They don’t want in centimetre**	
5.		**Which one you’re supposed to change**	
6.	Class	**45**	
7.	TM	**45**	*TM writes 45 on the board*

			and her pen is still poised at the board as she looks at the class
8.		**45 centimetre**	
9.	Class	**go back…back**	
10.		**go back twice**	
11.	TM	**don't say go back**	
12.		**Say right or left**	
13.	Class	**left**	
14.	TM	**one time**	
15.	Class	**two time**	
16.	TM	**two time**	
17.		**Zero point four**	
18.	Class	**five**	
19.	TM	**five**	

Standing with her marker pen poised at the board, TM looks at the class. Although TM did not actually ask for the direction the decimal point must "move", her students call out, "Go back… back. Go back twice" (lines 9 & 10). Despite TM chiding them, "don't say go back, say right or left" (lines 11 & 12), her students did give an answer that is related to direction even though it was not the more appropriate mathematical term. Her poised pen at the board seems to mediate her question that is which direction the decimal point should "move". Her students not only give the direction the decimal point should "move" but also how many times it should "move" (lines 9-10). This has only been made possible because of the shared knowledge which they had jointly constructed in the previous excerpts.

TM does not say much as she elicits and prompts in this excerpt after her "teacher direct" discursive practice (lines 1-4). In fact there seems to be more joint construction (lines 14-15 and 17-18) of the conversion task. TM draws the curved arrow moving left as she counts aloud, "one time" (line 14). Her students take up on her prompting and continue counting as TM now "moves" the curved arrow from between 4 and 5 to the front of 4 and says, "zero point four" (line 17) and her students complete it for her, "five" (line 18). TM and her students again draw on the shared knowledge that they have jointly constructed, for TM did not ask, “how many times?”.

The earlier two excerpts of the same lesson, Lesson 4, show us that TM’s students started off using “front” (M:4:1, line 11 & M:4:2, line 14) and “back” (M:4:2, line 19) to describe the “movement” of the decimal point. TM did not reprimand them but offered them an alternative, “goes to right side or left side” (M:4:1, line 12). In M:4:2, TM went along with her students’ answer saying “after the seven” (line 17) and asked “move back or front?” (line 18). In M:4:3, TM says firmly “don’t say go back, say right or left” (lines 11-12). TM was probably trying to get them to articulate clearly the “movement” of the decimal point after seeing their confusion earlier on in the lesson. The students reply, “left” (line 13). TM orients her students towards the content-related word “to the right/left” but not to “1 place/2 places”. TM still uses “one time, two time” (line 14 & 16) and her students follow what is made available to them by her, “one time” (line 15).

In excerpt M:7:1 below, TM’s talk is about and around conversion of unit, $10 \times 65mm = \_\_\_cm$. In this excerpt, TM’s talk directly touches upon all the three aspects: the direction the decimal “moves”, how many times the decimal must “move” and why. What is noticed in this excerpt is that there is not much follow up on students’ replies because TM’s questions are direct and the answers she receives are also precise. It seems that her teacher talk in her previous excerpts has helped to mediate the mathematical knowledge and as such her students answered without much prompting.

Excerpt M:7:1

No.	Speaker	Classroom Interaction	Observation
1.	TM	**Ok,**	
2.		**look at “e”**	
3.		**10 times 65**	
4.		**We get … 650 milli..metres**	
5.		**But they want you …**	
6.	Class	**convert**	

7.	TM	**convert to centi ↑…metre**	
8.		**So 650**	
		millimetre to centimetre ↑	
9.		**What are you supposed to do?**	
10.		**Times or divide? ↑**	
11.	Class	**divide**	
12.	TM	**You must go this…aaa….**	
		right side or left side?	
13.	Class	**left side**	
14.	TM	**Left ↑**	
15.	Class	**side**	
16.	TM	**right to left**	
17.		**How many times?**	
18.	Class	**one**	
19.	TM	**How many times? ↑**	
20.	Class	**one**	
21.	TM	**Why only one time?**	
22.	Class	**Because 1 centi…..**	*all answer together*
23.	TM	**because 1centimetre equal to 10..**	
		millimetre=	
24.	Class	**=10 millimetre**	
25.	TM	**You move one time**	
		You get 65.0 centi..metre or	
26.	Class	**65**	
27.	TM	**65**	
28.	Class	**centimetre**	
29.	TM	**correct**	

In this excerpt her students come to attend to the unit after the conversion task. When TM states, "you get 65.0 centi.. metre or" (line 25), she pauses after "centi.." and getting no reply completes it, "..metre". But when she elicits with "or", her students reply "65 centimetre" (lines 26 & 28) showing that they have now attended to the unit.

TM again re-initiates her "bowl system". She does not use the content-related word "move" but uses "go" instead, "you must go this …aaa… right side or left side?" (line 12). The slight hesitation shows that TM is carefully choosing her content-related word. She did not simply use "front/back" (M:4:2, line 18) or "after" (M:3:1, line18). The students respond, "left side" (line 13) and TM repeats "left" (line 14) and the students finish it off for her, "side" (line 15).

Then TM becomes even more specific. She drops off the "side" and states, "right to left" (line 16). TM is making available the content-related word "to the right/left". TM still does not use the content-related word "1 place/2 places". She still asks, "how many times?" (line 17 & 19). She does, however, ask them to explain why the decimal point is "moved" only once (line 21).

In excerpts M:7:2 below, like the M:7:1 above, TM's talk is about and around conversion of unit. There are two questions that are in discussion: (i) 100 x 45mm = _cm and (ii) 100 x 5.8cm = __m. The classroom interaction related to the question (i), just like in M:7:1 above, has directly touched upon all the three aspects related to conversion of units: (i) the direction the decimal "moves", (ii) how many times the decimal must "move" and (iii) why. Unlike M:7:1 above, in which she referred to the three aspects related to conversion of units through questions, in this excerpt TM does it with statements, "because millimetre to centimetre, so "move" one time from right to left" (lines 10 & 11). She covers the question "why" with "because millimetre to centimetre". With "so move one time" she covers the question "how many times?" and with "from right to left" she covers the direction the decimal point will "move". Perhaps TM feels that as she is only checking the work on the board and that by now she and her students already have with them the jointly constructed knowledge regarding conversion of units, it is sufficient to state directly and not go on eliciting the answer.

As TM is dealing with the question (ii) 100 x 5.8cm = __m (lines 34-55) in this excerpt, just as in M:3:3, TM again adopts the students' voice and asks a question. She assumes a childlike tone while she asks the question. She then resumes her teacher voice immediately after that. TM seems to step into the student role when she has some mathematical tip/clue to give her students. In this Lesson 7, TM is trying to point out that if it is whole number, the zero after the decimal point can be omitted; 580.0 is the same as 580. In Lesson 3, she stepped into the student role and distinguished the "moving: of the decimal when it is whole number and when it is a decimal number.

Excerpt M:7:2

No.	Speaker	Classroom Interaction	Observation
1.	TM	**Ok:**	
2.		**look at the “g”**	
3.		**100 times 45 millimetres**	
4.		**You will get 4500 milli ↑..metres**	
5.		**And then they wanted you**	
6.		**They want you convert to centi ↑..metre**	
7.		**So: must move…one ↑**	
8.	Class	**time**	
9.	TM	**time**	
10.		**Because millimetre to centi..metre**	
11.		**So move one time from right to.. left**	
12.		**Only one time**	
13.		**So 450.0 centimetre also can One more answer ?**	
14.			
15.	Class	**450 c-m**	
16.	TM	**450 c-m also … can**	
17.		**This one you can use the bowl system**	
18.		**45**	
19.		**From where you must move your …**	
20.	Mo	**right**	
21.	TM	**bowl system?**	
22.	Ch	**right to left**	
23.	TM	**right to left**	
24.		**or.. left to right?**	
25.	Mo	**right to left**	
26.	TM	**from right to left**	
27.		**4500 millimetre**	
28.		**Which one is easier?**	
29.		**The vertical form is easier**	
30.		**Or your bowl system is easier?**	
31.	Class	**bowl system**	
32.	TM	**Clear?**	
33.	Class	**yes**	
34.	TM	**ok…**	
35.		**look at “i”**	
36.		**100 time by 5.8**	
37.		**Change it to a bowl system**	
38.		**5.8**	

39.		**From right to left or from left to right?**	
40.	Class	**left to right**	
41.	TM	**left to ↑**	
42.	Class	**right**	
43.	TM	**how many times?**	
44.	Class	**two**	
45.	TM	**one time**	
46.		**Two time**	
47.		**Equal 580**	
48.		**Teacher here is 580**	*TM's voices changes slightly – taking on a childlike tone and style and is slightly softer than usual*
49.		**But the answer is 580.0 centimetre**	
50.		**Is it the same? ↑**	
51.	Class	**Yes**	
52.	TM	**Yes**	
53.		**Still the answer is**	
54.		**The answers are ↑**	
55.		**same**	

<u>(i) Interaction around the math problem: 100 x 45mm = _cm (Lines 1-33)</u>

TM still seems to practice more "teacher elicit" discursive structures but with minimum prompts in this Lesson 7. For example, in line 19, before she could end her question, "From where you must move your" Monica calls out her answer, "right" (line 20). As TM ends her question in line 21 "bowl system?", Charmaine calls out her answer, "right to left" (line 22). In earlier excerpts, the students seem to be mostly completing TM's prompts. TM would in raised intonation ask, "milli ↑" and her students complete it with "metre" or TM would say, "one time ↑" and her students complete it, "two time" as she "moves" her curved arrows. However it is individual students such as Charmaine and Monica who seem to be doing that. The rest of the class still seem to rely on TM's prompts as she seeks a response as seen in this excerpt itself (lines 34-55).

TM is still using the content-related word "move" in lines 7, 11 and 19. She starts off with "so must move … one time" (lines 7 & 9). Then in line 11, TM expands her sentence, "so move one time from right to left". In this statement, TM seems to touch upon all the aspects related to conversion of units: (i) "move", (ii) to left/right and (iii) 1 place/2 places. She uses the first two content-related word, "move" and "from left to right" (lines 23, 24, 26) but uses "one time" instead of "1 place/2 places".

In this first part of the excerpt, it seems as though only Charmaine and Monica have attended to the direction the decimal point should "move". When TM initiates the question (line 19) Monica replies, "right" (line 20) and "right to left" (line 23) while Charmaine replies, "right to left" (line 22). But in the second part of the excerpt, the class joins as they too respond (line 40 & 42), indicating they have also attended to the direction the decimal point should "move".

(ii) Interaction around the math problem: 100 x 5.8cm = __ m (Lines 34 – 55)

In this second half of the excerpt (line 34 onwards), even Monica and Charmaine did not call out the answer before TM's elicitation but "blended" their voice with the rest of the class. While Monica and Charmaine seem to answer even before TM ends her elicitation discursive practice (lines 1-33), the rest of the class seem to wait for TM's prompts. The class only responds, "left to right" (line 40) after TM had prompted them by asking, "From right to left or from left to right?" (line 39). In another instance, the students respond, "two" (line 44) after TM had asked, "how many times?" (line 43). This shows that the rest of the class too have attended to the direction the decimal point should "move".

As TM moves over to check this question, she does not use the content-related word "move". In fact she just says, "change it to a bowl system" (line 37) and asks, "from right to left or left to right?" (line 39). TM again uses little talk. Her students now follow her lead and answer, “left to right” (line 40). TM too seems to be more specific as she does not use “side” as she did in “right side or left side” (M:4:1, line 12 & M:7:1, line 12).

However, TM still does not use the content-related word “1 place/2 places” but asks them, “how many times?” (line 43). The students answer “two” (line 44) and TM proceeds to show the decimal point moving two places as she counts, “one time, two time” (lines 45 & 46). In this excerpt TM makes available orally two content-related words: “move” and “to right/left” and visually the decimal points moving left 2 places.

In excerpts M:9:1 below, TM’s talk is about and around conversion of unit, 13m 50cm = ___cm. I find that in this last lesson on the unit on “Length”, both TM and her students seem to occupy equal talk space in the classroom. Comparisons with the excerpts in the beginning of the lessons in this unit on “Length” reveal that TM seemed to dominate the classroom talk but in this excerpt it is visibly reduced. Although it is still very much teacher controlled, her turns are not as long or as frequent as they were earlier on. There is visibly more student participation although it may merely be completing teacher utterances/slot filling.

Excerpt M:9:1

No.	**Speaker**	**Classroom Interaction**	**Observation**
1.	TM	**The answer is thirteen minute=**	
2.		**=er. thirteen metres and fifty centi..metres** **Correct or not?=**	
3.		**=They ask you to convert in ↑**	
4.	Class	**centimetres**	
5.	TM	**Centi ↑**	
6.	Class	**metres**	
7.	TM	**Which one you’re supposed to convert into centimetres?**	
8.	Class	**thirteen**	
9.	TM	**Thir ↑**	
10.	Class	**teen =**	

11.	TM	**= teen**	
12.		**This one is already in 50 centimetres**	
13.		**No need to convert**	
14.		**So: how many times?**	*TM writes 13 on the board*
15.	Class	**Two times**	
16.	TM	**From? ↑**	*TM places her marker pen after the digit 3 in number 13 she wrote on the board and turns to look at the class. Her hands are still poised at the blackboard.*
17.	Class	**Back**	
18.		**Back**	
19.	TM	**Left… right to left or left to right…**	*TM does not wave her arms*
20.	Class	**right…right…**	*TM draws two curved arrows to the right away from the digit 13*
21.	TM	**One time, two time 1300 centi..metre**	
22.	Class	**plus…plus with the 50**	
23.		**Plus with the 50**	
24.	TM	**Plus with**	
25.		**50**	
26.	TM	**You get**	
27.	Class	**1350 centimetre**	
28.	TM	**1350**	
29.	Class	**centimetre**	
30.	TM	**correct**	

A close scrutiny of her talk seems to also show her using "minimal language". For instance, in line 16, she asks, "from?" and her students seem to know what she is asking for and respond appropriately while in M:7:2, TM had asked, "from where you must move your.." (line 19). This shows that her students have attended to the shared knowledge they have jointly constructed with their teacher. In fact her students precede with their answers even before TM seeks them (lines 21-25) showing that there is space for student contribution even though the setting might be a transmission-modelled, teacher-fronted classroom once the shared or jointly constructed mathematical knowledge has been internalised.

When TM asks, “from?” (line 16) and her students reply, “back, back” (line 17 & 18). TM does not follow up with the answer they provided but goes on to orient them again, “right to left or left to right” (line 19) and her students follow her orientation and answer, “right… right…” (line 20). It seems as though her students have not attended to the mathematical English. But the students’ answer, “1350centimetre” (line 27) show that they have again attended to and internalised indicating the unit as they have done in M:7:1 (lines 26 & 28), “65 centimetre” and in M:7:2 (line 15) “450 c-m”. TM’s discursive practice of providing direct prompts in M:3:3, “Where’s your symbol?, Where’s your unit? Where’s your unit?” (line 31-33) and M:5:1, “you must put your units over here” (line 12), “make sure you put your units” (lines 16 & 19) as well as her discursive practice in providing indirect prompts in M:3:1, “milli… metre” (line 30) and M:4:2, “270milli…” (line 27) have helped her students internalise it.

In this excerpt, TM does not use the content-related word “move”. She merely asks, “So how many times?” (line 14) and the students reply “two times” (line 14). TM’s students seem to understand what is embedded in her question, that is, she is asking them how many times the decimal places must “move” when they convert metre to centimetre. Although TM does not use the content-related word “move”, her students and she seem to have, in the previous lesson, jointly constructed the meaning and they understand that she is asking the number of times the decimal points must “move” when they do the conversion. This shows they have attended to the opportunities made available thus far.

This is the last lesson of the unit on “Length”. It seems that TM’s students did not consistently appropriate the content-related word “to left/right”.

Although it appears that they have not taken up consistently the affordance "to right/left" in words but they have attended to it in gestures. TM's students also did not consistently use the content-related word "move". They alternated between using "move" and "go". The students never used the content word "1place/2 places" because it was never made available to them by their teacher although it was made available to them in the school chosen supplementary books.

In this last lesson of the unit on "Length", TM's students seem to have attended to her "bowl system" way of converting units of length. The opportunities TM made available to her students have been internalised as later excerpts reveal that her students needed minimum prompts to convert units of length using the "bowl system". TM's students did not attend to the prescribed "partition method" in the Ministry mandated official textbook as it was neither introduced nor made available to them. TM's "bowl system" has been made available for them in TM's school chosen supplementary books. Although TR, the first participant in this study, does use the Ministry mandated textbook, she too ends up emphasising her "jumping method" despite it not being made available in her school chosen supplementary book. The Ministry mandated textbook seems to encourage conceptual understanding of "relationship between units" and "conversion of units" while the school chosen supplementary books seem to promote procedural knowledge. In section 4.6 below, the various texts that inform TM and TR's teaching and learning *of* mathematics *in* English are examined. This will be further explored in the following section.

4.6 “Relationship between units” and “conversion of units” in the Ministry mandated official books and school chosen supplementary books

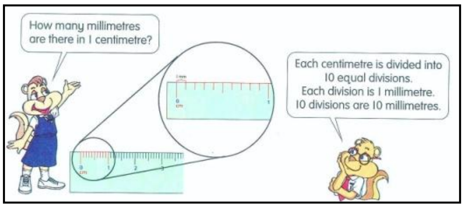
TM and TR are guided by (i) the prescribed Curriculum Specification (Appendix B), (ii) the Ministry mandated textbook (Appendix C), (iii) the official Teacher’s Guidebook (Appendix D) and the (iv) school chosen supplementary books (Cho & Che, 2007a & 2007b; Tan & Lavindran, 2007a & 2007b). Their students, on the other hand, have the mandated textbook loaned to them for free by the Ministry which they return to the school at the end of the schooling year and the school chosen supplementary book(s) which they get to keep as they have to buy it. These four sets of texts are analysed first before I go on to investigate how they inform TM’s and TR’s teaching and learning of mathematics. Instead of analysing each text individually, I seek to analyse the mathematical content in focus, that is “relationship between units” and “conversion of units”, across the four texts. After that I will analyse TM’s and TR’s teaching and learning practices.

4.6.1 Relationship between units

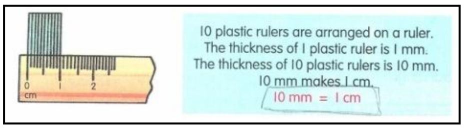
According to the curriculum specifications (Appendix B), the second *learning objective* is: students will be taught to understand the relationship between units of length and the *learning outcomes* are: students will be able to state the relationship between centimetre and millimetre while the *suggested teaching and learning activities* is students construct “tables of relationship” between units of length.

Despite the suggested teaching and learning activities, “tables of relationship” is neither evident in the textbook and supplementary book(s) nor was it taught in class. However, TR and her students did jointly construct “relationships between units” through the ribbon matching activity and using the rulers in the first three lessons. TM, on the other hand, lists the “relationships between units” on the board during the first lesson (M:1:B) for her students to copy into their books.

Under the "*Points to Note*" in the curriculum specifications (Appendix B), teachers are told to "emphasise these units of length relationships: 1m=100cm and 1cm=10mm". While the textbook (Appendix C) explains how the relationship is derived in words and pictures, the teacher's guidebook (Appendix D) proceeds to give step-by-step procedure to help teachers jointly construct with their students the "relationship between units". The supplementary books merely state the relationships between the units (see Figure 6 below).



Textbook
(Wan, Lee & Rabiyah, 2004a, p. 130)



Textbook
(Wan, Lee & Rabiyah, 2004a, p. 134)

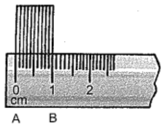
Teaching and Learning Activity (TB pg. 130 – 131)

1. Introduce units of millimetre by asking pupils to observe the 10 equal divisions in every centimetre on a ruler.
2. Point to pupils that each small division is 1 mm.

Teacher's Guidebook
(Wan, Lee & Rabiyah, 2004b, p.150)

Teaching and Learning Activity (TB pg. 134)

1. Tie up the 10 plastic rulers with a rubber band. Place the rulers from A to B on a ruler.



2. Ask pupils:
   What is the length from A to B? (1 cm)
   How many plastic rulers are used? (10 plastic rulers)
3. Explain to pupils:
   The thickness of each plastic ruler is 1 mm.
   So, the thickness of 10 plastic rulers is 10 mm.
4. Relate that 10 mm = 1 cm.

Teacher's Guidebook
(Wan, Lee & Rabiyah, 2004b, p. 154)

1 cm = 10 mm
1 m = 100 cm
1 m = 1 000 mm

TM's Supplementary Book A (p. 74)
(Tan & Lavindran, 2007)

I m = 100 cm
I cm = 10 mm

TR's Supplementary Book B (p. 13)
(Cho & Che, 2007)

Figure 6: Relationship between Units
(in official textbook and teacher's guidebook)

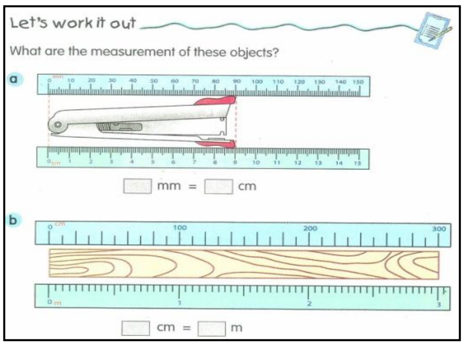
While TR makes an attempt to use the suggested activity in the textbook (p. 130) and the teacher's guidebook (p. 150) during her lesson (R:1:3) as she jointly constructs with her students the 1cm=10mm relationship using (i) the students' short ruler, (ii) by drawing on the board and (iii) referring to the textbook, TM does not use any of the suggested activity. Instead, TM gives the relationships to her students as she writes them on the board and gets them to copy them down as notes into their exercise book (M:1:B). In fact TM goes on to give several other relationships (see Figure 7 below) besides the two core relationships:

1) 1cm=10mm	7) ½m=50cm
2) 1m=100cm	8) ¼m=25cm
3) 1km=1000m	9) ¾m=75cm
4) ½cm=5mm	10) ½km=500m
5) ¼cm=2.5mm	11) ¼km=250m
6) ¼cm=7.5mm	12) ¾km=750m

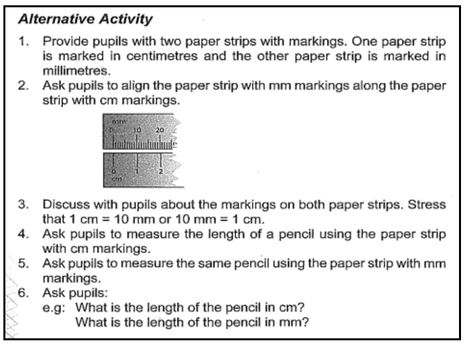
Figure 7: TM's table of relationships

After she has written them on the board, TM turns to the class and says, "Copy and memorise. Remember… any time, any day, anywhere!" TM repeats this several times. Her students explain to me that TM would ask them these relationships between units whenever or wherever she meets them around the school and if they cannot answer they cannot do whatever they were going to do. For example, they said (in between giggles), if they were in the canteen eating a hotdog and should TM pass by and question them on the relationships and they could not answer, they then cannot eat the hotdog.

The textbook (Appendix C) and the teacher's guidebook (Appendix D) in the "alternative activity" section also suggest some activities to reinforce the relationships between units as shown in Figure 8 below:



Textbook
(Wan, Lee & Rabiyah, 2004a, p. 134)



Alternative Activity

1. Provide pupils with two paper strips with markings. One paper strip is marked in centimetres and the other paper strip is marked in millimetres.
2. Ask pupils to align the paper strip with mm markings along the paper strip with cm markings.
3. Discuss with pupils about the markings on both paper strips. Stress that 1 cm = 10 mm or 10 mm = 1 cm.
4. Ask pupils to measure the length of a pencil using the paper strip with cm markings.
5. Ask pupils to measure the same pencil using the paper strip with mm markings.
6. Ask pupils:
   e.g: What is the length of the pencil in cm?
   What is the length of the pencil in mm?

Teacher's Guide Book
(Wan, Lee & Rabiyah, 2004b, p. 154)

Figure 8: Activities to reinforce relationships between units

Using her ribbon activity, TR does something similar as indicated in the textbook (p. 134) and the teacher's guidebook (p. 154). Distributing pairs of ribbons around and getting her students to measure them in different units (R:2:4 - R:2:7), TR and her students jointly construct four different relationships between centimetre and millimetre unlike TM who merely writes them on the board.

Both TR and TM emphasise in speech and in writing on the board the two core relationships; 1cm=10mm and 1m=100cm. Every time their students get stuck with tasks related to conversion of units, both TR and TM remind them of the two basic relationships. Besides that, as they begin and end their lessons, they seem to always emphasise (see "writing on the blackboard" after excerpts R:1:1, R:1:3, R:2:4-R:2:15, R:6:1, M:1:B, M:3:2, M:3:3) these two relationships between units.

4.6.2 Conversion of units

According to the curriculum specifications (Appendix B), the second *learning objective* is: students will be taught to understand the relationship between units of length and the *learning outcome* is students will be able to convert units of length. The *suggested teaching and learning activities* related to this outcome is students: use "conversion tables" to convert from one unit of length to another.

These "conversion tables" are not evident in the textbook or supplementary book(s) but are found in the Teacher's Guidebook (Appendix D) in the Remedial Section. The suggested activity using this "conversion table" is oral drills. In fact, the oral drill was already recommended in page 155 of the teacher's guidebook (see Figure 9). In the guidebook (p. 156), it is also suggested that teachers guide their students to do the conversion of units *mentally*. Although they did not engage their students in mental "conversion of units", TR and TM did tell them to "memorise" (TM in Lesson 1) and "remember" (TR in R:2:14 and R:2:15) the "relationship between units" and the "conversion method".

Remedial

1. Oral drills on conversion of units using conversion table.

mm	cm
10	1
9	0.9
8	0.8
7	0.7
6	0.6
5	0.5
etc.	

cm	m
100	1
90	0.9
80	0.8
70	0.7
60	0.6
50	0.5
etc.	

Teacher's Guidebook (p. 158)

Key Notes

- Oral drill using conversion table.

Teacher's Guidebook (p. 155)

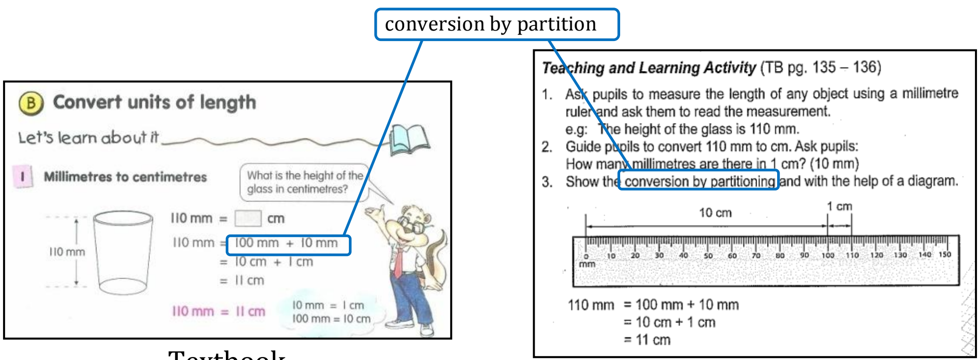
Guide pupils to convert 2 cm to mm mentally.
1 cm = 10 mm
2 cm = 20 mm

Teacher's Guidebook (p. 156)

Figure 9: Oral drills in Teacher's Guidebook (Wan, Lee & Rabiyah, 2004b)

Both TR and TM do not jointly construct with their students any "conversion table" during their lessons of the unit on "Length" nor did they carry out the "oral drill" as suggested in the teacher's guidebook. However TM, in M:2:B, created four tables for her students to measure objects in a certain unit and convert into other specified units. Her four tables did not take on the task of "drill" as recommended in the teacher's guidebook (pp. 155 & 158).

The conversion method recommended in the textbook (Appendix C) and teacher's guidebook (Appendix D) is "conversion by partitioning" as shown below. In the teacher's guidebook, besides the partitioning method, the use of diagram is also recommended (step 3, p. 155). See Figure 10.

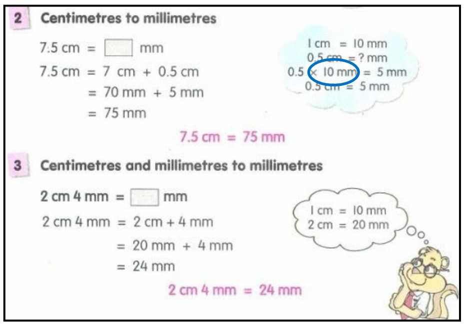


Textbook
(Wan, Lee & Rabiyah, 2004a, p. 135)

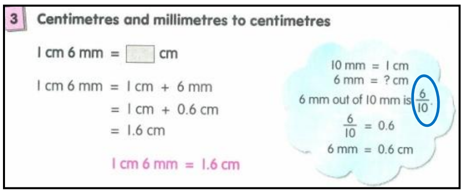
Teacher's Guidebook
(Wan, Lee & Rabiyah, 2004b, p. 155)

Figure 10: The partition method

While TR makes an attempt to incorporate the “partition method” (R:2:12 and R:2:13) as she teaches conversion of units, she does not show diagrammatically as recommended in the teacher’s guidebook. TM neither introduces “partitioning method” nor the diagram to her students. However, the textbook (Appendix C) and the teacher’s guidebook (Appendix D), indirectly suggest using multiplication and division for the conversion of units while promoting the “partition method”. See Figure 11 below.



Textbook
(Wan, Lee & Rabiyah, 2004a, p. 135)



Textbook
(Wan, Lee & Rabiyah, 2004a, p. 136)

> Guide pupils to convert 6 mm to cm. Revise the concept of fractions and decimals learnt, and show the diagram.
> 6 mm out of 10 mm is $\frac{6}{10}$.
> $\frac{6}{10} = 0.6$

Teacher’s Guidebook
(Wan, Lee & Rabiyah, 2004b, p. 156)

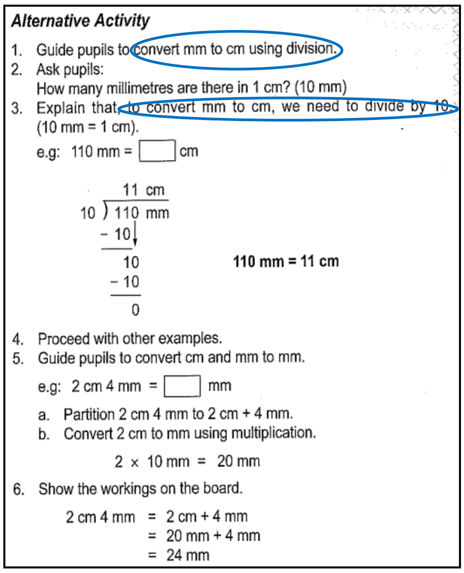
Figure 11: Conversion of units by multiplying and dividing

The teacher’s guidebook suggests, “Revise the concept of fractions and decimals learnt” (p. 156) and this is captured in the “blue clouds” in the textbook (pp. 135-136). The suggestion for long multiplication/division is captured in the “blue cloud” and the shape of the “blue cloud” is in the same shape of the “thinking bubble” of the mascot as it rests its face on its hands in a thinking gesture. The role of the mascot (see Figure 12 below) is explained in the teacher’s guidebook:

> The textbook presents a pair of mascots which pose questions intermittently. They also give useful mathematical tips and brief notes whenever the need arise.

Figure 12: The mascot in the official textbook
(Wan, Lee & Rabiyah, 2004a, p. vii)

The message the mascot as well as the blue cloud shape seems to convey is that the multiplication/division as suggested by the concept of fractions and decimals is to be done mentally. However in the "Alternative Activity" section as shown below (Figure 13, teacher's guidebook, p. 157), the long multiplication and division have been explicitly depicted. But the very fact that it is in the "Alternative Activity" and not in the main "Teaching and Learning Activity" section indicates that the "partition method" is more recommended than the multiplication/division method for conversion of units.

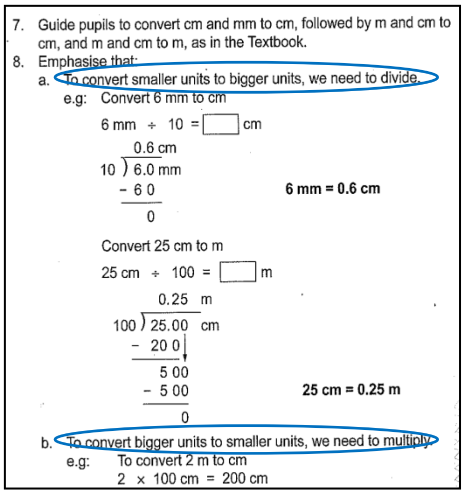


Alternative Activity

1. Guide pupils to convert mm to cm using division.
2. Ask pupils:
   How many millimetres are there in 1 cm? (10 mm)
3. Explain that to convert mm to cm, we need to divide by 10 (10 mm = 1 cm).
   e.g: 110 mm = ☐ cm

   10) 110 mm = 11 cm; − 10; 10; − 10; 0

   110 mm = 11 cm
4. Proceed with other examples.
5. Guide pupils to convert cm and mm to mm.
   e.g: 2 cm 4 mm = ☐ mm
   a. Partition 2 cm 4 mm to 2 cm + 4 mm.
   b. Convert 2 cm to mm using multiplication.
   2 × 10 mm = 20 mm
6. Show the workings on the board.
   2 cm 4 mm = 2 cm + 4 mm
   = 20 mm + 4 mm
   = 24 mm



7. Guide pupils to convert cm and mm to cm, followed by m and cm to cm, and m and cm to m, as in the Textbook.
8. Emphasise that:
   a. To convert smaller units to bigger units, we need to divide.
   e.g: Convert 6 mm to cm
   6 mm ÷ 10 = ☐ cm

   10) 6.0 mm = 0.6 cm; − 6 0; 0

   6 mm = 0.6 cm

   Convert 25 cm to m
   25 cm ÷ 100 = ☐ m

   100) 25.00 cm = 0.25 m; − 20 0; 5 00; − 5 00; 0

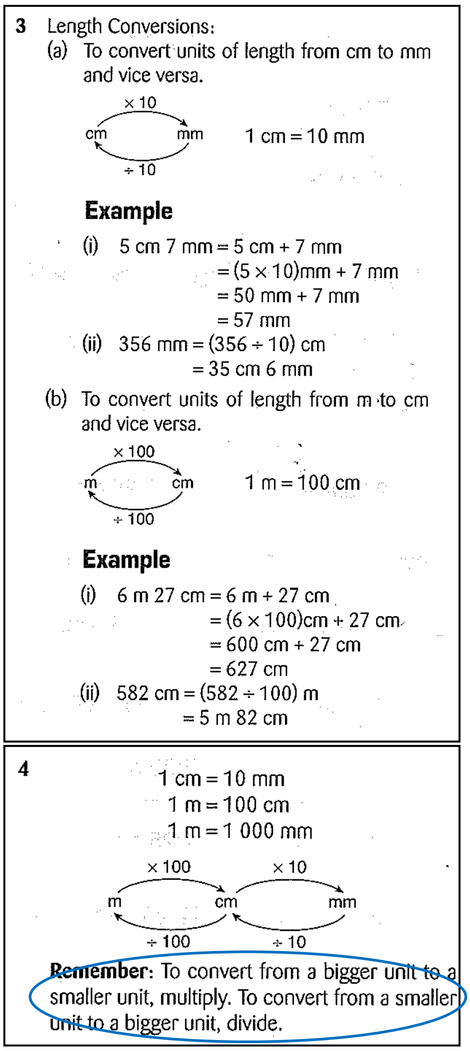
   25 cm = 0.25 m

   b. To convert bigger units to smaller units, we need to multiply.
   e.g: To convert 2 m to cm
   2 × 100 cm = 200 cm

Teacher's Guidebook (p. 157)

Figure 13: Alternative activity in teacher's guidebook
(Wan, Lee & Rabiyah, 2004b, p. 135)

This multiplication/division method of conversion suggested in the "alternative activity" in the teacher's guidebook (Figure 13) section is similar with the recommended method in the supplementary books as shown in Figure 14 below.



3 Length Conversions:

(a) To convert units of length from cm to mm and vice versa.

$\text{cm} \xrightarrow{\times 10} \text{mm}$, $\text{mm} \xrightarrow{\div 10} \text{cm}$ 1 cm = 10 mm

Example

(i) 5 cm 7 mm = 5 cm + 7 mm
= (5 × 10)mm + 7 mm
= 50 mm + 7 mm
= 57 mm

(ii) 356 mm = (356 ÷ 10) cm
= 35 cm 6 mm

(b) To convert units of length from m to cm and vice versa.

$\text{m} \xrightarrow{\times 100} \text{cm}$, $\text{cm} \xrightarrow{\div 100} \text{m}$ 1 m = 100 cm

Example

(i) 6 m 27 cm = 6 m + 27 cm
= (6 × 100)cm + 27 cm
= 600 cm + 27 cm
= 627 cm

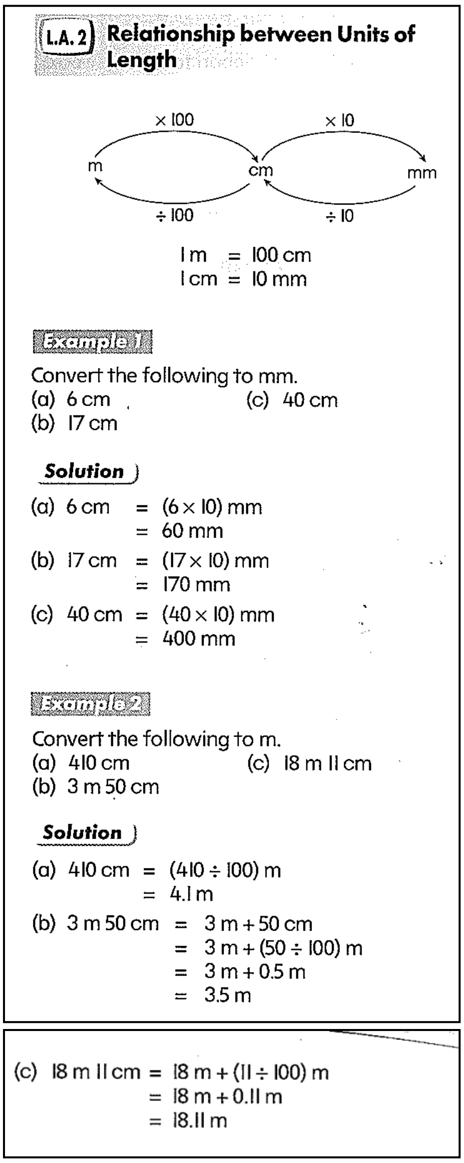
(ii) 582 cm = (582 ÷ 100) m
= 5 m 82 cm

4 1 cm = 10 mm
1 m = 100 cm
1 m = 1 000 mm

$\text{m} \xrightarrow{\times 100} \text{cm} \xrightarrow{\times 10} \text{mm}$, $\text{mm} \xrightarrow{\div 10} \text{cm} \xrightarrow{\div 100} \text{m}$

Remember: To convert from a bigger unit to a smaller unit, multiply. To convert from a smaller unit to a bigger unit, divide.

TM's Supplementary Book A
(Tan & Lavindran, 2007, p.74)



L.A. 2 Relationship between Units of Length

$\text{m} \xrightarrow{\times 100} \text{cm} \xrightarrow{\times 10} \text{mm}$, $\text{mm} \xrightarrow{\div 10} \text{cm} \xrightarrow{\div 100} \text{m}$

1 m = 100 cm
1 cm = 10 mm

Example 1

Convert the following to mm.
(a) 6 cm (c) 40 cm
(b) 17 cm

Solution

(a) 6 cm = (6 × 10) mm
= 60 mm

(b) 17 cm = (17 × 10) mm
= 170 mm

(c) 40 cm = (40 × 10) mm
= 400 mm

Example 2

Convert the following to m.
(a) 410 cm (c) 18 m 11 cm
(b) 3 m 50 cm

Solution

(a) 410 cm = (410 ÷ 100) m
= 4.1 m

(b) 3 m 50 cm = 3 m + 50 cm
= 3 m + (50 ÷ 100) m
= 3 m + 0.5 m
= 3.5 m

(c) 18 m 11 cm = 18 m + (11 ÷ 100) m
= 18 m + 0.11 m
= 18.11 m

TR's Supplementary Book B
(Cho & Che, 2007, p. 13)

Figure 14: Conversion method in school chosen supplementary books

Both TM and TR jointly constructed the long multiplication/division method, with their students. TM gave it in her notes on the board while TR incorporated it in her teaching and in her notes as well. Their students showed they were more at ease with this method of conversion as most of them who came forward to the board to solve the conversion task set proceeded to do so using the long multiplication/division.

While TM and TR accepted the long multiplication/division method of conversion, there seems to be more emphasis on their "bowl system" and "jumping method" (as shown below in Figure 15). Whenever their students solve the conversion tasks using the long multiplication/division, they would put a tick beside the working and proceed to solve it using the "bowl system" (M:3:2, M:3:3) or "jumping method" (R:6:2 & R:7:1). TM does this from the very beginning (from Lesson 1 itself, M:1:B) while TR does this mostly in later lessons like Lesson 6 onwards although she also introduces the "jumping method" in Lesson 2 (R:2:13).

5 Conversion involving decimals.

Example

(a) 0.5 cm = <u>5</u> mm

0.5 cm = (0.5 × 10 mm) = 5 mm

Move the decimal point 1 place to the right.

0 . 5

(b) 58 cm = <u>0.58</u> m

58 cm = (58 ÷ 100) m = 0.58 m

Move the decimal point 2 places to the left.

58 . 0

Note:

(i) Move decimal point 1 place to the right when multiplying with 10 and 1 place to the left when dividing by 10.

(ii) When multiplying with 100, move decimal point two places to the right and when dividing, move decimal point 2 places to the left.

TM's Supplementary Book A
(Tan & Lavindran, 2007a, p. 74)

QUESTION 3 CLONE UPSR 2002

Which of the following conversions is false?

A 40 cm = 0.4 m
B 40 cm = 4 mm
C 400 cm = 4 m
D 400 cm = 4 000 mm

Analysis

The requirement of the question

To convert and find out which conversion is false.

Important points to note

Conversion from cm to m, divide by 100.
Conversion from cm to mm, multiply with 10.

Operation

Division/Multiplication

Solution

40 ÷ 100 = 0.40 m 40 × 10 = 400 mm

400 ÷ 100 = 4.00 m 400 × 10 = 4 000 mm

Answer: B

TM's Supplementary Book B
(Tan & Lavindran, 2007b, p.29)

Example 4

Calculate the following.

(a) 9.8 mm × 1 000 = _____ cm
(b) 47 m 85 cm ÷ 5 = _____ m _____ cm

Solution

(a) 9.8 mm × 1 000 = 9 800 mm
= (9 800 ÷ 10) cm
= 980 cm

TR's Supplementary Book B
(Cho & Che, 2007b, p. 14)

Figure 15: Conversion involving decimals

Looking at TM's notes (M:1:B) on the board, it seems to resonate with the supplementary book. TM's teaching also seems to adopt the supplementary book way of teaching and learning of mathematics (Figure 15). Her "bowl system" is not evident in the curriculum specifications (Appendix B) or textbook (Appendix C). Nor is it evident in the teacher's guidebook (Appendix D) although an indirect reference has been made – "Revise the concept of fractions and *decimals* learnt" (Figure 11). With the reference to "decimals", even though the "bowl system/jumping method" is not directly or explicitly shown in the textbook or teacher's guidebook, it is accepted and indirectly recommended because the "bowl system/jumping method" adheres to decimals. Although TR does teach her students conversion by the "partition method", she too like TM stresses more the "jumping method". Unlike TM's supplementary book (Book A, p. 74 and Book B, p. 29) that highlights and emphasises "conversion involving decimals" (Figure 15), TR's supplementary book does not do so. There is merely a small reference to the moving of the arrows in Book B (p. 14), but it is related to the mathematical task (9.8mm x 1000) and not the conversion task (mm to cm). Despite not finding it in the textbook or the teacher's guidebook and also not being recommended in the supplementary book, TR still ends the unit on "Length" emphasising the "jumping method" to do conversion of units.

Every time their students get stuck with a task related to "conversion of units", both TR and TM remind them of the two basic relationships and the operation (multiplication or division) to be used to do the conversion task as shown below. Besides that, as they begin and end their lessons, they emphasise these two "relationships between units" as well as the operation to be used. A look at the blackboard (R:2:14, M:1:B & M:4:1) reveals that both TR and TM write in a way that is similar to the notes in the supplementary book(s) as shown in Figure 16 below. TM's notes have additional information - not only the direction the decimal points should "move" but also the number of times it should be "moved" according to the operation (multiplication/division).

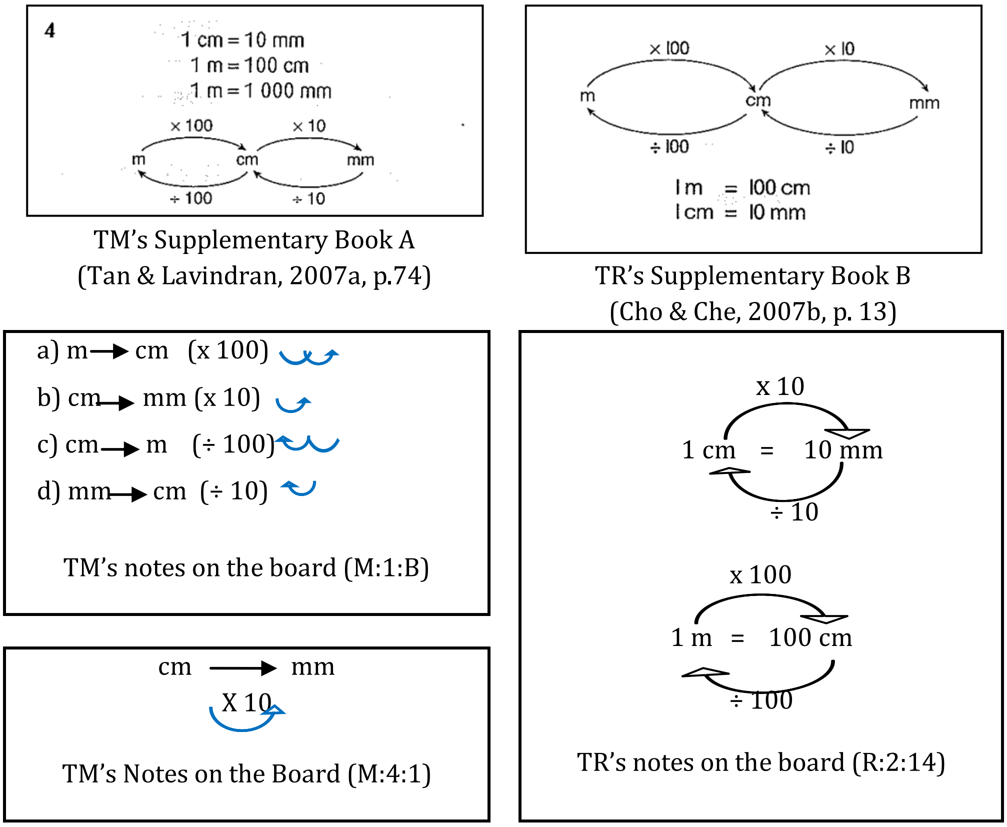


Figure 16: Relationships between units and conversion of units
(in school chosen supplementary books and teachers' notes on the board)

Both TM and TR, in their stimulated recall, said that it is more important for their students to know the "bowl system/jumping method" (Figure 15) than the textbook recommended "partition method" as the "bowl system/jumping method" will help their students immensely during mathematic tests and exams. TM says, "I teach them the "bowl system" from the beginning itself....They can do faster the conversion.... If they can memorise they can do already." TR, on the other hand, gets her students to explore the different methods of conversion before recommending her "jumping method".

4.6.3 Supplementary books and exams

In the supplementary books, the questions are formatted to mirror the tests and exams the students will eventually sit for. The tests and exams have two parts: section A (Figure 17) and section B (Figure 18). For example:

SECTION A

Answer all questions. Each question is followed by four choices of answer. Select the best answer. The diagrams provided are not drawn to scale unless stated.

1 8 m 7 cm =
A 870 cm C 87.0 cm
B 807 cm D 80.7 cm

2 Convert 700 cm to mm.
A 7 mm C 700 mm
B 70 mm D 7 000 mm

3 Which of the following conversion is **correct**?
A 10 cm = 100 mm
B 5 cm = 500 mm
C 800 cm = 80 m
D 10 cm = 1 m

10 Which of the following lengths is reasonable for the length of a pen?
A 14 mm C 14 m
B 14 cm D 140 m

11 Which of the following methods of conversion is **incorrect**?
A mm → cm (× 10)
B cm → m (÷ 100)
C m → cm (× 100)
D cm → mm (× 10)

and Vicky, calculate the length each person will get. Give your answer in cm.
A 150
B 115
C 70
D 50

16 Diagram 2 shows the distance between Adnan's house and his school and Lim's house and his school.

Figure 17: Section A of exam paper (sample)

SECTION B

Answer all questions. Write your answers clearly in the spaces provided in the question paper. Show your working. The diagrams provided are not drawn to scale unless stated.

1 Convert 654 cm to m and cm.

Answer: ______

3 (a) Convert 9.3 m to cm.
(b) Calculate 9 × 95 cm. Express your answer in metre.

Answer: ______

Figure 18: Section B of exam paper (sample)

As speed and accuracy is an essence in the mathematics test/examinations as well as the "bowl system/jumping method" being accepted as legitimate working in these tests/examinations in Malaysia, TM only focuses on the shortcut method to do conversion because it is "easier" (M:7:2, lines 28-30). Although TR attempts to explore other methods of conversion, in her later lessons, she too only focuses on "jumping method" saying it is "safer" (see section 5.4.4).

4.7 Summary of data analysis and findings

In this section I summarise my findings and analysis around my four research questions:

1. How does teacher talk mediate the learning of mathematical content and mathematical English?
   - 1a) What discursive practices are made available for the learning of mathematical content and mathematical English?
   - 1b) What opportunities are made available for the learning of mathematical content and mathematical English?
2. What other mediational tools, besides teacher talk, mediate the learning of mathematical content and mathematical English?

The summary of data analysis and findings for research questions 1 and 2 are informed by Vygotsky's sociocultural theory of learning and development and his key concept of mediation that has been discussed at length in sections 2.2 and 2.4. Meanwhile, the summary of data analysis and findings for research questions 1a and 1b are based on the review of literature on discourse and triadic dialogue in section 2.5.

4.7.1 Teacher talk mediating the learning of mathematical content and mathematical English

I found that teachers' talk plays a crucial role in mediating the learning of mathematical content and mathematical English in several ways as discussed below:

4.7.1.1 Mediating mathematical concept and mathematical English not found in the textbook

Through her classroom spoken and written interaction, TR (R:1:1) informed her students: (i) the four units of length, (ii) the units for long/short lengths (in abbreviations and in an ascending order) and (iii) the relationship between centimetre and millimetre. Like TR, TM also informed her students through written interaction (M:1:B): (i) the definition of length, (ii) the three units of length in an ascending order and (iii) twelve relationships between units.

TR's language use (spoken and written interaction) in the classroom mediated the mathematical terms and mathematical knowledge regarding what standard units are (R:1:1). In her talk she expanded on length as she distinguishes between "shorter length" and "longer length". She also expanded on "standard units" as she listed the measurements orally and visually on the board, writing the abbreviations "mm, cm, m, km". The mathematical terms related to length, "short/shorter" and "long/longer" are not used in the textbook. Neither does the textbook explain what standard units are. It is TR's classroom talk that mediated this mathematical knowledge that "mm, cm, m, km" are standard units. If TR had not used the mathematical terms "shorter/longer" and explained the mathematical knowledge of standard units in her classroom talk, her students would have had no opportunity to learn it.

TM's notes can be considered written interaction and language is being used in the notes. TM's notes mediated the mathematical knowledge of what length is, through the definition she wrote on the board. From her notes, her students know that to measure length they have to start at one end and go to the other end. This piece of information is not stated explicitly in writing in the textbook although it is implicitly represented in the illustrations.

Unlike TR who only wrote the abbreviated form after making it available orally, TM spelled out the whole unit and wrote the abbreviations within brackets in her notes. While TM defined what length is which TR did not, TM did not touch on the concept of shorter/longer length which TR did. That means, at that stage of the lesson, TR's students had the opportunity to be introduced to both mathematical concept and mathematical English through TR's use of shorter/longer and to make the connection to the respective units. But they were not told what length is, an important mathematical concept for this unit on "Length". On the other hand, TM's students had the explanation of what length is and the units used for length written for them on the board. But they had no notion of the difference between the units such as which units were to be used to measure shorter/longer lengths. TM's students had the opportunity to learn the mathematical concept of what length is but were not provided the opportunity to learn the mathematical English (short/long) related to it.

Although TR's students were not told what length is, like TM's students who copied down the definition of length, TR's students got to know the tool(s) to measure length – the ruler(s). They may not know the definition of length but they know what length is because TR made available for them the tangible object(s) to measure length - the ruler - and they know that one of the uses of the ruler is to measure length besides using the ruler for underlining or drawing margins. Continuing her mediation of the mathematical concept of shorter/longer length which she introduced in R:1:1, TR contextualised her example in a setting that is familiar to her students in R:2:1. She chose the teacher's table and students' textbook when she asked which tool would be more suitable to measure the length of the table and the thickness of the book. Her examples, in this excerpt, further reinforced the difference between short/long lengths and the short/long ruler/tool to be used to measure the lengths.

TM's four tables in M:2:B also seemed to indirectly mediate the short/long concept. Although TM did not state it orally like TR or showed it with short/long rulers like TR, her four tables, indirectly, mediated for her students the distinction between shorter/longer lengths. TM's task in these tables revealed that objects to be measured in millimetre and centimetre and converted into centimetre and millimetre respectively were smaller objects: pencil (table A) and eraser (table C). Objects to be measured in centimetres and metres and converted into metre and centimetre respectively were larger objects: door (table B) and bench (table D).

In short, it is TR's and TM's talk and language use (spoken and written interaction) that mediated mathematical content and mathematical English that is not found in the mandated textbook.

4.7.1.2 Mediating conversion formula/method not found in the textbook

TR and TM are guided by the ministry prescribed syllabus and curriculum specifications as well as the ministry mandated textbook. Besides that, both the teachers are also guided by their school chosen supplementary books. While TR made an attempt to teach her class the textbook way of converting units, the "partition method" (R:2:12 and R:2:13) before adopting the conversion methods in the supplementary book (long multiplication/division and "jumping method"), TM completely did not refer to the textbook and only taught the way that was made available by the chosen supplementary book. In fact, TM mostly highlighted and focused her students' attention to her "bowl system".

The school chosen supplementary books highlight aspects of procedural knowledge that mirrors the many tests and examinations TM and TR have to prepare their students for. This includes the two methods of conversion TR and TM teach their students, that is the long method (division and multiplication) and the short method ("jumping method" and "bowl system"). The school prepared tests, the state education department prepared examinations and the end of primary school achievement exam (UPSR), a public exam which determines the status of the school, influence TR's and TM's teaching and learning events in the classroom. It is through teachers' talk that this procedural knowledge; especially the shorter method ("jumping method" and "bowl system") is mediated for the students as it is not found in the mandated textbook.

For example, in R:2:13 TR talked Faiz through the "jumping method" as he converted 7.5cm to 75mm. Having explained the textbook way - the "partition method", TR called Faiz forward to show another way to do the conversion. Faiz began to do the conversion, multiplying the long way but was stopped by TR who guided him through the steps of the "jumping method" with her talk. TM, in M:3:3, also talked Shu Yen through the "bowl system" as she converted 7.377m to 737.7cm. However, it seems that teacher talk only was not enough to help Shu Yen. As TM guided Shu Yen with her talk, she also accompanied her talk with writing the formula/notes and drawing the arrows on the board which helped Shu Yen to do the conversion task using the "bowl system" which means that teacher talk alone is insufficient to mediate mathematical knowledge.

4.7.1.3 Emphasising mathematical content and mathematical English

TR tried very hard to use the new medium of instruction in their classroom as she carried out the teaching and learning activities. Despite her effort, instances of code-switching are seen. For example, there was more Bahasa Melayu usage in TR's Lesson 1 but the usage gradually lessened in Lesson 2. In R:1:2, although TR began in Bahasa Melayu, she slowly changed to English as she believes (in the stimulated recall, "I sengaja [[purposely]] change to English. Saya percaya lebih banyak mereka dengar [[I believe the more they hear it]], the better-lah") the more often they hear her talk in English the better able they would be to pick up mathematical English. In R:1:3, TR translated her questions from English to Bahasa Melayu. While most of the time she translated what she had said in English into Bahasa Melayu, she also did the reverse when she translated “besarkan” to English, “enlarged” (R:1:3). In her stimulated recall, TR mentioned that it was important for her students to be exposed to as much “English talk” as possible. TR also said that she code-switched when she saw her students having difficulty comprehending what she was saying or when she was concentrating on getting the mathematical content across. For example in R:2:12, TR used English throughout the excerpt and switched to Bahasa Melayu only at the end to emphasise the conversion formula. In R:2:15, TR only used the Bahasa Melayu term “tukar” after having made available for her students the everyday common term “change” (R:2:14) instead of just using the mathematical term, “convert” (R:2:14).

TM, in her excerpts related to her “bowl system”, hardly code-switched to put her point or the content across. However, she stepped into her students’ role (M:3:3, line 45 and M:7:2, line 48) and with a slightly changed voice asked questions and after that reverted to her teacher’s voice, as she answered her own questions to put her point or content across. Both TR and TM used their talk in different ways to put their point across. While TR switched to Bahasa Melayu, TM stepped into the role of a student.

4.7.1.4 Role of questions

Both TR’s and TM’s questions they asked in class play a mediating role. TR moved slowly away from external tangible tools (such as the ribbons and rulers) and moved to, although still external, but intangible tool, her pedagogic questions to mediate the teaching and learning of mathematical content (R:2:4-R:2:7). For example in the ribbon activity, TR initially used the ribbon to elicit the answer and show the relationship between the units. By the end of the activity (R:2:7), TR no longer used the ribbons and only with her questions elicited the relationships. TR’s questions also seem to determine and control her students’ responses. In R:2:1, TR’s students picked the clue from her questions to answer. When her students answered differently, TR revoiced her question until they responded by picking up on the clue her question provides.

By asking questions, TM modelled the logic of learning her method of converting units of length using her "bowl system" and the strategies her students can use to do conversion of units on their own. Put another way, TM jointly constructed a template with her students for doing conversion of units using her "bowl system". As TM asked questions around the three aspects related to conversion of units as presented in the school chosen supplementary book (see Figure 5), (i) the direction the decimal point "moves" (ii) the number of times it "moves" (iii) why it "moves" 1/2 place(s) to the right/left, she mediated the learning of conversion of units using the "bowl system" for her students. This template, brought about by her questions, was then to work as the mediator for her students during conversion tasks. I found that TM's repeated questions related to these three aspects helped the students construct the knowledge that when they convert a certain unit, it must involve all the three aspects. When TM's students responded to her question(s), they seem to respond orally as well as use gestures as they show the direction the arrows must "move".

In short, questions, a big part of teacher talk in the classrooms, play a big mediating role. While some questions from the teacher may seem to be limiting students' responses such as TR's in R:2:1 (lines, 10, 18 & 20) where her questions push her students to be specific as she looks for one specific answer she has in her mind, other questions can be seen as liberating, such as TM's as she accepts both modes of reply; oral and gestures, as they prepared students for independent work.

4.7.1.5 Talk about the mistake

In M:3:1, TM picked on Charmaine's mistake and assisted Charmaine and the class to see the mistake in the "bowl system" they had copied. TM got her students to recall the previous lesson, Table C specifically, and focused their attention on the sample task she had given. She then explained the example and the conversion task. Although TM started off by explaining the correct one, she did not just stop there. She went on to problematise the error and explain what had gone wrong in the conversion. This "talk about the mistake" plays a role in mediating the teaching and learning of conversion of units because TM is helping them see the error. Compared to Lessons 1 and 2 where they had only copied the "bowl system" that was given to them, in this lesson the error made public and the correct version showed helped her students revisit the "bowl system" that was taught to them during the unit on "Decimals". TM's talk about and around the error was a relevant teaching and learning event and appropriate mediating "move". Another example of TM's talk playing a mediating role was seen in M:4:3 when TM chided her students, "don't say go back, say right or left". As the textbook does not have the "bowl system", the students only had TM's talk as the resource for the mathematical English that surrounds the "bowl system".

4.7.1.6 Reduced teacher talk

Once mathematical knowledge and language had been jointly constructed, teacher talk visibly lessened and became more precise, probably because teacher and students now have shared knowledge and understanding of the mathematical content and mathematical English. In R:6:1, although TR's talk was minimal, she touched on all the three vital aspects of the conversion formula without lengthy elicitation and discussion process. TM, in M:4:3 with her pen poised on the board as she looked at the class, managed to get her students to give the direction the decimal point should "move". In M:9:1, she only asked, "from?" and her students responded to the direction the decimal point should "move".

4.7.1.7 Increased student talk

I found that once the jointly constructed mathematical knowledge and language has been internalised, students control the classroom talk to a certain extent. They seem to lead the way even before their teacher elicited or prompted for an answer. In R:2:11, even though TR initiated the interaction, it was clearly controlled by her students. The class called out the method of conversion and answer to the conversion task even before TR requested it. In TM's class, Charmaine and Monica regularly did this. For example in R:4:2, Charmaine asserted her answer over the noise of the class and TM followed Charmaine's response. At other times, even though TM directed her question(s) to individual students, the class as a whole had no qualms calling out their answer forcing TM to acknowledge their talk. All this happened, not in the beginning of the unit on "Length" but much later on as lessons progressed that is after the students have had the shared, jointly constructed knowledge with them which I believe empowered and enabled them to take more control of their own learning.

4.7.1.8 Learning to talk maths & talking to learn maths

"Learning to talk maths" seemed to take precedence over "talking to learn maths" in both the classes. The analysis of the classroom discourse of both, TM and TR revealed that there was not much opportunity afforded to their students for "talking to learn maths". For example, with the emphasis on procedural knowledge, TM concentrated on getting her students to learn her "bowl system" way of talking so as to participate in the celebrated way of knowing maths in her classroom. This "bowl system" and the interaction around it, according to TM would help her students during tests and exams (in stimulated recall). If "teaching to the test" is going to be the main agenda then mathematical procedural knowledge will have more emphasis than conceptual knowledge; thus the interaction around procedural knowledge with its emphasis on "learning to talk maths" in a particular way, that is the "exam way" will take precedence.

4.7.2 Other mediational tools, besides teacher talk, mediating the learning of mathematical content and mathematical English

It is not only through teacher talk that mathematical knowledge and mathematical language could be mediated. TR's rulers and ribbons as well as the textbook besides the writing on the blackboard were her mediating tools as she and her students jointly constructed the mathematical knowledge and language. TM mainly used the notes and formula she wrote on the board as well as gestures to construct the "relationship between units" and "conversion of units" besides her teacher talk.

4.7.2.1 Rulers

TR used her rulers to mediate two aspects of mathematical knowledge: (i) the concept of long and short as well as (ii) the relationship between units. By using the example of the students' short ruler and her long/one-metre ruler in R:2:1, TR mediated the mathematical concept of short and long. Just by holding both the short ruler and her long/one-metre ruler, TR made visible and tangible the concept of short and long. Continuing her mediation of the mathematical concept of shorter/longer length, TR contextualised her example in a setting that was familiar to her students. She chose the teacher's table and students' textbook when she asked which tool would be more suitable to measure the length of the table and the thickness of the textbook. In R:1:2 and R:1:3 TR used the students' short ruler and her long ruler to help her students "see/discover" and jointly construct the mathematical knowledge related to length, that is the 15cm=150mm, 1m=100cm and 1cm=10mm relationships between units.

Although TM did not state in her speech the concept of short/long like TR nor show it with short/long rulers like TR, the examples in her four tables (in M:2:B) mediated for her students the distinction between shorter/longer lengths. TM's task in these tables revealed that objects to be measured in millimetre and centimetre and converted into centimetre and millimetre respectively are smaller objects: pencil (table A) and eraser (table C) in M:2:B. Objects to be measured in centimetres and metres and converted into metre and centimetre respectively were larger objects: door (table B) and bench (table D) in M:2:B.

4.7.2.2 Textbook

As TR was trying to mediate the 1cm=10mm relationship between units in R:1:3 using the students' short ruler and her drawing on the board, she resorted to the textbook to finally mediate the relationship. After TR had focused her students' attention to the textbook, she managed to elicit the correct answer. I found that, no matter how briefly TR and her students refer to it, the textbook plays an important mediating role. The use of illustrations to complement the notes in the textbook helped TR's students see the 1cm=10mm relationship compared to TR's drawing on the board and the use of the short ruler.

4.7.2.3. Blackboard

In R:1:2, the writing on the blackboard played a rather important role in mediating the correct mathematical content. As TR wrote on the board, "15cm=150mm" (lines 18-19), she asked her students, "IS ..aaa .. 15↑centimetres the same: as 100 millimetre?↓" (TR writes 150mm on the board although she says 100mm). It was the writing on the blackboard and not the incorrect teacher talk (saying 100mm instead of 150mm) that mediated the correct mathematical content.

In R:2:8, TR had written the conversion formula (from cm to mm), x10, and she mentioned it thrice and on the blackboard, underlined it as well as drew a box around it. Then in R:2:9, TR wrote another question on the board (6cm=__mm), just below the highlights (underlining and drawing the box) and the example (5cm=50mm) she had discussed in R:2:8. Her students immediately called out the answer, in R:2:9, without much prompting or direction from TR. They seem to draw upon the already mediated conversion formula and the highlights during R:2:8 that were still on the board. This shows that besides teacher talk, the blackboard played an important mediating role as well.

Before the start of the session with "conversion of units" or when her students got stuck in the midst of the conversion of units, TM re-wrote her notes on the board. For example, in M:3:2, her notes which usually consisted of "cm → mm or mm → cm" or "cm → m or m → cm", "x 10" or "÷10" or "x 100" or "÷100" and the curved arrows moving once/twice to the left/right. Her practice of writing these notes on the board acted as a mediator for her students when they came forward to solve the conversion task. Many students looked at the notes on the board as they solved the conversion task. Here, TM's notes became mediators as her students solved the conversion tasks. However, I found that some students could not solve the task despite the formula being up there on the board like Shu Yen in M:3:3. When these students got stuck, TM went and stood beside them, speaking in slightly lowered tone, and helped them with prompts and clues, many a time getting her students to refer to her notes on the board, as they did the conversion task. Here, teacher talk was important to accompany the notes on the board for some students.

4.7.2.4. Arrow(s)/arched curved line(s) of the "jumping method" and "bowl system"

TM's "bowl system" and TR's "jumping method" are not present in the ministry mandated textbook. However, this "bowl system" is evident in the school chosen supplementary book. Both these teachers promoted this method of conversion for exam purposes. Therefore they took some time to dwell on the "bowl system" and "jumping method" as their students would have to use it again in the following two units – Mass and Volume of Liquid. The "bowl system" and "jumping method" rely on the decimal point "moving" either to the right or left depending on the conversion task. These "movements" are depicted on the board using the arrow(s)/arched curved line(s). The arrow(s)/arched curved line(s) drawn on the board are important mediational tools for the conversion of units.

The term “bowl system” that TM has coined, is her mediational tool to her shorter way of tackling the conversion of unit. The school chosen supplementary books did not have a specific name for it, thus TM called it the “bowl system”. In these books there is only visual evidence of curved arrows moving to the right/left. According to TM, she had taught them during the unit on “Decimals”, that each curved arrow contains a number within it, hence the label “bowl”. “The curved arrow is like a bowl”, she says “and it’s easier for them to remember”. And if there is none, then a zero must be added, e.g. 270 (M:4:2). Therefore, by just referring to her conversion method, “bowl system”, TM’s students’ come to know what is expected. In M:4:1, TM just mentioned “bowl system?” (line 10) and with it elicited a response from her students as to the direction the decimal point/arrow must “move”. The mathematical knowledge the term “bowl system” evoke is the three aspects of conversion; the direction the decimal point “moves”, the number of times it “moves” and why it “moves” 1/2 place(s) to the right/left.

Unlike TM who consistently used curved arrows, with the arrow indicating where the decimal point ends, TR did not consistently use curved arrow. She mostly used the arched curved line. She “moved” her arched curved line from the top, 2 8.5=0.285 as though “jumping” hence the name “jumping method”.

4.7.2.5 Gestures

I found that as TM’s students engaged with her mediation through talk, TM also got them engaged with her visual mediation – where she demonstrated the moving of the arrow on the board and with her gestures (M:3:3 and M:4:1). TM tried to make her actions in speech and visuals explicit to mediate the learning of conversion of units using her “bowl system”. While some of TM’s students answered orally, her other students used their fingers to gesture the direction the arrow should “move” (see M:4:2). This is consolidated when TM drew the “movement” of the arrow(s) on the blackboard.

Unlike TM who frequently used gestures to support her teacher talk and drawing on the board, TR did not use much gesture as she used her "jumping method". In R:3:1 TR did not use gestures to accompany her teacher talk. Perhaps TR's lack of using gestures might be because she was consistent in her spoken interaction as to the direction the decimal point should be "moved" unlike TM. TR consistently used "left/right" while TM used "after, like this or like this, move here and then here, to right side or left side, back or front, that side or this side, right to left or left to right". But TM's inconsistency is compensated for by her consistent and frequent use of gestures.

4.7.2.6 Blue colour

In Lessons 1 and 2, TM was involved in more written interaction than oral interaction. TM wrote some notes and formulae on the board and asked the students to copy them down into their exercise book. Her students copied the notes down using their pencils. However, TM reminded her students to draw the arrows of her "bowl system" in blue. TM's students bring extra blue colour pencils to use during mathematics lesson. When TM introduces a new learning point, she highlights it and asks her students to use their blue colour to highlight it as well. TM used the blue colour, as an external tool, to mediate the "movement" of the arrow in her "bowl system" by making it visibly explicit. Inherent in the "movement" of the blue coloured arrow was all the three aspects of conversion; the direction the decimal point "moves", the number of times it "moves" and why it "moves" 1/2 place(s) to the right/left. TM used the blue coloured arrows in her "bowl system" to prompt her students to think of the three aspects of conversion.

4.7.2.7 Ribbons

TR used ribbons to jointly construct the "relationship between units" (R:2:4-R:2:7). Besides constructing the relationships, the ribbons also mediated the concept of "same length". While TR had used the students' ruler and her one-metre ruler to mediate the concept of long/short, the ribbons mediated for her students the content-related phrase, “is equivalent to/ is equal to/ the same as”. Her students not only heard it from their teacher’s talk, they “saw” for themselves the concept of “same length”, through the ribbons, despite the difference in units.

4.7.2.8 Use of examples

Besides the notes TM and TR wrote on the board, I found both these teachers leaving solved mathematical problems on the board as examples and point of reference. As they called their students to the front to solve other maths problems, their students seem to be looking at the examples on the board as they attempted their own (R:2:9 and M:3:3). The examples acted like models for their own maths working.

After having jointly constructed a few relationships between centimetre and millimetre during the ribbon activity, TR used them to derive the conversion formula (cm to mm & mm to cm). After deriving each conversion formula, TR tested it out while leaving the example on the board. The examples were of immense help to the students so that by the end of the activity, they could solve the conversion even before TR prompted them (see R:2:7).

4.7.2.9 Use of tangible tools

TR’s use of rulers and ribbons to mediate the relationship between units helped also to mediate the actual length of the units under study, 1mm and 1cm (using the students short ruler) and 1m (using the teacher’s long ruler). TM did not use these tangible tools to enable her students discover the actual length but her tables in Lesson 2 (M:2:B) enabled her students to use tools to measure. As they carried out their tasks of measuring and recording, TM’s students too could see for themselves the actual length that corresponded to the unit. By using the tools, especially the ruler, students could notice and attend to the measurement and the units. They could also notice and attend to concepts like short/long/same length.

4.7.3 Discursive practices made available for the learning of mathematical content and mathematical English

At the start of lessons and towards the end of lessons, both TR and TM use "teacher inform". Although it may seem one-way and not multidirectional, the purpose of this discursive practice at these stages was to inform the students of the content as they began the lesson and to summarise as they ended the lesson. However in between the start and the end of the lesson, both teachers employed other discursive practices as well; namely teacher elicit, teacher repeat, teacher prompt, teacher direct and teacher check. And in the midst of these discursive practices, they also used other practices such as recasting/revoicing students' responses, revisiting/recycling key ideas, relating to/drawing on students' previous knowledge, and using cued elicitation to encourage joint construction.

4.7.3.1. Teacher inform

I found that both TR and TM seem to rely heavily on the "teacher inform" discursive practice as they started the lesson on "Length". TR did it through her oral interaction while TM did it through her "written interaction". In R:1:1 and M:1B., TR and TM provided for their students the mathematical English shorter/longer and mathematical knowledge of what standard units are. The textbook has no mention of the terms longer/shorter, neither does it explain what standard units are and nor does it give a definition on length. It was the "teacher inform" discursive practice that unpacked these mathematical knowledge and mathematical English for the students. This "teacher inform" discursive practice actually provided students the language structure of "informing/making statements".

At the end of each teaching and learning event as seen in the excerpts and at the end of the whole lesson, both TR and TM summed up important mathematical content and concepts. They once again went into "teacher inform" mode. For example in R:2:14 and R:2:15, TR dominated the classroom talk as she summarised the lesson at the end of the day. TR summarised after jointly constructing the conversion formula (see R:2:8). TM also did the same in M:3:3 as she explained the difference in moving the decimal point of whole numbers and decimal numbers.

4.7.3.2 Teacher elicit

While TR's Lesson 1 primarily used the "teacher inform" discursive practice, this discursive practice eased and the "teacher elicit" type tooks over in Lesson 2. With more "teacher elicit" discursive practice, student participation also increased. For instance in R:2:1, when TR expounded on the concept of short/long and in R:2:4 - R:2:7, when TR carried out the ribbon activity, students participated more visibly than in Lesson 1.

In M:3:1, TM picked on Charmaine's mistake and made it a teaching and learning event as she did the correction on the board. As she discussed and highlighted the mistake, TM got the rest of the class involved by eliciting their response. Her classroom interaction was not directed to only Charmaine and TM did not go into her "teacher inform" discursive practice to inform Charmaine of her mistake. She recaptured the mistake on the board, got the class involved with the correction as she elicited responses and jointly constructed the correction.

4.7.3.3 Teacher repeat

"Teacher repeat" seems to be another discursive practice that TR used heavily. She repeated her questions to afford her students the opportunity and space to focus on the content. For example, it was not solely "teacher inform" discursive practice that made available the mathematical concept of "one metre" (R:2:1). When TR informed her students that that her long ruler is "one metre", she held the ruler up for them to "see" how long one metre actually was. However, her repetition within her discursive practice of "teacher inform" created more opportunities for her students to attend to the mathematical concept and mathematical English. She repeated "one metre" four times so that her students could attend to the length of one metre. TR also repeated her steps to mediate learning instead of rushing through, especially when she was in the midst of jointly constructing mathematical knowledge. In R:1:3, she repeated her question four times, twice in English and twice in Bahasa Melayu when she asked, "How many millimetre are there in one centimetre?".

Besides repeating the three aspects of the conversion using her "bowl system", TM constantly reminded them of how many zeros "ten" and "hundred" have (e.g. M:3:2) as they determined the number of times the arrow should "move". However, when TM repeated the direction the decimal point should "move", she was not consistent with the use of the appropriate register. She said, "move/go to right/left, back/front, this side/that side or before/after" instead of consistently repeating "left/right". It is not surprising then that her students were also not consistent (e.g. M:4:3). But she made up for it by being consistent with her gestures and her drawing the arrows of her "bowl system" on the board. And her students used gestures correctly.

4.7.3.4 Teacher prompt

TR constantly prompted her students to state the conversion formula and she usually did it with a rising intonation. She began the turn and waited for her students to complete it. For example in R:1:2, converting 15cm to millimetre, TR prompted, "15 times by ↑" and waited for her students' response. In R:3:1, TR prompted them to remember the "jumping method" which she had re-introduced in R:2:13 and taught during the unit on Decimals. TR's prompts were mostly directed to the class.

TM's class also showed evidence of prompts. The prompts were mostly from TM and sometimes from the class. For example in M:3:3, Shu Yen who was nominated by TM did not know how to begin or proceed with the task set to her. TM walked over to her and with TM's prompts she was able to solve the task. While TM's talk was focused towards Shu Yen, the class and Charmaine joined and provided prompts as well.

4.7.3.5 Teacher direct

TR seems to be directing her students' attention to various objects when she was trying to jointly construct the 1cm=10mm relationship in R:1:3. Instead of straightaway telling them the relationship between the units, TR began by directing her students' attention to their short ruler. To enable them to "see" what she wanted them to count, she directed her students' attention to the drawing on the board. Receiving incorrect responses from her students, she finally directed them to the illustration in the textbook. In R:2:12, TR directed her students' attention to the two operations they need to use during conversion of units.

Every time her students got stuck trying to do a conversion task, TM directed their attention to the "notes" (see M:3:2 & M:4:1) she had written on the board. Like TR, TM also did not straightaway tell them the operation to be used or the number of times the decimal point should be "moved" or even the direction the decimal point should be "moved". Instead, she pointed and directed them to the notes on the board. Most of her students, like Hidayah in M:3:2, refer to the notes she was directed to and completes the assigned task. Some students, like Shu Yen (see M:3:3), the "teacher direct" move was insufficient and thus TM moved closer to her and added the curved arrows beside the notes as she directed Shu Yen's attention to the added information and this helped Shu Yen to solve the conversion task she was assigned.

4.7.3.6 Teacher check

When TR uses Bahasa Melayu, she took on the "teacher check" discursive practice. She used Bahasa Melayu not to inform or create new knowledge but to check if her students had understood and to emphasise the information/knowledge that she jointly constructed in English. By using Bahasa Melayu in her classroom discourse, TR was affording her students, especially the ones who were struggling in English, an opportunity to engage with the mathematical content.

TM on the other hand, shared the role of "teacher check" with her students when she invited the class to join her in checking their friends' work on the board, for example Charmaine's mistake. TM nominated some students to the front to solve mathematical problems on the board. The solved mathematical problems become the teaching and learning event as TM and the rest of the class jointly check with her invitation, "correct or not" (see M:3:3).

4.7.3.7 Recasting/revoicing students' responses

TR and TM often repeated their students' responses and almost always expanded their answers. For example, when her students answer "fifteen", TR repeated and expanded it to "fifteen centimetre" (R:1:2). Although in the beginning her students did not engage with it and kept omitting the unit in their answer, later they seem to have attended to it for they answered with the unit (R:2:7). According to TR, it was important that she stressed this structure and ensured her students have attended to it because omitting the unit in the exam would mean that they would lose marks.

TM, in M:4:1, recasted the response from the class, "front…front". TM revoiced as she asked, "goes to right side or left side?". And in M:4:3, TM is reproachful as she recasts her students' response, "Don't say go back. Say right or left".

4.7.3.8 Revisiting key ideas

Both TR and TM revisited the mathematical knowledge related to "relationship between units" and "conversion of units" repeatedly throughout their lesson. By revisiting these two aspects in almost every conversion task they set their students, they are making available for their students to attend to these key mathematical content. Besides every conversion task they discussed at the board, the summing up TR and TM did at the end of the lesson enabled them to revisit and recapture the conversion rule and formula for their student to take note.

4.7.3.9 Relating to/drawing on students' previous knowledge

To locate the concept of "relationship" in familiar grounds, TR drew on the jointly constructed knowledge in the previous topic, "Time", that also draws on the concept of relationship. As TR began her unit on "Length" and linked with the previous unit on "Time", she reminded her students that they already have the knowledge about "relationship" and that they were going to draw on this understanding as they learn a new topic. Only after recalling this connection with the earlier topic on "relationship" did TR proceed to give them the 1cm=10mm relationship.

Both TM's "bowl system" and TR's "jumping method" are not introduced for the first time in this unit on "Length". The "bowl system" and "jumping method" of multiplying and dividing with 10 and 100 have been taught to their students during the unit on "Decimals". Both TR and TM drew on this knowledge as they transfered the teaching and learning from the unit on "Decimals" to the unit on "Length".

4.7.3.10 Using cued elicitation to encourage joint construction

In R:2:7 and R:2:9 TR was not in her "teacher check" mode where only she knows the answer but by using the question tag, "isn't it?" TR relinquished a little of her "teacher inform" discursive practice and "teacher check" status and began to share the knowledge constructing role with her students as she saw that most of her students now knew how to do the conversion. TM, on the other hand, invited her students to share the role of checking with her "correct or not?" (M:3:3). With her invitation, "correct or not?", TM encouraged the joint construction of the mathematical knowledge.

4.7.4 Opportunities made available for learning of mathematical content and mathematical English

Only through TR and TM, their students had the opportunity to learn another two methods of conversion that is different from the prescribed method in the mandated textbook. It is also through their teacher talk that the students had the opportunity to learn relevant mathematical English and when neither of the teachers used certain mathematical terms, the students were also not exposed to these terms and did not have the opportunity to learn them. I also found that certain mathematical knowledge was made available to the students by omission, that is, the students made informed/intelligent guesses based on what was unavailable. I summarise the findings under three heading: (i) opportunities made available, (ii) missed opportunities and (iii) opportunities made available by omission.

4.7.4.1 Opportunities made available

4.7.4.1.1 Concepts, content & terms

In R:1:1, TR made available, both orally (in her talk) and visually (on the board) mathematical concepts and mathematical English. She stated "millimetre, centimetre, metre and kilometre" and wrote "mm, cm, m, km". She stated and wrote the units in an ascending order, bigger (in value) and longer (in length). Besides that, TR did not state important terms like "shorter" and "longer" on their own but connected them to the relevant/respective standard units. TR also made available the mathematical concept and mathematical English "short/long" with the use of the ruler(s) and "same length" with the use of her ribbons. Her students had the opportunity to attend to these mathematical concepts and mathematical English not only through her classroom talk but also through tangible objects (rulers and ribbons).

TM also made available, although in written form only, the definition of length and the units of length as well as their abbreviated form and in an ascending order in M:1:B. However unlike TR who only wrote the abbreviated form after making the full form available in speech, TM spelled out the whole unit and wrote the abbreviations within brackets. TM's students had the opportunity to learn the mathematical concept of what length is but were not provided the opportunity to learn the mathematical English related to it, which is shorter/longer.

I found that in TM's classroom, the opportunities for learning the conversion of units came in the form of notes on the board, teacher's gestures and classroom dialogue. For the learning of mathematical English, the content related words to the conversion of units, it was centred mostly on what TM made available in spoken dialogue and her gestures. The affordance was also made available, in spoken dialogue, by two students particularly, Charmaine and Monica. This means that students from TM's class had the opportunity presented to them not only by TM but also by their classmates too.

I also found that some students attended to TM's affordance, especially "right/left", in speech while some used gestures. However, the students did not show consistency as in the last lesson (see M:9:1) when TM asked them from where the decimal point should "move", they responded "back, back" and not "to the left". When the content-related language "1/2 decimal places" were not made available, the students too never made use of it at all. Even students like Charmaine and Monica did not ever once use this content-related phrase.

TR had also made available, in speech content-related phrase "relationship" and "is equivalent to/ is equal to" and visually the symbol, "=". The phrases and the symbol were constantly made available throughout the two lessons. She also made available other phrases such as "the same as" and in Bahasa Melayu, "sama" that describes the relationship between units.

4.7.4.1.2.Linking with previous topic

As TR began her unit on "Length" (see R:1:1), she connected the concept of "relationship" with the previous topic in "Time". She reminded her students that they already have knowledge about "relationship" and that they were going to draw on this understanding as they learn a new topic. Another point to note is the way TR pronounced the word “re:la:tion:ship:” in an elongated way twice which emphasises the teaching and learning content. Having now focused her students to the content-word “relationship”, she went on to give the relationship while writing on the backboard, 1cm=10mm. In R:2:15 when she did the final summing up of the conversion for the “relationship between units” and “conversion of units”, TR once again linked to the previous topic on “Time”. The students had the opportunity to make the links with the previous unit as they engaged in learning the new unit.

4.7.4.1.3.Code-switching

As TR code-switched, she made available to her students the opportunity to jointly construct the mathematical knowledge that might have remained elusive because of the new medium of instruction. TR made available the mathematical term “convert” in ordinary, everyday language, “change”. In Bahasa Melayu, the term “tukar” covers both these terms. Although the word “change” does not have the same nuances as “convert”, the term “tukar” is the only Bahasa Melayu term that comes close to the mathematical term “convert” and the translation for “tukar” is “change” in everyday language. The students were afforded the opportunity to attend to both the mathematical term (convert) and the everyday language (change) consolidated in Bahasa Melayu with “tukar”.

4.7.4.1.4.Conversion formulae/method

TR and TM made available for their students two methods to do conversion tasks; the long multiplication/division and the “jumping method/bowl system” were not prescribed in the mandated textbook. The textbook prescribes the “partition method”. According to both these teachers, in the reality of the classroom their two methods of conversion are important. In fact, taking into consideration the many exams/tests they have to prepare their students for, they said they are bound to emphasise the “jumping method/bowl system”. TM’s notes on the board in M:1:B and measurement task in M:2:B, only makes available these two methods and not the prescribed textbook's "partition method".

4.7.4.2 Missed opportunities

4.7.4.2.1. Mathematical terms

Other mathematical terms have been made available in the textbook (Appendix C) but they were not made available to the students by their teachers. Mathematical terms such as "height, width, breadth, thickness" were never used by TM at all and TR uses only "thickness". The mathematical meaning and difference between these mathematical terms were not explored, explained, examined and they were not made available to TM's students. The mathematical concepts and mathematical English related to these terms were not mediated in written or spoken form. There was no discursive practice around these terms and there was no opportunity for TM's students' to attend to them.

TR, who followed the textbook closely, did touch on "height" and "width" besides "thickness". When TR used the term, "thickness" and showed them what thickness meant as well as the ruler/tool that is used to measure thickness, TR has made available for her students both the mathematical concept and mathematical English related to the term thickness and its connection to this unit on "Length". As she discussed the tasks in the textbook (Appendix C), TR made available for her students two terms, "width" and "height". Her students had to measure the *width* of the stamp and the *length* of the safety pin. They also had to estimate the *height* of their friend. However, TR did not really explore, explain or examine the differences and similarities between these terms. And TR too, like TM, did not use the term "breadth".

4.7.4.2.2 Linking with previous topic

While TR linked the concept "relationship" with the previous unit on "Time", she did not connect her "jumping method" to the topic on Decimals. According to TR, in her stimulated recall, it is during the topic on "Decimals" that she taught her students the "jumping method". However she does hint in R:2:13 and R:3:1 that she has taught them the "jumping method" before. TM also had taught her students the "bowl system" during the unit on "Decimals" and she too like TR does not make the link for her students.

4.7.4.3 Opportunity made available by omission

In R:2:10, TR wrote on the blackboard, 30mm=__cm. A look at the blackboard reveals that that the conversion task that was on the board, from R:2:8 and R:2:9, are from centimetre to millimetre and the method, TR had highlighted by drawing a box around it, $\boxed{\text{x 10}}$. When they saw the board in R:2:10, they saw that the conversion task (30mm=__cm) was just the opposite, because it was from millimetre to centimetre. From the units in this question, they knew that they could not use "multiplication" and made an informed decision to "divide". Even though they did not mention "divide", their answer, "three centimetre" showed that they did attend to it mentally. The mathematical knowledge to convert millimetre to centimetre, they have to "divide", had then been made available by omission.

4.7.5 Other findings

Besides the findings mentioned above, categorised around the research questions, there are other related findings that I have noticed in TM's and TR's class. They will be discussed below:

4.7.5.1 Discursive space

Like in all teacher-fronted classrooms, TR and TM nominated who responded to their elicitation if they sought individual response. Otherwise, the class responded as a whole. And the excerpts display this element of teacher talk controlling the teaching and learning event and dominating the discursive space. In a way they do, but within this teacher control there was discursive space for students as well. This discursive space seemed to be increasing as the lessons progressed. In fact, one of TR's students initiated a question (R:2:5) while another offered to show another way to do conversion (R:2:12) while a third kept calling the teacher until the teacher responded by going over to the student's desk (R:2:14).

TR's students seemed to respond as a class to TR's elicitation and individual responses were seen only when TR nominated particular students. In R:2:4 where TR nominated Iris to come to the front of the class and hold the ribbon and later on Aishah to ask if the two ribbons were of the same length. But another one of her students, Adrianna, nominated herself. Responding to Adrianna's bid, TR invited her to the front to hold the other ribbon. Although Adrianna did not contribute to the classroom "talk" per se in the joint construction of the relationship between 30cm and 300mm, her participation in holding the ribbon up and being in front of the classroom with Iris perhaps was an initial start to help her with the process of the joint construction. Perhaps by being in front and holding up the ribbon Adrianna was actively constructing the relationship between the units of the ribbon although TR eventually took the ribbon from both Iris and Adrianna and held them together to show that the two ribbons were of the same length. In the beginning of R:2:4, when TR seemed to hold the discursive space longer, she seemed to be in the "teacher inform" mode. However, she relinquished the floor when she called Iris and Adriana forward. With the students physically sharing the teacher space in front of the class, they seemed to "force" TR to relinquish the "teacher inform" mode and adopt the "teacher elicit" mode. When she did that, there was more student participation for example in R:2:5 with Tali. Compared to Adrianna who merely held up the ribbon TR passed to her, Tali had more contribution towards the joint construction of the 20cm=200mm relationship as she and her group had to decide if their ribbon was the correct one before Tali raised her hand. TR got Tali to state the measurement of her ribbon, "200mm" and got Tali and Aishah who were in front to compare the ribbons instead of doing so herself like she did in R:2:4. Adrianna and Tali entered not only into the teacher space physically but also entered into the discursive space of the class which was usually controlled by TR.

In TM's class, she too nominated her students especially when she wanted them to come to the board and solve the mathematical problem she wrote on the board. Then when TM checked the students' solution on the board, she did so with the whole class. Charmaine and Monica constantly injected their answer as TM handled the classroom talk. In fact the class as a whole made many bids to catch TM's attention and often offered answers compared to the students in TR's class. TM's students seemed to contribute to the discursive space more often than TR's students. For example, in M:9:1 both TM and her students seemed to occupy equal talk space in the classroom. Comparisons with the excerpts in the beginning of the unit on "Length" which revealed TM seemingly dominating the classroom talk but in M:9:1, this was visibly reduced. Although it was still very much teacher controlled discursive space, TM's turns were neither as long nor as frequent as they were earlier on.

4.7.5.2 The power of teacher validation

In M:3:1, TM ignored Monica's correct and more appropriate reply and took up what Charmaine had said and asked Charmaine for more elaboration. But Charmaine remained silent for she might have realised that Monica's answer, "left to right" was more appropriate than her own answer "four". Monica modified her answer from "left to right" to "after four" when she did not receive any validation from her teacher. By following up on Charmaine's answer, "four", TM seemed to be validating it compared to Monica's answer. Seeing her teacher follow up on Charmaine's response, Monica might have felt that her answer was not what her teacher wanted and modified her answer to suit her teacher's question even though her answer was actually correct and more accurate. Thus is the power of teacher following up on student's response – the power of validating students' response(s).

4.7.5.3 Conceptual understanding versus procedural fluency

From the excerpts, it is evident that TM had focused solely on her "bowl system" after she had written the different relationships between units as notes on the board. Having taught them, from Lesson 1 itself this “bowl system”, TM encouraged her students to use it even though they seem to prefer the long multiplication/division. Every time the conversion task was solved using the long multiplication/division, TM went on to demonstrate right beside the solution her “bowl system”. Her students eventually developed fluency in using this method of conversion for they even indicated with gestures the direction and the number of times the arrow should be “moved”. TM seemed to be focusing on helping her students find answers to problems according to set rules which Schwartz (2008) calls procedural fluency.

TR’s students, on the other hand, jointly constructed the concept of short/long/same length, the different relationships through the ribbon activity and rulers. With TR, they jointly constructed the conversion formulae and were taught the “partition method” and they also tested the jointly constructed conversion formulae using the long multiplication/division method before learning the “jumping method”. Although TR eventually focused on procedural fluency as well, she tried to consolidate her students’ content knowledge through conceptual understanding.

Comparing the Ministry mandated textbook and the school chosen supplementary books that the students have access to, the textbook has less language usage in the form of explanation compared to the supplementary book, especially TM’s books. It seems that the supplementary books provide more linguistic scaffolding while the textbook provides more illustrations and pictorial scaffold related to the mathematics content for both TM and her students. The textbook seems to represent and advocate conceptual understanding of mathematics while the supplementary books embody and encourage procedural knowledge. The questions in the supplementary books are like the questions found in tests/exams. Hence procedural fluency that the “bowl system/jumping method” offered was important.

4.7.5.4. Teaching for understanding versus teaching for testing

The chosen excerpts have given an insight into the ways TR and TM handle the second learning objective – "relationships between units" and "conversion of units". TR's teaching and learning procedures and activities from Lessons 1-5 concentrated on jointly constructing an understanding of the mathematical content. Mostly from Lesson 6 onwards, TR emphasised her "jumping method" to do the conversion. It can be seen that, having jointly constructed with her students the shared conceptual knowledge, TR's teaching now focuses on assessment needs and exam ways of knowing. TM, on the other hand, only concentrated on getting her students to be exam-wise. She directly and solely focused on her "bowl system" and jointly constructed this knowledge with them.

In short, my findings revealed that teacher talk plays a crucial role in mediating the learning of mathematical content, concepts and terms, especially those not found in the textbook. The shorter conversion methods, not evident in the prescribed official textbook, were made available by both the teachers through their talk in the classroom. Although there was no direct reference to the supplementary books which have been written the "exam way", these books seemed to inform the teachers', especially TM's, teaching of "relationship between units" and "conversion of units". With the implementation of ETeMS, both the teachers employed code-switching strategies whenever their students or they were stuck. Besides that, teacher talk seemed to vary in degrees of control for once the content and concept had been mediated, students seemed to take some ownership of the classroom interaction and joint construction of the mathematics knowledge. This analysis also revealed the importance of other mediating tools like the physical objects to mediate the mathematical content and mathematical English. A close scrutiny of the classroom interaction revealed that, despite the seemingly single directional talk and mostly triadic dialogue, both the teachers were employing several discursive practices as they jointly constructed mathematical content and mathematical English with their students. However, the study revealed that there was more of an emphasis on teaching for testing than teaching for understanding, hence more attention on procedural fluency compared to conceptual understanding.

4.8 Discussion

In this section I situate my stories of ETeMS, specifically the teaching and learning of mathematics in English, within some important ideas of sociocultural and sociolinguistic theories as I try to apply them to my findings with the aim of understanding what happens within the academic wor(l)d of the linguistically altered classrooms in this study. The Malaysian mathematics classroom has had another level of complexity added to it and little is yet known about how meaning-making is jointly constructed and mediated through the interactions of the classroom community when the medium of instruction is changed.

I focused on the classroom interaction in the linguistically altered mathematics classroom in two primary schools in Malaysia. I focused on classroom interaction because from the perspective of sociocultural and sociolinguistic theories, teaching and learning is jointly constructed by both teacher and students as they interact in the classroom. These theories claim that pedagogy is tied closely to interactions between people in the classroom. Barwell (2005) claims that "mathematics is constructed through discursive activity" (p. 119). The elements of discursive activity such as the spoken, written or symbolic interaction, including the use of gestures and other non-linguistic aspects of interaction, Barwell says, plays a big role in the construction of mathematical knowledge. My findings have illustrated the ways linguistic and non-linguistic resources were used in the teaching and learning of mathematics in a second language.

My study has shown evidence of linguistically altered interaction in the mathematics classrooms in Malaysia. Stacey (2002) says that teaching is seen by followers of Vygotsky's sociocultural theory as a product of interactions between the teacher, the students and mathematical content in a context. Stacey's statement aptly captures the inter-connectedness and complexity of teaching. But what mainly holds this complexity is the interaction. While in Malaysia everything remains the same that is the teacher, the students, the mathematical content and even the context as Stacey pointed out, the medium of instruction is new. I seek to understand the once familiar classroom with its now unfamiliar medium of instruction due to ETeMS through the lens of sociocultural and sociolinguistic theories. These insights have important pedagogical implications for both the teaching and learning practices as well as the policy. I begin with Vygotsky's idea of the zone of proximal development (ZPD).

4.8.1 Assisted performance

Vygotsky claims that the development of a behaviour occurs on two levels that form the boundaries of ZPD. The lower level is the child's independent performance – what the child knows and can do alone. The higher level is the maximum the child can reach with help and is called assisted performance. Bodrova and Leong (2007) found that between maximally assisted performance and independent performance lie varying degrees of partially assisted performance. It is in this "varying degree of partially assisted performance" during the teaching and learning of "conversion of units" that I am interested in. In the excerpts that have been analysed in Chapter Four, TR and TM in varying degree of partially assisted performance mediated the teaching and learning *of* mathematics *in* English.

Looking at TR make the link to the topic on "Time" in Lesson 1 from the perspective of Vygotsky's ideas on ZPD, it seems that at the lower level of ZPD - the students' independent performance – TR makes the assumption that her students know about the concept of "relationship" because they have encountered it in the previous topic on "Time". What TR is trying to do, in her Lesson 1 on "Length", is bring her students to the higher level of ZPD – that is, use the knowledge already jointly constructed on this concept of "relationship" to another setting, to this unit on "Length" specifically.

There are two methods of conversion both TR and TM seem to focus upon that are not found in the mandated textbook which offers the "partition method". One is the long method where they either have to multiply with or divide by 10 or 100 depending on the conversion task. The other is the shorter method, TR's "jumping method" and TM's "bowl system" where you "move" the decimal point 1 place/2 places either to the right/left. While the students are familiar with the long method, TM and TR are trying to teach them and get them to use the shorter method as it will be useful during exams. This means that at the lower level of ZPD - the students' independent performance - the students know how to multiply or divide by 10 or 100 using the long method to convert units of length. The higher level of ZPD - the "jumping method and bowl system" - is where TM and TR are pushing their students with assisted performance.

4.8.2 ZPD and mediators

Looking at the interaction between TM and her students in their shared teaching and learning activities during the "conversion of units" using the "bowl system" TM questions her students and elicits answers as well as follows up on their answers. Bodrova and Leong (2007) say that "mediators exist in shared activity" (p. 58). As TM questions and elicits answers, she gets her students involved as she mediates and at the same time jointly constructs, with them, the sense-making process of doing conversion using the "bowl system". TM constantly touches on the three aspects related to her "bowl system" – (i) the direction the decimal point is going to "move", (ii) the number of places the decimal point is going to "move" and (iii) the justification for the number of times the decimal point should be "moved". By asking questions, TM also models the logic of learning and the strategies her students can use to do conversion of units next time. Put another way, TM jointly constructs a template with her students for doing "conversion of units" using her “bowl system”. This template is to work as the mediator during conversion tasks. As her students engage with TM’s oral mediation, TM also gets them engaged with her visual mediation – where she demonstrates the moving of the arrow on the board and with her gestures. Bodrova and Leong (2007) explain that this is natural in the process of teaching and learning because “external mediators are among the first mental tools young children learn to use” (p. 51). TM tries to make her actions in speech and visuals explicit to mediate the learning of conversion of units using her “bowl system”. Her students also respond orally to her questions as well as use gestures as they show the direction the arrows must “move”.

Looking at the term “bowl system” and “jumping method” TM and TR have coined, it is their mediational tool to the shorter way of tackling the conversion of unit. TM reminds her students to draw the arrows of her “bowl system” in blue. Jappinen (2005) in her study on Content and Language Integrated Learning (CLIL) students noted that the CLIL students needed much support to “move” through their ZPD in terms of (i) extra explanations and help from the teacher and fellow students, (ii) special gesticulation and “movement”, (iii) special features of spoken language, and (iv) supportive materials. From Jappinin’s view, TM uses the blue colour, as an external tool, to mediate the “movement” of the arrow in her “bowl system” by making it visibly explicit. In fact during the stimulated recall session, TM emphasised the importance of using the blue colour especially in the notes they copy. This suggests that TM views mathematics as sets of procedures to be learnt hence the importance to her of notes. She said the blue colour helps them to be more aware of the “bowl system” and helps her students attend to it. Inherent in the “movement” of the blue coloured arrow is all the three aspects of conversion; the direction the decimal point “moves”, the number of times it “moves” and why it “moves” 1/2 place(s) to the right/left. Bodrova and Leong say that “we create mediators to prompt a specific response” (p. 51). TM’s blue coloured arrows are her mediators to prompt her students to think of the three aspects of conversion and help them move through their

ZPD in terms of her “bowl system”. Besides the blue colour pencil and the blue coloured arrows, the use of other mediators in TM’s and TR’s classes also play important roles in the teaching and learning *of* mathematics *in* English. McDonald et al (2005) state that, “all manner of things have been considered as tools if their function or their consequence is mediation” (p. 114).

4.8.3 Tools as mediators

As seen in the previous sections, TR used several other tools as mediators. TR’s use of rulers and ribbons also helped mediate the mathematical content and conversion formula. Several researchers have highlighted the importance of using tools for the teaching and learning of mathematics. Schliemann (2002) says that, “tools, artifacts, and cultural representations are important components of mathematical learning” (p. 301) while Cobb et al (2001) say, “an emphasis on tools is generally consistent with the notion of mediated action” (p. 121). Anthony & Walshaw (2008) also observed that, “tools can act as a springboard for discussion and for structuring mathematical knowledge” (p. 212). Looking at TR and her use of the rulers and ribbons which mediated the concept of long/short/same length as well as the “relationships between units” (1cm=10mm and 1m=100cm), her students got so “see” the concepts and the actual length compared to students in TM’s class. TM’s students were told that 1cm=10mm and 1m=100cm, but they had no notion of the actual length of 1mm, 1cm or 1m.

While TR’s tools can be seen as increasing her students’ access to the mathematical concepts and content, McDonald et al (2005) cautions against this interpretation because it acts upon “the assumption that by handling objects, students will gain an understanding of the mathematical concepts represented” (p. 119). Furthermore, in TR’s class the tool was not being used as “a means of reasoning about measures” as observed by Cobb et al (2001) in their study but used as “a measurement device” (p. 145). McClain (2002) also talks about this danger of, “giving agency to the tools instead of acknowledging the importance of accounting for the students' activity as they used the tools for analysis" (p. 246).

Having explored how students are afforded opportunities (or not) to learn mathematics through tools, Anthony & Walshaw (2008) say that, "whatever tools in use, research has found that messages conveyed *by teachers' words* and actions are of paramount importance in influencing the way in which learning occurs" (p. 210). Anthony & Walshaw pointed out succinctly that *teacher's words*, in this study interpreted as teacher talk during classroom interaction, are of paramount importance. Teacher's words or teacher talk is an important mediating tool. This is also pointed out by Schliemann (2002):

> Given the complex interaction between the use of tools and the development of reasoning and learning, the question that should concern educators is not how powerful or effective cultural tools are in promoting learning, but rather what teaching practices and classroom interactions can promote meaningful learning and understanding of the mathematical principles and relations embedded in cultural tools and representations (p. 302).

Anthony & Walshaw as well as Schliemann capture the complexity of teaching and learning mathematics *in* English in Malaysia since the implementation of ETeMS. In the section below, I explore talk as mediator as TM and TR teach *in* English.

4.8.4 Talk as mediator

It is through TR's use of "short(er)/long(er)" in her talk and the use of the rulers that helped her students learn this concept. The textbook did not have these adjectives. It is then not made available for them. They may not have attended to it if TR had not given them this linguistic scaffold. As Ohta (2005, p. 509) says, "a teacher's lecture can serve as a scaffold upon which students can construct new knowledge, functioning as assistance in the ZPD".

When TM picks on Charmaine's mistake and assists Charmaine and the class to see the mistake in the "bowl system" they had copied, her "talk about the mistake" plays a role in mediating the teaching and learning of conversion of units because TM is helping them see the error. Compared to Lesson 1 (M:1:B) and Lesson 2 (M:2:B) where they had only copied the bowl system that was given to them in Lesson 3 (M:3:1), the error made public and the correct version showed help the students revisit and bring to their attention the "bowl system" that was taught to them during the unit on "Decimals". The teaching and learning event around Charmaine's mistake acts as a mediator. According to Bodrova and Leong, "mediators can assist a number of mental processes: perception, attention, memory and thinking" (p. 54) and TM's move in making the error as a teaching and learning event is relevant and an appropriate mediating move.

TM's and TR's practice of writing the "notes" related to "relationship between units" and "conversion of units" on the blackboard also act as mediator for their students when they come forward to solve the conversion task on the board. While some could use the notes to solve the problems, I find that some students could not. It was the "teacher talk" that accompanied the "notes" that mediated the mathematical tasks.

4.8.5 Code-switching

TR uses informal, everyday language "change" in mathematics lessons alongside the technical mathematical vocabulary "convert". In fact she also code-switches and uses "tukar" to help her students grasp the meaning of "conversion". TR's "assisted performance" (Bodrova & Leong, 2007) was delivered in both English and Bahasa Melayu at various instances in varying degrees. TR used Bahasa Melayu when she needed to check if her students understood and when she needed to explain new ideas she had put forth. Kasule & Mapolelo (2005, p. 602) say that, "each student's mother tongue is the key to the world and a means of alleviating the abstract nature of classroom learning events". Some studies (Akindele and Letsoela, 2001; Nyati Ramahobo and Orr, 1993) have portrayed the view that code-switching is a form of compensatory strategy for some linguistic deficiency in the teacher. However, Setati (2002), reveals that code-switching is an additional teaching resource. She explains that code-switching is a support which allows mediated learning to occur through talk while students continue to develop proficiency in the target language.

TM does not code-switch so often but every now and then steps into the student role to ask questions. When TM steps into the students' role she seems to use her deliberate action as a mediator to get her students to focus on and attend to the points she wants to raise – the difference between moving the decimal point if it is whole number and decimal number (M:3:3) as well as the similarity between whole number with and without the decimal point (M:7:2). Bodrova and Leong say that "the ability to attend deliberately is a necessary skill for learning" (p. 55).

4.8.6 Sharing space and opportunity

I looked at the physical setting of the traditional teacher-fronted classroom because Poole & Patthey-Chavez (1994) say that, "any observer of school discourse practices soon realises that they are profoundly influenced by their larger settings" (p. 6). When TR stands alone in front of the classroom, she dominates the discursive space. She begins with the "teacher inform" mode, as though she has a lot of knowledge and information to impart. As she progresses into the "teacher elicit" mode, she shares the discourse space with her students, especially during the ribbon activity. It is as though her load of knowledge/information is lighter after she has shared and jointly constructed new knowledge with her students. Her students who have been quiet in the beginning when TR was in her "teacher inform" mode seem to now share more openly in the joint construction of knowledge as TR moves into "teacher elicit" mode. There is also evidence of students calling out the correct answer and method of conversion even before TR elicits or prompts. TR also shares the blackboard when she invites two students to solve the problem on the board. In fact after she has let Arissa into her "teacher space", Arissa offers to solve the conversion task in another method. TR is reminded, by Arissa's offer, of the "jumping method" which she then prompts Faiz to follow. While TR might be controlled by the teacher-fronted spatial arrangement where talk is structured so that the floor cannot remain with the student for long (Poole & Patthey-Chavez, 1994, p. 11), her students find space and opportunity to participate in the construction of mathematical knowledge.

4.8.7 Triadic dialogue

Interaction in most teacher-fronted classrooms are usually triadic in nature (see section 2.5.1). Haneda (2009b, p. 344) says that triadic dialogue is the staple of many classrooms, with teachers mainly asking known-information questions (KIQ) as they involve their students in the co-construction of knowledge. There is a clear difference from the version of triadic dialogue – the IRE exchange Mehan (1979) talks about where the teacher uses KIQs to test students' understanding or evaluate the accuracy of the response. While TR and TM also ask their students many KIQs, I noticed that, like in Haneda's findings, it was to involve their students as they jointly construct the mathematical knowledge within the new medium of instruction. Through their discursive practices, both TR and TM not only validated their students' responses but also reformulated and expanded on them. Both TR's and TM's classroom interaction showed evidence of Bodrova & Leong's idea of "assisted performance" which they say includes behaviours performed with the help of or in interaction with, another person. They explain that this interaction may involve giving hints and clues, rephrasing questions, asking the child to restate what has been said, asking the child what s/he understands, demonstrating the task or a portion of it and so on (Bodrova & Leong, 2007, p. 40). Evidence of Bodrova and Leong's "assisted performance" is seen in TR's and TM's discursive practices despite being heavily triadic in nature.

4.8.8 Progression and regression

Every time TR's students respond to her elicitation, they omit saying the unit which is important especially for exams. TR patiently repeats and recasts their answer with the unit. Then finally a forward movement is seen where they seem to have attended to the affordances made available by TR, because they state their response complete with the unit. However soon after that a regression seem to happen where the students again respond without stating the unit. Lantolf & Aljaafreh (1995) claim that students' development and performance is not a smooth linear process, but is one that entails forward movement and regression. Lantolf & Aljaafreh's forward movement and regression can also be found in TM and we see the effect on her students. I found that the language TM uses to deliver the mathematical content does to a certain point affect the teaching and learning in class. Her inconsistency in using "back and front", "here and there", "this side and that side" instead of constantly using left/right did affect her students. Until Lesson 9, her students display confusion. But TM makes up for it with her gestures and drawing on the board. And her students too correctly use gestures to respond.

4.8.9 The texts

TM did not refer at all to the textbook or the teacher's guidebook except when she assigns her students some homework. TR does make an attempt to include the textbook in her teaching. She gets her students to refer to the textbook as she tries to jointly construct the 1cm=10mm relationship (R:1:3). But she too uses the textbook to mostly assign homework. This is not surprising because McDonald et al (2005) observed that a textbook "was not manipulated to achieve understanding, but it was a material artifact carrying written messages" (p. 123).

Both TR and TM remind their class repeatedly to memorise. There also seems to be an emphasis on "memorising" in the teacher's guidebook (see Figure 9). In page 155 (see Figure 9), "Oral *drill* using conversion table" is recommended under the "Key Notes" icon. Then in page 156 (see Figure 9), it is recommended that teacher's "guide students to convert 2cm to mm *mentally*" under the Teaching and Learning Activity section. And "oral *drills*" is once again recommended in page 158 (see Figure 9) under the Remedial section. Although TR advocates memorising with understanding and knowledge, when she spends some time on jointly constructing conceptual knowledge before moving on to procedural knowledge, TM seems to advocate solely the memorisation of her “bowl system”.

4.8.10 Use of examples

From the ribbon activity, TR had jointly constructed a few relationships which she writes on the board. These relationships now act as tools as TR jointly derives the conversion formula with her students. Watson & Mason (2005) talk about the use of the example, a task format that is traditionally taken-for-granted within the mathematics classroom, affording students the opportunity to attend to the mathematics that is being taught. Anthony & Walshaw (2008) also found that “providing a mathematical focus can occur through a range of task formats” (p. 204). By leaving solved mathematical problems on the board, TR and TM afforded their students the opportunity to engage independently with the examples as they tried to solve the question allocated to them. These examples act like models for the students to refer to. TR and TM then go on to write a few questions on the board and get some students to come up and solve the problems. As Anthony and Walshaw state, “practice tasks help children develop fluency and automaticity” (p. 201). As they are engaged in practice tasks, they refer to the examples for guidance.

Having the examples on the board helps the students “notice” and “become aware” of certain features of the conversion task which Ohta (2005) identifies as “input enhancement”. A concept similar to “input enhancement” and “noticing” was also discussed by Cazden (1993, 2001). She calls it “revealing”. She says that between “immersion” and “telling”, “revealing” is a powerful concept that helps students immensely to “notice” and “become aware”. Having taught (“telling”) them the “bowl system/jumping method” and letting them practice (“immersing”) them in conversion tasks, the examples left on the board play the role of “revealing”. Besides that, the use of “examples” in the mathematics classroom is also encouraged by Vygotsky

(1978). He calls it "imitation" and it is a powerful pedagogical tool. Vygotsky says that, "a full understanding of the concept of the zone of proximal development must result in re-evaluation of the role of *imitation* in learning" (p. 87). By trying to "imitate" the example on the board as TM's and TR's students solve their own mathematical problem, the examples act as a temporary crutch until they can reach the higher level of the ZPD when they can solve the conversion task without referring to any example. Anthony & Walshaw (2008) say that, mathematical modelling tasks can provide young children with rich opportunities to engage in a range of mathematical practices as they apply previous learning to their present question.

4.8.11 Conceptual understanding versus procedural fluency

Kilpatrick et al (2001) report that mathematical proficiency is composed of five strands, namely conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, and productive disposition. They comment that traditional curricula emphasise only one of these five: procedural fluency. While this is true of TM and her teaching of the "bowl system", TR does make an attempt to build her students' conceptual understanding although the reality of the exams cause her to place more importance on procedural fluency through her "jumping method".

Sfard and McClain (2002) recommend replacing "learning-as-acquisition" with "learning-as-legitimate peripheral participation". They say that, "those who adhere to this approach talk of *knowing* rather than *knowledge* and of *mathematizing* rather than *mathematics*" (p. 115). Looking at TM's classroom interaction as she teaches "relationships between units" and "conversion of units" from Sfard and McClain's advice, as TM gets her students familiar with her "bowl system", it would seem that she is concentrating on "knowledge", "mathematics" and "learning-as-acquisition". Perhaps this is because TM concentrates on procedural fluency and automaticity which is valued in assessment. Although TR's structure of her lessons show that she attempts to incorporate conceptual knowledge before going on to procedural fluency, her classroom interaction reveals otherwise. Where you would expect to see the essence of "knowing", "mathematizing" and "learning-as-legitimate peripheral participation" in the classroom interaction, I noticed instead an emphasis on "knowledge", "mathematics" and "learning-as-acquisition". The interesting question that arises is whether this happens because of the change in the medium of instruction or because they felt that their students were not "linguistically ready" (Wee, Atweh, Clarkson & Ellerton, 2008).

4.8.12 Teaching for understanding versus teaching for testing

In the reality of school mathematics, exams play an influential role. Zevenbergen (2005) found that, "one of the most obvious structuring practices in mathematics education is that of assessment" (p. 613). Both TR's "jumping method" and TM's "bowl system" and all the classroom interaction that surround the teaching and learning of this conversion method is geared towards the many tests and exams their students have to sit for. This is supported by Mulligan et al (2006) who found that tasks that focused on improving students' visual memory and enhancing their ability to identify and apply patterns resulted in a marked improvement in students' assessment scores. Thus, it is hardly surprising that "teaching for testing" has more emphasis than "teaching for understanding" in both TM's and TR's classrooms.

4.8.13 Learning to talk maths and talking to learn maths

The divide between conceptual understanding versus procedural fluency and teaching for understanding versus teaching for testing seem to have an effect on the kind of talk and interaction that takes place in the mathematics classroom. In fact Cobb et al (2001) found through interaction, that the actual learning trajectory of the classroom community can be documented (p. 125). They identify two types of discourse in the mathematics classroom; calculational discourse and conceptual discourse:

> In calculational discourse, the focus of classroom conversations is on the calculational method or process for producing results.

> Calculational explanations of measuring activity involve giving a warrant by demonstrating how a measurement tool was used to produce a numerical value. In contrast, the hallmark of conceptual discourse about measuring is that students are obliged to give a backing by explaining how they structured space as they measured (p. 134).

They emphasise that classroom discourse should be conceptual rather than calculational in nature. Looking at TM and TR's classroom discourse from their point of view, it would seem that calculational discourse was the main form of discourse in both the classrooms; the learning trajectory would then be procedural fluency. For conceptual discourse to be encouraged, the students to a certain extent need to be afforded the opportunity to participate in the classroom discourse. But the students in TM's and TR's classes are used to the teacher-fronted classroom, where teachers' talk dominates the classroom discourse. This is not surprising because the students already understand the culture of the classroom (McDonald et al, 2005, p. 118) and the students in my study started schooling three years ago. Despite the change in the medium of instruction, this element still manifests itself in TR's and TM's classrooms. Anthony & Walshaw (2008) say that "the daily practices and rituals of the classroom play an important part in how students perceive and learn mathematics" (p. 197). The students in these two classrooms have been ritualised and socialised into less participation in class, and therefore less used to "talking to learn maths". It would seem that the newly introduced medium of instruction does not seem to affect the way mathematics is taught but the teacher-fronted classroom culture does.

TM's classroom talk reveals that it is more calculational than conceptual which is expected as she concentrates on the teaching of procedural knowledge related to her "bowl system". TR's classroom talk, despite dwelling on the teaching and learning of conceptual knowledge, reveals that it is also rather calculational than conceptual in nature. This is not surprising because Anthony and Walshaw (2008) found from their research that mostly "the mathematics talk highlighted procedures rather than conceptual understanding" (p. 199). They found in their study that the level of engagement in actual mathematical task was minimal as "cognitive space" was limited. They reported that pause times for thinking were rarely offered and students were occasionally 'talked over' (p. 201). While I found this to be true in the beginning lessons of both TM's and TR's unit on "Length", later lessons reveal that students took more control and their participation increased in the classroom. After having jointly constructed the "shared jointly constructed knowledge" (in terms of sociocultural theory) by the teacher (in terms of teacher-fronted, transmission modelled classroom), the students in both the classroom showed more agency. However their interactional structure was more calculational than conceptual as they were mostly afforded and attended to the teachers' calculational discourse.

Meaney (2006) stated that developing conceptual understanding requires the teacher to move from prompting students to recognise the new language to facilitating experiences in which new language is needed for efficient communication of mathematical ideas. Meaney's idea of "facilitating experiences" is seen in TM's and TR's class as they get their students to come forward and solve the conversion task they set their students. But the experience these two teachers facilitate is the "fluency" and "automaticity" that is beneficial for assessment purposes. Meaney's suggestion that "the language needed for efficient communication of mathematical ideas" was not and could not be facilitated, to a certain extent, because of an emphasis on exam knowledge. Or it may have also been caused by linguistic incompetency.

4.9 Summary

I have applied ideas from both sociocultural and sociolinguistic theories to understand how learning occurs in two linguistically altered mathematics classrooms. My analysis of mediating academic wor(l)ds reveals that the teaching and learning activities in the mathematics classroom were highly influenced by the discursive activity that celebrated the exam and assessment way of knowledge, hence the emphasis on “bowl system” and “jumping method”. This study also reveals that the two teachers in my study still rely heavily on the triadic dialogue or calculational discourse as opposed to conceptual discourse in their classroom. Despite that, both the teachers were employing several discursive practices like recasting/revoicing students’ responses, revisiting key ideas and relating to/drawing on students’ previous knowledge as they jointly constructed mathematical knowledge with their students. Practices like code-switching, use of gestures and visuals were used as compensatory strategies in the joint construction of mathematical content and mathematical English.

The linguistically altered classrooms in this study have also been analysed to gain insights into classroom life. This will be discussed in the following chapter, mediating social wor(l)ds: stories of teaching and learning in linguistically altered classrooms.

CHAPTER FIVE

Mediating Social Wor(l)d: Stories of Teaching and Learning in Linguistically Altered Mathematics Classrooms

5.1 Introduction

Having in the previous chapter narrated the stories of the academic wor(l)ds of the two linguistically altered mathematics classrooms in Malaysia, in this chapter I seek to narrate the stories of their social wor(l)ds. The academic and social aspects of teaching and learning are not in a binary opposition of cognitive and affective domains, but are intertwined in the everyday classroom life jointly constructed by teachers and students. Thus, I apply sociocultural and sociolinguistic theoretical and methodological framework outlined in Chapters Two and Three to analyse classroom interaction as well as teaching and learning events and practices to include the affective aspects in the overall analysis of teaching and learning mathematics *in* English.

The teachers in these two classrooms were engaged in the *task* of teaching the prescribed topic on "Length" *in* English. Amidst their *task* of teaching, we get glimpses of different *activities* that were going on. Coughlan & Duff (1994) have shown that "an activity comprises the behaviour that is actually produced when an individual (or group) performs a task" (p. 175). Cobb (1998) says that what begins as one activity can reshape itself into another activity in the course of its unfolding. As TM and TR are engaged in the task of teaching the unit on "Length" in English, other activities that were going on amidst the task of teaching and learning are explored in order to get a deeper understanding of life in the linguistically altered classrooms. Therefore as I examine classroom interaction, I look at the multimodality of the interaction for "they may substitute for what is not (or cannot be) said" (Stivers and Sidnell, 2005, pp. 8-9). Examining classroom interaction and practices in the way Stivers and Sidnell propose would enable me not only to understand the interrelated cognitive and affective dimensions of teaching and learning, but allow me to present a more comprehensive picture of classroom life.

I will begin, in section 5.2, by depicting two incidents that give a glimpse into the "ways of being" (Heath, 1983) that are expected and accepted in teacher-fronted classrooms in Malaysia. Next, in section 5.3, several excerpts of classroom interaction pertaining to "language repair" during the teaching and learning of mathematics *in* English are analysed. Then, in section 5.4, I go on to describe selected classroom events and practices related to "mathematical repair" during this teaching and learning *of* the unit on length in English. "Laughter and silence" in classroom interaction is also investigated to give more insights into the social life of the two classrooms in this study in section 5.5. In section 5.6 I summarise my findings around my final research question and in section 5.7, I apply some of the important ideas from sociocultural and sociolinguistic theories with the aim of understanding what happens within the social wor(l)d of the two linguistically altered classrooms in this study.

5.2 "Way of being" in teacher-fronted classrooms in Malaysia

I have selected two incidents accompanied with excerpts that depict a "way of being" (adapted from Heath's (1983) "way*s* of being") in Malaysian classrooms. In Malaysia generally, and in our teacher-fronted classrooms specifically, standing up when spoken to is seen as a sign of respect for the older person or the person in authority especially when they are talking to someone younger. The excerpts from TM's and TR's classes as well as the contextual clues capture the incident related to this "way of being".

5.2.1 In TM's classroom

I begin with the incident from TM's class, in excerpt TM:2:1 [SW], where Monica, a student, seems to be aware of the "way of being" and acts accordingly by eventually standing up without being prompted to do so. In Lesson 2, having drawn four tables on the board for the students to fill the measurement of the objects they measure, TM walks around the class, checking on her students as they copy down the tables into their exercise books. All the students were seated at their desks copying the tables from the board. I noticed TM hovering over her students, giving a comment or two and moving on. Her students remain seated and mostly nod as TM gives her brief comments. TM too does not linger long. But when she comes to Monica's table, she stops for a longer period of time. She points out to Monica that her rows are too narrow and there might not be enough space to fill in the measurement and do the conversion task. After a few turns of interaction, Monica who is seated stands up as she answers her teacher.

Excerpt TM:2:1 [SW]

No.	Speaker	Classroom Interaction	Observation
1.	**TM**	**This space is enough for convert?**	*Three tables are arranged to form a row and Monica is **seated** at the centre table. TM stands at the end of the row, leans over and points to Monica's exercise book.*
2.	**Mo**		*Monica, who is **seated**, is in the midst of looking down at her book, looks up and nods to TM who has placed both her hands on the first table and is leaning down looking at Monica.*
3.	**TM**	**Is it enough?**	*TM straightens up and folds her arms across her chest.*
4.	**Mo**		*Monica, **seated**, nods again while looking at her teacher.*
5.	**TM**	**Enough?**	*TM turns slightly to her right and points her right hand towards the whiteboard.*
6.		**Can you show the working?**	
7.	**Mo**		*Monica, **seated**, is still looking at TM.*
8.	**TM**	**Enough?**	*TM, standing with her arms folded, looks at Monica. Her voice becomes sterner.*
9.	**Mo**		*Monica, **seated**, nods while TM looks*

			at her.
10. 11	**TM**	**If too..** **too nearer means?**	*TM, still standing with her arms folded look down at Monica seated at her desk. She now has a slight frown.*
12.	**Mo**		*Monica now **slowly stands up**, her hands on her desk, while still looking at her teacher*
13. 14. 15.	**TM**	**The** **Ok** **You're going to convert, isn't it?**	*TM, places her hands on the first table and leans down looking at Monica.*
16.	**Mo**		*Monica, **standing**, nods at her teacher.*
17. 18. 19.	**TM**	**The** **If the numerals to convert is too nearer means** **what you're supposed to do?**	*TM, still leaning down, looks at Monica and points to her exercise book.*
20.	**Mo**	**write smaller**	*Monica, still **standing**, looks down at her exercise book, and then looks up at TM as she answers.*
21.	**TM**	**Why two lines?**	*TM straightens slightly from her leaning position while her hands are still placed on the first table. Her frown deepens. Monica, **standing**, is facing her teacher.*
22.		**Why you never leave three lines like that?**	*TM is still frowning. Monica is **still standing** and facing her teacher. TM now points to the book of the girl seated beside Monica, on her right, that is at the first desk TM is leaning on.*
23.		**See**	*TM presses her lips together. Monica, **standing**, looks down at her friend's book.*
24.	**Mo**		*Monica, **still standing**, reaches for*

			her eraser and begins to erase.
25.	**TM**	**No need**	*TM straightens up and begins to move away as Monica looks.*
26.		**Next table**	
27.		**Leave three lines**	*TM points her finger towards Monica's exercise book.*
28.	**Mo**		*Monica, **still standing**, nods vigorously and begins to draw the next table.*
29.	**TM**	**Sit**	*Monica **sit**s down.*

I noticed that Monica stood up on her own without being prompted by anyone as TM talked to her. When TM hovered over other students with her brief comments, none of the students stood up. When TM reached Monica, Monica too initially did not stand up. But as TM kept on talking, Monica showed an awareness of the expected "way of being", that it is rude to be seated when an older/elder person is standing and talking to you. In addition, TM's stance (arms folded), her frown and stern voice further reinforced this awareness and on her own accord, Monica stood up and remained standing until she is told to sit by her teacher.

5.2.2 In TR's classroom

In TR's class Aswa, unlike Monica, displays no understanding or awareness of the "way of being" and we see TR gently reprimanding Aswa for her lack of awareness. It is almost the end of Lesson 7. TR has finished the lesson for the day, sets her class some homework and walks around the classroom checking on her students. As she approaches her table at the front of the class, one student approaches her. While TR is attending to the student, Aswa seated at her desk right behind the class calls out to TR twice. On Aswa's second attempt, TR nods in her direction as she tells Aswa to wait while still attending to the girl who had approached her. As she is doing so, another boy comes up to TR with his exercise book. TR returns the book to the girl, turns around and reaches for the book the boy is holding out. At that moment, Aswa, still seated at her desk calls out again three times. TR looks up, tells the boy that Aswa had called first and walks over to Aswa. As TR reaches Aswa, she gently reprimands Aswa, saying that the boy also had question to ask but he came looking for her, the teacher, unlike Aswa who is sitting and waiting for the teacher to come to her.

Excerpt TR:7:1 [SW]

No.	Speaker	Classroom Interaction	Observation
1.	**As**	**Cikgu: [[Teacher:]]**	*Aswa is seated at her desk as she calls out to get her teacher's attention.*
2	**TR**		*TR is standing at the first row of desks just in front of the teacher's table, talking to a student who has approached her. She appears not to have heard Aswa calling her.*
3.	**As**	**Cikgu [[Teacher]]**	*Aswa is still seated at her desk as she calls out a second time, slightly louder.*
4.	**TR**	**Sekejap: [[Wait a while]]**	*TR, holding the girl's exercise book, is still in conversation with her. She now looks up, looks at Aswa seated at her desk and nods. She has a slight frown and a look of irritation.*
5.		**Boleh? [[Can?]]**	*TR gives Aswa a little smile. She turns to the girl standing beside her and continues the conversation. Another boy, with his exercise book in his hands, walks up to TR who is still in conversation with the girl. The boy waits beside TR. Having finished with the girl, TR turns to her left, sees the boy with his exercise book held up and takes hold of the book.*
6.	**As**	**Cikgu [[Teacher]]** =	*Aswa, still seated at her desk calls out.*
7.		= **Cikgu [[Teacher]]** =	
8.		= **Cikgu [[Teacher]]**	
9.	**TR**	**Ya-lah [[Yes]]**	*TR looks at Aswa.*

10.		**Aswa panggil dulu [[Aswa called first]] =**	*TR looks at the boy and points towards Aswa seated at her desk. Then both TR and the boy move towards Aswa. She returns his exercise book and the boy returns to his desk.*
11.	**As**	**= Aaa, saya panggil dulu huh [[Aaa, I called first huh]]**	*Aswa, still seated, looks at the boy walking beside TR.*
12.	**TR**	**Apa? [[What?]]**	*TR is in front of Aswa, who is seated at her desk, looking at her.*
13.		**Dia jalan. [[He walked.]]**	
14.		**Dia jumpa saya [[He came to see me.]]**	*TR bends over while looking at Aswa seated at her desk.*
15.		**Awak duduk [[You sit]]**	
16.		**Cikgu! Cikgu! [[Teacher! Teacher!]]**	
17.		**Panggil [[Calling]**	*TR is still bent over but is looking at Aswa's exercise book. She then goes on to explain the mathematics problem Aswa is facing.*
18.		**Bahagi dulu [[Divide first]]**	
19.		**You divide dulu[[first]] by four**	

In many teacher-fronted classrooms in Malaysia, the two students approaching the teacher is seen as a sign of respect for an older person or a person in authority. Aswa's behaviour of sitting and waiting for the teacher to come to her is considered rude in the Malaysian culture for two reasons – (i) Aswa is younger and she should be the one to go to the older person (or person in authority) and not wait for this person to come to her and (ii) it is Aswa who wants something and it is only right that she makes the attempt to seek it. Furthermore, the act of sitting and calling out while waiting to be attended to is seen to go against the regular way of being in our Malaysian culture.

5.2.3 "Way of Being" and language

We see Monica standing up to talk to her teacher as she responds not just to TM's paralinguistic features/ body language (arms folded , frown and stern voice) but also to the cultural "way of being" in the Malaysian classrooms (respect for age and authority). Aswa on the other hand does not seem to take into consideration these aspects that Monica is sensitive to. Firstly, seated at her desk she calls her teacher, summoning TR to come to her. Secondly she does not respond to TR's paralinguistic features/body language - that is her slight frown and look of irritation. However, TR seems to gently but directly reprimand Aswa by comparing her to the other two students, the girl and the boy, who came seeking her for help. What is interesting to note is the choice of language used to reprimand Aswa, TR and Aswa converse in Bahasa Melayu. When TR reprimands Aswa, she continues using Bahasa Melayu as though the shared first language better captures the essence of the cultural "way of being" in Malaysia than English does because soon after that TR begins to incorporate English in her responses to Aswa as she goes on to discuss mathematics.

Having been socialised into this "way of being" that is steeped in Malaysian culture since TR and TM were students themselves and having experienced this "way of being" as teachers teaching mathematics *in* Bahasa Melayu, both TR and TM found themselves in a totally different situation since the implementation of ETeMS. With English being the new medium of instruction, TM and TR now have to teach mathematics *in* English. While they are used to "mathematical repair" during the teaching and learning *of* mathematics, TM and TR were experiencing a new form of repair during their teaching and learning of mathematics *in* English. They were experiencing "language repair" and this was a new "way of being" for TM and TR as well as their students.

5.3 Language repair

Repair, in the field of Conversation Analysis, refers to an organised set of practices through which participants are able to address and resolve troubles or problems of speaking, hearing or understanding in talk. Repair, say Schegloff, Jefferson & Sacks (1977), is the mechanism through which certain "troubles" in interaction are dealt with. This repair mechanism has been described in terms of (i) who initiates the repair (self or other), (ii) who repairs the problem (self or other), and (iii) how the repair unfolds. With the implementation of ETeMS, I noticed several "language repairs" couched in the midst of teaching and learning the unit on "Length" *in* English in both TM's and TR's classes. These "language repairs" will be discussed at length in this section.

5.3.1 Language repair: In TM's lesson 2

The excerpt below, extracted from TM's Lesson 2, has been described in M:2:B (see section 4.4). There are two aspects of interest in the excerpt of classroom interaction below. First, Charmaine offers a language contribution; "objects" as another term for "things". Second, Charmaine repairs TM's incorrect phrase, "without wet".

TM stands in the middle of the class and looks out from where she is standing. She proceeds to walk outside to look at the rain. She had planned to take her students out for some measurement activity. As she re-enters the class, Charmaine who sits near the door asks loudly…

Excerpt TM:2:2 [SW]

No.	Speaker	Classroom Interaction	Observation
1.	**Ch**	**Does that mean ↓ we can't go out ↑ ?**	*TM looks at Charmaine, but does not answer her. TM proceeds to walk to the centre of the room.*
2.	**TM**	**ok class now we're going to go outside →**	
3.		**Ok you must ↑ find five things ↓**	*TM places her fingers on the front desk and slightly leans on it while facing the class.*
4.		**That means five things →**	*TM straightens up and looks in the direction of Charmaine.*

5.		**You must →**	*TM straightens up and looks in the direction of Charmaine.*
6.	**Ch**	**five objects →**	*TM nods.*
7.	**TM**	**You must↑ list out on your: = →**	
8.		**= in your: maths book = →**	*TM places her fingers on the front desk and again leans slightly forward while still looking at the class*

(lines 9-26, regular classroom routine talk)

27.	**TM**	**You are not going to go outside the field**	
28.		**or anywhere huh… ↑**	*TM points out of the class using her left hand and then her right hand.*
29.		**You can↑ go canteen →**	*TM points behind with her right forefinger.*
30.		**You can go and measure the bench…. ↓**	*TM again holds both her hands up, together, at her chest level and pushes her hands away from each other as though pulling a measuring tape.*
31.		**Clear or not? ↑**	*TM has both her hands up and apart, as though holding the measuring tape horizontally.*
32.	**Class**	**Yes ↓**	
33.	**TM**	**I will ↑ bring you ↓**	*TM brings both her hand towards her shoulders.*
34.		**You just follow me… →**	*TM drops her left hand but holds her right hand, with her fingers straight together, just in front of her right shoulder.*
35.		**Without wet →**	*TM points out to the rain using her left hand.*
36.	**Ch**	**Without getting wet →**	*TM nods at Charmaine seated at the front, right side of the class.*
37.	**TM**	**Clear? ↑**	*TM looks to the front and places her fingers on the desk in front and leans slightly forward.*

38.	**Class**	**Yes ↓**	
39.	**TM**	**Anything ↑ to ask →**	*TM straightens up walks around the class as she divides the students into groups of six.*
40.	**Class**	**No ↓**	

TM acknowledges, with a nod, Charmaine's language contribution of "objects" as another term for "things". Although TM does not use Charmaine's language repair in her speech, she does incorporate it in her writing on the board.

Writing on the board (during excerpt M:2:2)

A. Find 10 things/objects in millimetre (mm)		
Objects / Things	millimetre (mm)	Convert to centimetre (cm)
Example: a) pencil	75 mm	= 7.5 = 7.5 cm

Charmaine also makes another contribution "without getting wet" (line 36) to TM's statement, "You just follow me without wet" (lines 34-35) which is a direct translation from Bahasa Melayu "tanpa (without) basah (wet)". In Bahasa Melayu, "tanpa basah" is perfectly correct. Charmaine repairs it and supplies TM the repaired phrase "without getting wet". TM nods in acknowledgement but does not repeat the repaired phrase. There is no inflection in Charmaine's voice when she adds "getting". It is as though Charmaine understands that "without wet" is correct when it is a direct translation from Bahasa Melayu. In an even tone, Charmaine gently repaired her teacher's English. TM, having acknowledged Charmaine's repair with a nod in her direction, turns to the class and asks the class, "Clear?" and they answer "Yes". She asks again, "Anything to ask?" and they answer "No". It is as though TM is showing Charmaine that even though she spoke in "wrong English", the class still understood her.

5.3.2 Language repair: In TM's lesson 3

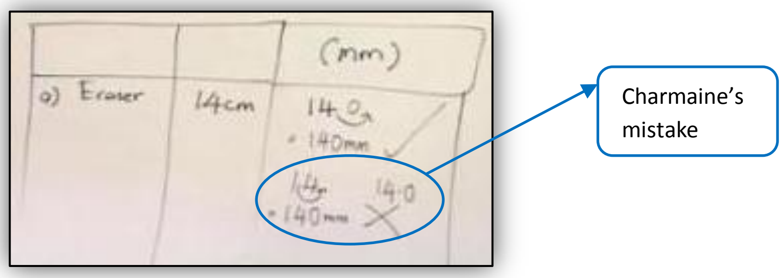
This section is made up of five inter-related excerpts of transcripts from TM's Lesson 3. The first four excerpts, (TM:3:1[SW] – TM:3:4[SW]) builds up to the "language repair" initiated by Charmaine in the fifth excerpt, (TM:3:5[SW]). The first four excerpts show us regular everyday classroom interaction where TM, the teacher identifies a mistake, reprimands the student and uses the student's mistake as a teaching point. This is the common classroom structure and "way of being" students and teachers are used to in whole-class, teacher-fronted classrooms found in Malaysia. The number of times Charmaine is referred to for her mistake and her silence in accepting the castigation are examples of the behaviour expected and accepted in many whole-class, teacher-fronted classroom. The fifth excerpt is a contradiction to the expected classroom "way of being", especially in primary level. In this excerpt, we see a young student, Charmaine, correcting her teacher. With her one utterance, she displaces the teacher – the teacher's position and social authority in class and the "way of being" students and teachers are used to and have been socialised into.

The first excerpt from TM's Lesson 3 (TM:3:1[SW]) captures the interaction of TM in front of the board highlighting Charmaine's mistake. The first part (lines 1-30) captures the teaching and learning event surrounding Charmaine's mistake (see M:3:1 in section 4.5 for detailed discussion). Further interaction around this event was transcribed (lines 31-48) and analysed as the "language repair" in the fifth excerpt begins from the event in this first excerpt.

TM walks around the class checking her student's exercise books. TM is in front, at the right end of the classroom, at the first row of desks when she finds out that one of her students, Sandra, had copied wrongly the example she had given in the previous class. TM questions her and is told that she had copied it from Charmaine who sits just behind Sandra, at the second row of desks. TM walks over to Charmaine, picks up her exercise book, looks at it for a while and then calls out to her class. Charmaine remains seated at her desk with her face in her hands, her elbow on her desk as she looks at TM walking to the whiteboard with her (Charmaine's) exercise book in her hands.

Excerpt TM:3:1 [SW]

No.	**Speaker**	**Classroom Interaction**	**Observation**
1.	**TM**	**Ok class →** ...	*TM is at Charmaine's desk, which is at the right side of the class), holding Charmaine's exercise book.*
2.		**Ok,**	*TM walks to her own table at the left corner or the classroom and reaches into her pencil case and takes out a whiteboard marker.*
3.		**look at your Table ↑ C ↓**	
4.		**Look at your Table C ↓** .... (softer and faster than line 2)	*TM turns to face the whiteboard, mounted on the front wall of the classroom*
5.		**This one is your table, isn't it? ↓**	*TM draws the table on the board. Her back faces the class*
6.	**Ch**	**Ya [[Yes]]**	



7.	**TM**	**Ok "a" ↓** ...	
8.		**eraser ↓** ..	*TM fills in the table.*
9.		**correct? ↑** ..	
10.		**After eraser is centimetre = →**	*TM divides the table into two columns.*

11.		**= that means fourteen centi .. metre → ..**	*TM fills in the second column. She writes 14cm*
12.		**When you're going to convert**	*TM adds another column and labels it (mm). She writes 14 then turns to face the class in the direction Charmaine sits.*
13.		**to millimetre ↑** ……..	
14.		**the arrow is moving from ↑**	*TM walks over to Charmaine and returns her exercise book.*
15.	**Ch**	**Four →**	
16.	**Mo**	**<u>Left to right</u> →** ….	
17.	**TM**	**<u>Four?</u> ↑** …	
18.		**or after four? ↓**	
19.	**Mo**	**After four →**	
20	**TM**	***AFTER* ↑**	
21.	**Mo**	**Four ↓**	
22.	**TM**	**Copy the wrong one or not? ↑**	*TM returns to the whiteboard. As she walks back to the board, her back is towards Charmaine. When she stops at the board, her right shoulder is parallel to the whiteboard. She is facing the left side of the class. Her back is towards Charmaine. She is not looking in the direction of Charmaine.*
23.	**Mo**	**No ↓**	*Another student, Monica, not Charmaine, who answers*
24.	**TM**	**You *must* move from here ↓ ..**	*At column three where TM had written the number 14, she places her marker pen after the digit four and draws a curved arrow moving to the right, one time. Her right shoulder is parallel to the board. She is facing the left side of the class. Her back is towards Charmaine.*

25.		**How many times? ↑**	*TM is facing the left side of the class. Her back is towards Charmaine.*
26.	**Mo**	**One →**	
27.	**TM**	**one time ↓**	
28.		**zero →**	*TM adds the digit zero just above the curve. Her body is half turned, facing the left side of the class.*
29.		**The answer is one hundred forty ↑** ..	
30.		**milli** .. **metre ↓**	*TM looks at the board. Her body is half turned, her right shoulder parallel to the board.*
31.		**But you know →**	*TM turns to face the class.*
32.		**some budak pandai [[clever children]] → = = you know? ↓**	
33.	**Ch**	**like me ↓** …	
34.	**TM**	**you know budak pandai [[clever children]]? ↑**	*TM looks in the direction of Sandra and Charmaine as she smiles*
35.	**Ch**	**like me ↓**	
36.	**TM**	**one more? ↑**	*TM looks in the direction of Sandra and Charmaine as she smiles.*
37.	**Ch**	**like her ↓**	
38.	**TM**	**aaa ↑** ..	
39.		**She did it like this ↓** …	*TM writes 14 on the board, just below the example she had shown on the board. Her right shoulder is parallel to the board and she stands facing the left side of the class, her back towards Charmaine.*
40.		**She move one time, ↑** …	*TM moves the arrow one time from between the digit one and four.*
41.		**then write the answer →**	
42.		**one hundred forty ↓** ……	*TM writes 140mm*
43.		**She move like this means = →**	

44.	**= the answer is fourteen point ↑ ..**	
45.	**zero ↓**	*TM writes 14.0 on the board*
46.	**This one is incorrect method ↓**	*TM puts a cross beside the second explanation, 14.0*
47.	**This one is correct →** ….	*TM puts a tick beside the first explanation, in the beginning of this excerpt. Then she turns to face the class.*
48.	**Look properly →**	*TM reminds the class, then walks over to Charmaine's row of desks and continues checking the work of the girl who sits beside Charmaine. TM glances at Charmaine's book and cracks a joke. The interaction was too soft and was not caught on tape but their smiles were.*

The excerpt above depicts Charmaine's mistake being made public. Her mistake becomes a teaching point (line 37-45). Charmaine's mistake also becomes a point of teasing (lines 28-35). Charmaine accepts the teasing silently. However, we see her breaking this silence, not to defend herself but to claim responsibility. When TM teases her indirectly (see TM:3:1[SW]), "you know… some budak pandai [[clever children]]… you know…" (lines 29 & 32), Charmaine responds. She says loudly, "like me" twice (lines 31 & 33). When TM asks "one, more?", waiting for Sandra to respond too, but it is Charmaine who answers for Sandra. Charmaine quickly says "like her" (line 35), not allowing Sandra the time or opportunity to own up or accept responsibility as though Charmaine felt that it was not Sandra's fault. Charmaine perhaps feels responsible for Sandra's mistake because Sandra had actually copied from her. Charmaine realises that it was because of her that Sandra is also cast as having made the error. Charmaine assumes responsibility, not only for the fault on her own part but also on behalf of Sandra. Only after Charmaine publicly acknowledges her mistake, TM accepts her acknowledgement and then goes on to explain the error to the class as well as to Charmaine. TM begins "aaa…. she did it like this" (line 30-37). Only in line 37, did TM directly refer to Charmaine with the use "she".

Charmaine remains silent when TM asks, "Copy the wrong one or not?" (line 19). It was another student, not Charmaine, who answered "No" (line 20). Perhaps Charmaine's silence can be taken to indicate her growing awareness of her mistake. Charmaine had copied the example wrongly and when her teacher, TM makes public her mistake and uses it as a teaching point, Charmaine accepts it and remains silent.

It is not the end of Charmaine and her mistake. In TM:3:2[SW], we see TM again gently chiding, almost teasing Charmaine for her mistake. In this transcript we see Sandhiya (Sa), another student at the back, left side of the classroom walking over to TM who is in the middle at the right side of the class checking other students' books. TM is standing one row behind Charmaine's desk. After re-explaining to Sandhiya, who had copied it from Charmaine, what she had already explained in the first excerpt TM again mentions Charmaine and the mistake she made in copying the example wrongly.

Excerpt TM:3:2 [SW]

No.	Speaker	Classroom Interaction	Observation
1.	**TM**	**Who ask you to put before four?↑** ..	*TM is bent over Sandhiya's exercise book. TM is facing the back of the class.*
2.		**The example is after four ↓**	*TM turns to point the whiteboard.*
3.	**Sa**	**(inaudible)**	
4.	**TM**	**Yes →** …	
5.		**I told: you what! ↑=**	
6.		**= No, no ↑**	
7.		**not after seven ↓ =**	*TM holding Sandhiya's book and explains to her.*
8.		**= This one is ↓** ….	
9.		**point seven = →**	
10.		**= Ok girls ↑**	*TM turns to face the class as she*

			addresses the class.
11.		**Yesterday ↑**	
12.		**one point four or fourteen centimetre? ↓**	
13.	**S (T)**	**fourteen →**	
14.	**TM**	**fourteen centimetre, isn't it? ↑**	
15.	**CLASS**	**Yes →**	
16.	**TM**	**Why you go and copy the wrong one? = ↑**	
17.		**= one point four centimetre? ↓**	*TM looks at Sandhiya*
18.	**Sa**	**(inaudible)**	
19.	**TM**	***Charmaine*** **↑** …	
20.		**Huh ↑**	*TM turns to look at Charmaine and hearing her name being called, Charmaine also turns to look at TM.*
21.		**You copied from her → …….**	*TM turns and looks at Sandhiya.*
22.		**Sandra also did the wrong →**	*TM turns to the front and looks at Sandra, who sits in front of Charmaine.*
23.		**You also did the wrong →** (slightly softer)	*TM looks again at Sandhiya.*
24.		**You three budak pandai-lah! [[clever children eh!]] ↑** …	
25.		**Go and change now ↓**	*TM tells her to change and points to the whiteboard with the correct version.*
26.		**Charmaine:? ↑**	*TM looks at Charmaine, then turns and starts to walk behind. She calls in a gentle voice.*
27.	**Ch**	**Yes: →**	*Charmaine does not turn to look at her but continues with her work.*
28.	**TM**	**Why you did like this? ↑**	*TM is already bent over another student's exercise book.*

From my informal chats with TM, I found out that Charmaine is one of the "good" students in mathematics in her class. TM praised Charmaine for her mathematical ability. Throughout the unit on "Length", I also noticed Charmaine often calls out the answers or bids to get her teacher's attention. Furthermore she is industrious and helpful. I noticed many students quite often approach Charmaine to borrow her exercise books before and after the mathematics class. Being aware of Charmaine's positioning in the class, TM probably teases Charmaine because she and her books become the point of reference for many of the others in class. As seen in the excerpt above, Sandhiya made the same mistake as Charmaine as she had copied it from Charmaine.

In excerpt TM:3:3[SW], we see Charmaine still at the centre of being teased for copying wrongly. TM seems not to let her forget her mistake. Although this time it was not Charmaine's fault, TM does not seem to let the opportunity to tease Charmaine slip by as she gently chides her.

Excerpt TM:3:3 [SW]

No.	Speaker	Classroom Interaction	Observation
1.	**TM**	**sayang [[my dear]]** ↑ ….	*TM is now at the back, left side of the class, checking a student's book. She is looking down at the student seated at her desk.*
2.		**after four, sayang [[my dear]]** → ..	*TM is looking down at the student's book.*
3.		**What is this?** ↑	
4.		**Just now I explain to you** →	*TM looks up and points to the board in front of the class. But the student is looking down at her book.*
5.		**after four** ↓ ..	*TM looks at the student again.*
6.		**cannot see?** ↑ ..	
7.		**You can see or not?** ↑	*TM bends down, then holds the student's face and tilts it upwards.*
8.	**Class**	**laugh**	*Other students around her laugh and the student herself smiles.*

9.	**TM**	**can see ↑ …**	
10.		**After four →**	*TM bends over the student's exercise book and erases the mistake.*
11.	**Ch**	**What happen teacher:? ↑**	*TM turns to look at Chrarmaine*
12.	**TM**	**Don't tell her ↑**	*TM looks at the class while she points/nods at Chramaine's direction with her head.*
13.		**She also like that ↓**	
14.	**Class**	**(more laughter)**	*Charmaine looks down at her book and continues her work*

This student in the excerpt above is seated right at the back on the left side of the class. Charmaine is seated right in front of the right side of the class. This student did not copy from Charmaine but from Sandhiya who had copied it from Charmaine (see TM:3:2[SW]). Hearing the students around TM laugh, Charmaine asks what happened (line 4). TM once again takes the opportunity to tease Charmaine for her mistake (line 12-13) and the class laughs at Charmaine (line 14).

In this fourth excerpt, TM:3:4 [SW], TM calls the class to attention. She gets them ready to listen to her teaching conversion of units. It is interesting to notice the manner TM gets them ready especially with regard to Charmaine (line 13-23). Before starting the topic on conversion, TM gets the class to look in front, put everything down or away. I noticed TM usually does this when she has a new topic she wants to introduce; that is the class' total attention on her standing in front of the board at the front of the classroom. But in this excerpt, I noticed TM not only calls the class to attention, she once again takes the opportunity to tease Charmaine and remind Charmaine particularly, as well as the class generally, to be careful when copying.

Excerpt TM:3:4 [SW]

No.	Speaker	Classroom Interaction	Observation
1.	**TM**	**ok → ..**	*TM stands in front of the class, in the middle and calls her class to attention. She stands erect, her hands clasped together in front of her holding a white board marker. She scans the whole class as the students follow her instruction and keep their things away and get ready.*
2.		**Kavita, ↑**	
3.		**Maizatul ↑**	
4.		**Look in front ↓**	
5.		**Everybody put your pencil →**	
6.		**or anything else ↓ ..**	
7.		**Colour pencil = ↓**	
8.		**= pencil ↓ ……**	
9.		**eraser ↓ ….**	
10.		**your P.J. [[P.E., Physical Education]] ↓**	
11.	**Ch**	**Pencil box ↓**	
12.	**TM**	**Pencil box ↓ ..**	*TM looks at Charmaine. TM begins to swing her arms.*
13.		**And look properly, =**	*TM still swinging her arms by her side, still looking at Charmaine.*
14.		**= Don't copy the wrong one ↓**	*TM still swinging her arms by her side, still looking at Charmaine.*
15.	**Class**	**(laugh)**	
16.	**TM**	**Put your eyes bigger ↑ ..**	*TM places the tip of her fingers on the desk in front of her and leans forward a little, still looking at Charmaine.*
17.		**Even if you are wear the spectacles, → …**	*TM is looking at Charmaine who is seated at her desk.*
18.		**put bigger ↓ ..**	*TM brings both her thumb and forefinger nearer to her eyes and does the action of opening and closing. She is looking at the class as she does the action repeatedly.*
19.		**Put your = →**	
20.		**= put your fingers inside your: spectacle ↓**	*TM now looks at Charmaine who wears spectacles and repeats her actions with her fingers.*
21.		**and put er = →**	
22.		**= put bigger ↑**	*Charmaine puts her fingers in between her eyes and glasses and*

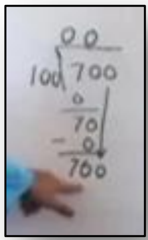
			mimicks TM's action of opening and closing using her thumb and forefinger.
23.		**Very: good ↓**	*TM praises Charmaine for mimicking her actions of "opening her eyes bigger". TM smiles at Charmaine.*
24.	**Class**	**(laugh)**	
25.	**TM**	**Ok, stop writing ↓** ...	*TM addresses the class. Her smile disappears, her tone changes from playful to serious. Her hands are again clasped together in front of her as she stands erect, once again scanning the class.*
26.		**Ok, now we"re going to ↑ ..**	
27.		***Con*↑..*vert* = ↓**	
28.		**= Ok ,centimetre ↓** ...	
29.		**to metre ↓**	*TM walks to the whiteboard in front of the class, her back facing the class.*

Charmaine is teased once again for her mistake. We see Charmaine taking part in the teasing when she heeds TM's call to 'put your eyes bigger' (line 20-22). In the first three excerpts, we see Charmaine being only at the receiving end of the teasing. In this fourth excerpt, although Charmaine is still at the receiving end, she actively participates in the tease by mimicking TM's action. When she does this, that is participate in her own tease, the rest of the class laugh *with* both Charmaine and TM (line 23) as opposed to the class only laughing *with* TM *at* Charmaine (line 15), TM calls the class to attention and starts the lesson, her smile disappears and her tone changes from playful to serious. After TM has explained the method to do conversion, she nominates a student to solve the conversion task she has written on the board, 700cm = ___m. The student comes forward and starts the conversion task using the long method of division.

In the fourth excerpt above, TM:3:4[SW] we saw the beginning of retaliation from Charmaine. While it was a silent gesture where she only mimics the action of her teacher instead of silently receiving the tease (see the first three excerpts), in this fifth excerpt below, TM:3:5[SW], we see Charmaine breaking the silence and returning the tease by repairing her teacher's language error.

Excerpt TM:3:5 [SW]

No.	Speaker	Classroom Interaction	Observation
1.	**TM**	**Itu seven hundred and sixty-ke? [[Is that seven hundred and sixty?]]** ↑ ….	*TM leans at the side of her table, near the whiteboard, her arms folded looking at the student solving a math problem.*
2.		**Why suddenly got six?** ↑	*TM points to the digit that looks like the digit six.*



No.	Speaker	Classroom Interaction	Observation
3.	**Class**	**[laugh]**	
4.	**TM**	**Your zero got tail huh?** ↑	*TM is still leaning against her table, but her hands are clasped together behind her. TM is still looking at the student doing division at the blackboard. She speaks in a playful tone.*
5.	**Ch**	**Teacher, actually it's not tail** ↑ ..	
6.		**It's hair** ↓…..	*TM looks up from the blackboard and looks at Charmaine. There is about 5 seconds of silence before she responds.*
7.	**TM**	**You don't talk** →	*TM is leaning against her table as she points her forefinger to Charmaine. She smiles as she reprimands her. Her voice is still gentle but no longer has the element of playfulness.*

8.	**Class**	**(laugh)**	
9.	**TM**	**From there you can see the tail →**	*TM is still leaning against her table. She waves her right hand to the right and left while looking at Charmaine.*
10.		**You can see the hair →**	
11.		**Everything can see, isn't it? ↑ ..**	*TM is still leaning against her table. She holds her palm upwards with her fingers pointed upwards.*
12.		**Only cannot see the arrow ↑**	*TM is still leaning against her table. She uses her forefinger to make the action of moving the arrow one time from the decimal point.*
13.		**Cannot see the four ↑**	*TM is still leaning against her table. She holds up four fingers.*
14.	**Class**	**(laugh)**	

The "language repair" in this excerpt, "teacher, actually it's not tail↑.. it's hair↓….." (lines 5-6) differs from the "language repair", "without getting wet→" (line 35, TM:2:2[SW]). While Charmaine initiated the repair in Lesson 2 without any inflection in her voice, her voice shows much inflection in this lesson 3. Furthermore, by calling "teacher" to specifically get TM's attention, and using the term, "actually", Charmaine not only repairs her teacher's language but seem to imply in her utterance that her mathematical error (merely copying wrongly) is relatively a minor error in comparison to TM's language error. I noticed that TM's teasing of Charmaine, in this lesson 3, ended after this "language repair" incident.

5.3.3 Language repair: In TR's lesson 1

This is TR's first lesson on the topic of Length. TR was giving an example to the class about buying a piece of material/cloth to make clothes for a festive season. She kept using the wrong word. She used "clothes" instead of "cloth" until the student just in front of her (seated at the first desk in the front row) whispered “cloth”. With a slight nod in the student’s direction, TR apologises, acknowledges the “language repair” “cloth” and uses the correct term thereafter. This is captured in the excerpt below.

Excerpt TR:1:1 [SW]

No.	Speaker	Classroom Interaction	Observation
1.	**TR**	**What will the problem occurs when we use estimation? =**	*TR stands in the middle of the class, between the blackboard and the first row of students’ desks facing her students. She holds the textbook up in her left hand and flips the pages. She looks at her book and the class alternatively. She then holds the book in her left hand and waves her right hand with her forefinger pointed as though stressing a point.*
2.		**= Apa masalah timbul kalau kita just estimate? ↓ …. [[What problem will occur if we just estimate?]]**	*TR is still standing in the same spot and is still waving up and down with her finger. She ends her question by opening both her arms wide.*
3.		**Estimate, ok =**	*TR slightly turns towards her table*
4.		**= I give you example ↓**	*TR places the textbook she is holding on her table while still looking at her students.*
5.		**Ok , I want to buy some clothes ↓ ..**	*TR brings both her hands towards her shoulder*
6.		**to make baju raya [[clothes for the festive celebration]] ↑ ..**	*TR moves her hands from her shoulder towards her body. Then she clasps her hands together just below her chest.*
7.		**Ok ↓**	
8.		**I go to the shop →**	*TR points her left hand towards the door which is on her left and again clasps her hands together just below her chest.*
9.		**Ok I said → ..**	*TR hands are still clasped together just below her chest.*
10.		**Ok, aaa ↑**	
11.		**I want aaa ↑ …**	
12.		**four arm’s span of clothes ↓ …..**	*TR opens both her arms wide*

13.		**So ↓**	
14.		**that →** ….	*TR drops her arms but raises her left hand and again points to the door on her left.*
15.		**aaa that man will measure using his arm's span, isn't it? ↑** ..	*TR opens both her arms wide.*
16.		**OK, maybe he is what? = ↑**	*TR drops her arms.*
17.		**= taller than me ↓** ..	*TR raises her right arm from her shoulder upwards towards her head*
18.		**So do I get more clothes or less? ↓**	*TR opens her arms wide and then shortens the width between her arms.*
19.	**Class**	**More →**	
20.	**TR**	**More, isn't it? ↑**	*TR nods.*
21.		**And then ↑** ..	
22.		**Nellie ↓** ..	*TR looks to her right and points to the girl sitting in front.*
23.		**went to the shop ↓** ..	
24.		**She met another guy = ↑**	*TR waves her right hand, from outwards to inwards, towards her body.*
25.		**= But this time that →**	*TR holds her hand horizontally in front of her just at her chest and makes an upward downward waving motion.*
26.		**that guy is quite short ↓**	*TR hands are at her side.*
27.		**aaa maybe like aaa →** …	
28.		**Ras ↑**	*TR looks to her left, then to her right and calls out the boy's name as she raises her right arm in his direction. She then looks back to the front.*
29.		**Ok ↓**	
30.		**shorter, isn't it? ↑**	
31.		**Come Ras**	
32.		**in front ↓** …	*TR beckons the boy with her hands.*
33.		**Let's see how's bigger? =** ↓ (slightly softer)	*TR opens both her arms wide.*
34.		**= Who's bigger? ↑ ↓ →** (even softer)	*TR's arms are still open wide. She then drops it after a while.*

35.	**S(Ind)**		*The student comes to the front and stands in front of TR.*
36.	**TR**	**Buka tangan [[open your arms]] ↑**	
37.		**aaa nampak? [[can see?]] ↑** …	*TR holds her hands up and moves slightly to stand directly behind the boy.*
38.		**Ok, if I'll selling clothes ↑** …	*TR drops her arms and holds the boys left wrist. They stand just in front of the first desk at the front row. Asmirah at that desk has her arms folded flat on her desk.*
39.		**Ok cloth = →**	*TR looks at Asmirah sitting at the first desk at the front row. Asmirah is on the right side of the class. TR gives her a slight nod. Asmirah's elbows are now on her desk and her hands cover her mouth.*
40.		**= Sorry, cloth ↑**	*TR looks away from Asmirah and looks to the left side of the class.*
41.		**From whom would you like to buy? =**	*TR still looks to the left side of the class away from Asmirah at the first desk at the front row.*
42.		**= From me or from Ras? ↑**	*TR now looks to the right side of the class. She looks above the heads of the students in the front row. She looks at the students at the back. Asmirah at the first desk at the front row drops her hand from her mouth.*
43.	**Class**	**From teacher**	
44.	**TR**	**From teacher**	
45.		**Why?**	
46.		**ok**	
47.		**why?**	*TR looks to both sides of the class.*
48.	**Class**	**Because we get more cloth**	
49.	**TR**	**Yes:**	*TR looks straight ahead.*
50.		**for the same amount of money**	
51.		**you get more isn't it…**	

52.		**more cloth…**	
53.		**ok…so that problem will occur.**	
54.		**But:**	*TR turns to her table and reaches for her long ruler.*
55.		**If: we use the same ruler**	*TR holds the ruler up with both her hands.*
56.		**this one-metre rule to measure the cloth…**	
57.		**everybody if …**	*TR holds the ruler at both ends and waves it up and down.*
58.		**aaa…**	
59.		**Aswa go to the shop and want to buy four metres…**	
60.		**ok….**	
61.		**she'll get four metres of cloth…**	*TR is still holding the ruler, her left hand is bent and her right hand is straight out to the right.*
62.		**if I go to the shop,**	*TR brings the ruler to the centre and waves it up and down again.*
63.		**I'll also get the same length of cloth…**	*TR has her left hand bent and her right hand straightened out.*
64.		**ok…**	
65.		**so we won't have any problem…**	*TR turns to her table and places the long ruler on the table.*
66.		**ok…**	*TR picks up the textbook.*
67.		**now let's look what we have here…**	
68.		**any question first…**	
69.	**Class**	**No**	
70.	**TR**	**That's very good…**	
71.		**Everybody understand**	

Instead of using the word "cloth", TR has used "clothes" (lines 5, 12, 18, 38). We see a similar situation as TM's when TR is corrected on the wrong usage of word. Unlike TM, TR acknowledges the correction with a slight nod, goes on to apologise (line 39, 40) and begins using the corrected term, "cloth" (lines 48, 52, 56, 61, 63). However, it would not be accurate to say that TR was not affected by the "language repair". After she had been corrected, she looked away for quite some time from where Asmirah sat. When she again turned to where Asmirah sat, she made no eye contact with Asmirah, but looked above her head towards the back of the class.

5.3.4 Repair and language

Students initiating "language repair" in the mathematics classroom is something new for both teachers and students in the two primary schools in this study. They find themselves in a strange situation which differs greatly with the "way of being" (see section 5.2) in teacher-fronted classrooms in Malaysia both teachers and students have been socialised into: TM responds with, "You don't talk" and TR looks away after receiving the "language repair" while Charmaine becomes silent and Asmirah literally closes her mouth with her hands after they had initiated the "language repair". Both teachers' and students' responses and reactions give an insight into how teaching and learning *in* English was affecting them.

As this study also looks at the teaching and learning *of* mathematics within ETeMS, I look at several incidents related to "mathematical repairs" to enable a comparison between "language repairs" and "mathematics repairs".

5.4 Mathematics repair

In this section I discuss four incidents of "mathematical repair" and highlight how teachers and students dealt with these repairs. Both TR and TM get their students to come to the board to solve mathematical problems. After these maths problems are solved, teachers examine the problems on the board and a repair is initiated if a mistake is found. The second incident of repair was initiated by a small group of students. The third incident relates to an absence of repair despite an awareness of the mathematical error. And the fourth repair, connected to the absence of repair in the third incident, brings about a self-repair.

5.4.1 Marking at the blackboard

TM and TR draw columns on the board. They nominate students to the front to solve mathematics problem designated to them. Once the students have solved the math problem on the board in front of the class, TM seems not to straightaway check the answers on the board. Most of the time, she asks the class, "correct or not?", and gives them time to respond before examining the answers. Only after the students have answered, does she use her red marker pen and correct the sum verbalising the steps aloud.

TR, on the other hand, does not invite her students to jointly mark with her. After her nominated students return to their seats, TR walks over to the board and starts marking. She too like TM verbalises the steps.

5.4.2 Other-Repair

Sometimes TM proceeds to mark the solved problems silently. She neither engages her students nor invites them to check the answers with her. It was during one such moment (in Lesson 7) that three students walk up to her with their exercise book and show her that one of the questions she had marked correct was actually wrong. TM listens to their explanation, looks at their book and then walks to the board and silently repairs her mistake. After she had made the necessary changes, TM continues her activity of checking the other problems the students have worked out on the board. This mathematical error was noticed not by TM herself but by her students and they initiated the repair, hence other-repair.

Before the error was pointed out After the error was pointed out

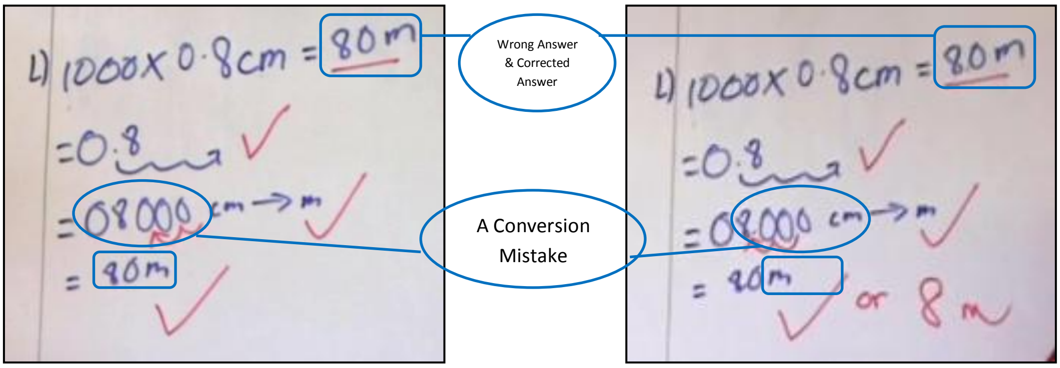


Figure 19. Student initiated repair

5.4.3 Absence of other-repair

TR, in Lesson 6, writes several mathematical problems on the board and hovers around as she helps the students she had nominated to solve the problems. Aswa was nominated to solve the maths problem below:

8070mm ÷ 100 = ___cm

There are two parts to this math problem:

(i) 8070mm ÷ 100, where the answer obtained will still be in millimetre

(ii) This answer in millimetre will then have to be converted to centimetre

Aswa begins the first part that is 8070 ÷ 100 using the long division method. She gets stuck and seeks TR's help. TR begins to help her before moving away to help another student. Aswa completes the problem and comes up with 8.7mm as the answer instead of 80.7mm. TR returns to Aswa, glances at her long division and tells Aswa to do the second part, conversion to centimetres.

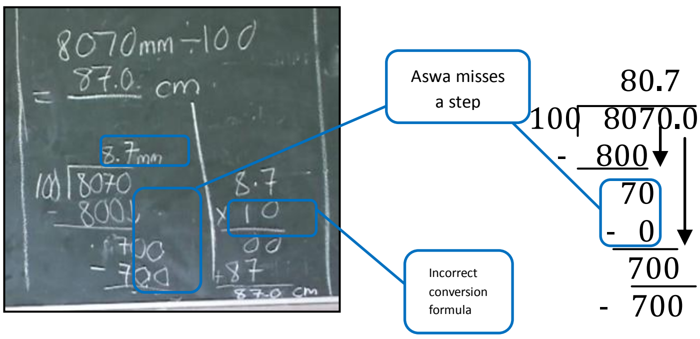


Figure 20: Error not repaired

The error was not noticed by TR. But it was noticed by Asmirah who supplied the word "cloth" in Lesson 1 (see TR:1:1[SW]) for she leans towards her friend beside her and points towards Aswa's working while shaking her head from right to left.

Then this 8.7mm was to be converted into centimetre. Aswa does not seem to be able to do the conversion task and looks towards TR for help once again. TR, using gestures, prompts her towards the conversion formula. TR waves her right hand from left to right saying "centimetre to millimetre". She repeats both the oral and visual communication twice. TR tells Aswa, "One c-m is equal to ten m-m" while waving her right hand from "left to right" and then asks, "What do you do?". Aswa replies, "Darab [[Multiply]]" and goes on to multiply using the long method. TR moves on to help another student.

The correct formula for conversion from millimetre to centimetre would be to "÷ 10" and the hand gestures from "right to left". This error was again not noticed by TR at this juncture. TR has moved to the other end of the blackboard to help another student. After solving the problem by multiplying with 10 instead of dividing by 10, Aswa returns to her desk. Asmirah who supplied the correct word "cloth" instead of "clothes" in Lesson 1, I observed, had both her hands on her chin and was still moving her head from left to right.

Asmirah who supplied the correct word "cloth" in Lesson 1 noticed and seemed to be aware of these mistakes in Lesson 6 but chose to remain silent. She did not initiate a repair, thus the absence of other-repair unlike TM's students who came forward and initiated the repair.

5.4.4 Self-Repair

When TR begins checking the solved questions on the board, she becomes aware of Aswa's mistake (8070 ÷ 100 = 8.7) in the first part of solving the problem and goes on to correct it using her "jumping method" as she checks aloud. She ends by saying that it is safer to use the jumping method than long division but does not point out where Aswa had gone wrong in her long division.

TR also does not point out the incorrect conversion formula Aswa used in the second part of solving the math problem that is multiplying with ten (x 10) instead of dividing by ten (÷ 10) as she converted millimetres (mm) to centimetres (cm). Instead TR solves the conversion task using the “jumping method”.

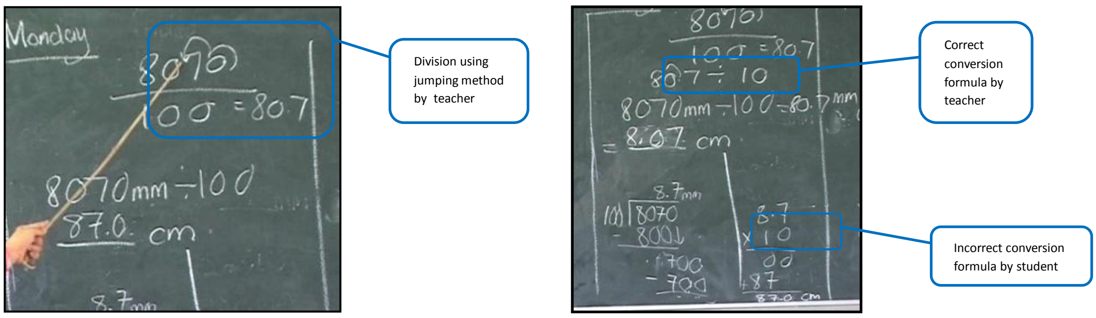


Figure 21: Teacher initiated repair

Having realised the mathematical error as she was checking Aswa’s solution on the board, TR initiates a self-repair (see section 5.4.3 for TR’s mathematical error as TR helped Aswa). Asmirah who had initiated the “language repair” in Lesson 1 refrains from initiating the “mathematical repair” in this Lesson 6. Asmirah holds her silence (in 5.4.3), absence of other-repair, until her teacher, TR, initiates a self-repair (in 5.4.4). Perhaps after the reaction she received from TR, avoidance of eye contact in Lesson 1, Asmirah does not want to go against the “way of being” in teacher-fronted Malaysian classroom. It could also perhaps be that this being a mathematical error, she was quite certain that her teacher, TR, would eventually realise the error and her thoughts proved to be right.

5.4.5 Repair and mathematics

TM openly invited her students to participate as she marks at the board. Her students, in this instance (see section 5.4.1, marking at the blackboard), saw themselves as joint constructers of mathematics. Seeing themselves as such, they went up to TM and initiated the other-repair when she made a mistake. TM incorporated the other initiated "mathematical repairs", corrected her mistake and carried on. This is different from the "language repairs" she received; "without getting wet" and "it's not tail, it's hair". She did not incorporate these repairs in her interaction. Perhaps TM did not mind the other initiated "mathematical repairs" for the students followed the accepted and expected "way of being" in the Malaysian classroom. They approached her and in hushed tones initiated the "mathematical repair".

TR also got students to come to the board and solve the math problems but she did not invite her students to check the answers on the board like TM did. Perhaps that is why her students, in contrast to TM's students, refrain from initiating a "mathematical repair". However TR incorporates the "language repair", unlike TM, and uses the correct term, "cloth". Perhaps TR realised that "measuring clothes" instead of "measuring cloth" may be confusing and is also unhelpful conceptually as she teaches estimation of length. This repair then, can also be seen as a "mathematical repair".

At various stages of the "language and mathematical repairs" and throughout the nine lessons on the unit on Length, I found much laughter in TM's class but an absence of it in TR's class. Joking and teasing and the laughter and smiles that ensue afterwards play a big part in TM's classroom. While there was much laughter because of the joking, light teasing or gentle "*making fun*" of other in TM's classroom throughout the unit on "Length", I did not notice any mean ridicule or malicious laughter that insults or downgrades another. The jokes and teasing were always accompanied by much smiles and a playful tone of voice. In the next section I explore laughter in interaction as it is a part of the "way of being" in TM's classroom.

5.5 Laughter in interaction

The five excerpts from lesson 3 (TM:3:1[SW] – TM:3:5[SW]), discussed in section 5.3 under "language repairs" give us a glimpse of teasing and laugher in TM's classroom. But the "teasing" may also seem to portray TM as always "*making fun*" of her students especially Charmaine. Therefore, I analysed the videotaped lessons and the transcribed classroom interaction for other instances of laughter in the classroom. I have selected four instances which highlight the different ways laughter was used in TM's class.

5.5.1 TM joking with the term "operation" with her students

The incidents of "language repair" in Lesson 3 (see section 5.3) seemed to portray TM as someone not comfortable with English, the new medium of instruction. The excerpt below shows otherwise. Using a homonym, TM cracks a joke which her students laugh at.

Excerpt TM:4:1 [SW]

No.	Speaker	Classroom Interaction	Observation
1.	**TM**	**Ok before we're going to .....**	*TM turn from the board after writing "Basic Operations Involving Length". She walks to the centre of the class and stands with her arm folded.*
2.		**basic operations involving a....**	
3.		**involving length**	
4.		**What mean for basic operation?**	
5.	**Class**	**plus, minus, divide ...**	*The class calls out loudly*
6.	**TM**	**not the doctor operation ↓ eh**	*Unfolding her arms, TM places her palms on the students' desks in front of her as she leans forward. She smiles as she jokes with her students*
7.	**Class**	**(laughs)**	
8.	**TM**	**This one is plus, minus, times↑ and**	*Straightening up, TM point to the board as she says*
9.	**Class**	**divide**	

In this excerpt, we see TM cracking a joke and making her students laugh. Besides that, TM is also explaining a potentially confusing term. "Operation" in common everyday language has several meanings and one of the common meanings would be the "doctor operation" (line 6). But in mathematics, "operation" has a different meaning such as "plus, minus, times and divide" (lines 5, 8 & 9). While there are a handful of students who are proficient in English like Charmaine, a large number of students in 4M are not as proficient. Using a joke, TM gets the mathematical term across and also manages to show her students (perhaps Charmaine especially) that she is not intimidated by the new medium of instruction.

5.5.2 Students teasing TM

Besides TM being mostly the one to initiate a joke or tease, the incident below captures her students in an incident where they are "teasing" her. There was a public announcement informing and reminding all the teachers in the school regarding the professional development course to be held from 8-10 pm that night. In this incident, the students initiated the joke. TM goes along with it. However the joke was not prolonged because TM diverts their attention back to the task.

Excerpt TM:9:1 [SW]

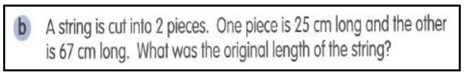
No.	Speaker	Classroom Interaction	Observation
1.	**Class**	**teacher…**	*TM is leaning against her table in front of the class with her arms folded, listening to the announcement when her students call her. She turns to face them.*
2.		**teacher…**	
3.		**The ghost will come**	
4.	**TM**	**the ghost will run away when he see me**	*TM smiles.*
5.	**Class**	**(laughs)**	
6.	**TM**	**OK** **number two** **read together**	*TM straightens up and walks to the centre of the class*

While the joke by the class is not directly related to mathematics, the incident shows that TM's students are comfortable cracking jokes with their teacher. This gives an insight into the social wor(l)d of TM's class. However, TM does not prolong the joke nor does she linger over it as she diverts her students' attention back to mathematics.

5.5.3 TM teasing yet protecting a student

The five excerpts from Lesson 3 (TM:3:1[SW] – TM:3:5[SW]) seemed to show TM as always "*making fun*" of her students especially Charmaine. But in the excerpt below, we see TM "*making fun*" of another student and her mistake, yet at the same time protects her identity from the class.

TM nominates a student to solve problem "b" shown below and afterwards checks the solution on the board. Then she goes on to check other students as they work at their desk. As TM is in the midst of checking, a student approaches her with her exercise book. TM discuses with her in low tones. Then TM walks to the board and the student returns to her place. The excerpt below captures this incident.


b A string is cut into 2 pieces. One piece is 25 cm long and the other is 67 cm long. What was the original length of the string?

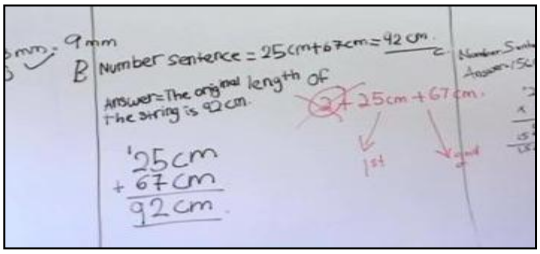


Figure 22: Student teased for error

Excerpt TM:9:2 [SW]

No.	Speaker	Classroom Interaction	Observation
1.	**TM**	**ok-lah**	*TM walks from the middle of the class where she has been checking on students as they did their own work. She walks to the board.*
2.		**got one**	
3.		**one student who go and plus**	*She goes to the second column on the board where one of her student had solved the math problem (b) correctly. Holding another student's book, she writes on the board using a red marker pen the student's mistake.*
4.		**two pieces**	
5.		**two pieces plus twenty-five centimetres plus sixty-seven centimetres**	
6.	**Class**	**(laughs)**	
7.	**TM**	**when I ask her why**	*TM circles the number "2" and looks at the class with a smile on her face.*
8.		**She say this one is digit**	
9.		**Digit means must plus**	
10.	**Class**	**(laugh)**	
11.	**TM**	**what she cannot understand**	*TM draws an arrow from 25cm and below it labels "1st". Then she draws an arrow from 67cm and below it writes "2nd".*
12.		**two pieces**	
13.		**this one is the first piece**	
14.		**this one second piece**	
15.		**so the two pieces are here**	*TM turns from the board and looks at the class.*
16.		**you are supposed to plus two or not?**	
17.	**Class**	**no**	

a bit later, after TM had finished checking the other solutions on the board

No.	Speaker	Classroom Interaction	Observation
26.	**Ch**	**teacher who's the girl?...**	*Charmaine, seated at her desk at the front, right side of the class asks.*
27.		**the girl?**	
28.	**TM**	**which girl?**	*TM turns to look at Charmaine with a questioning look*
29.	**Class**	**the one who plus 2**	*Charmaine is at her desk and looks at TM*

30.	**TM**	**cannot tell**	*TM smiles.*
31.	**Ch**	**why?**	*Charmaine is still seated and is*
32.		**Teacher why?**	*looking at TM*
33.	**TM**	**ok read together question number 3**	*TM turns to look at the class*

Although Charmaine had to undergo much “teasing” for her mistake, TM intentionally protects the student in the excerpt above. I noticed that this was one of the students TM had identified for me as a weak student; weak in mathematics and of limited English proficiency. TM “*makes fun*” of the mistake but not the student. Here she used laughter as a pedagogical tool to focus on the error and not the person.

5.5.4: Students teasing another student

TM had nominated a student to solve the question “c” below on the board. The student multiplied and did the conversion from centimetre to metre. But she did not show the working for the conversion of units and started instead writing the number sentence. It is at this juncture that the class calls out. TM, at this moment, was seated at her table looking at the class. It is interesting to note that TM did not join the class in “*making fun”* of the other student.

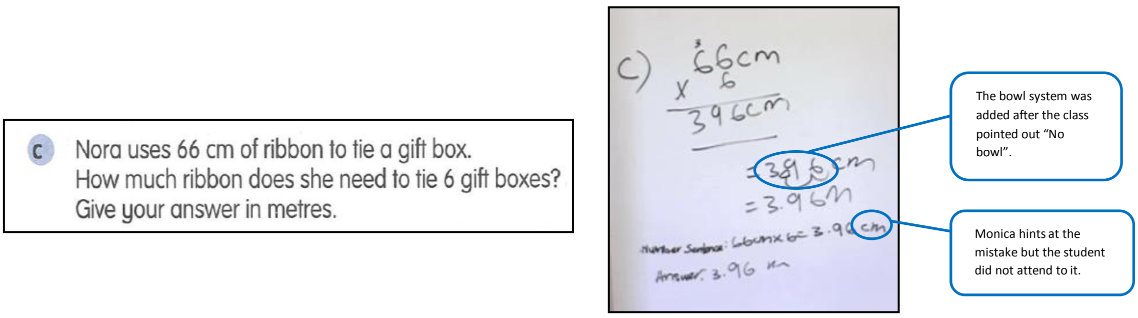


Figure 23: Classmate teased for error

Excerpt TM:9:3 [SW]

No.	Speaker	Classroom Interaction	Observation
1.	**Class**	**Teacher …. the bowl**	*The class calls out and some students are pointing their fingers towards the blackboard and moving their fingers in the motion of bowl system.*
2.	**TM**	**Ya [[Yes]]**	*TM looks at the class from her table where she is seated.*
3.	**Class**	**No bowl =**	*The class calls out again and some students continue pointing their fingers towards the blackboard and moving their fingers in the motion of bowl system.*
4.	**Mo**	**= and the number sentence =**	*TM turns to look at the board. She is still seated at her table.*
5.	**Class**	**= No bowl system =**	
6.		**= No bowl system**	*The student solving the problem at the board turns from the board to look at her classmates. TM is still looking at the board.*
7.	**Mo**	**Mangkuk dia .. [[her bowl]]**	*Monica calls out in a playful tone of voice.*
8.		**Teacher her mangkuk [[bowl]] …**	*The student turns back to the board and adds her arrows of the bowl system and continues to complete the number sentence. TM turns to look at Monica.*
9.	**Class**	**(laugh)**	*TM does not laugh, neither does she smile.*
10.	**Mo**	**She wash already-lah teacher….**	*The student and TM are looking at the board.*
11.	**Class**	**(louder laugh)**	*TM still neither laughs nor smiles.*
12.	**TM**	**ok,**	
13.		**next question.**	*The class becomes silent.*
14.		**Read together.**	

Although the students' teasing made the girl attend to the "bowl system" TM had been emphasising, TM does not join in the laughter *at* her student. TM many times "jokes" and "teases" her students over their mistakes but this time it is her students "teasing" their classmate and it has produced the same result, that is, the student at the receiving end of the tease attended to the mathematical point that was couched in the joke and tease.

When Monica code-switches (line 7), the class laughs (line 9). When she makes a joke of it (line 10), the class laughs again (line 11). TM remains silent probably because "mangkuk", beside the literal meaning, "bowl" and her mathematical meaning, "bowl system", has another inferred meaning. In marketplace language, calling someone "mangkuk" can mean that person is "stupid". In line 7, Monica's utterance, "Mangkuk dia .. [[her bowl]]" can also be translated as "she bowl" as the Bahasa Melayu pronoun, "dia" can mean both "her" and "she". TM might be reacting towards this implied marketplace meaning and thus refrains from laughing *with* Monica and the rest of the class. Perhaps TM questions the pedagogical value of this joke with "mangkuk" and its double meaning and makes the decision to end the joke. Getting no response from their teacher, the class becomes quiet as TM diverts their attention back to the task.

5.5.5 Laughter and "way of being"

In short, laughter has been used in different ways in TM's class. With her joke using "operation", TM makes her student aware of the difference in ordinary and mathematical meaning while establishing her status as someone proficient in English. When her students tease her about the "ghost", TM seems to play along with the joke and this creates solidarity between teacher and students. TM's tease has a pedagogical value when she teases a student for her mathematical mistake yet does not ridicule her by revealing her identity to the rest of the class. This has also been noticed when TM refrains from joining in the tease initiated by a student on her fellow classmate.

5.6 Summary of findings

I approach my data and analysis above with the intention to critically examine what actually happens in a linguistically altered mathematics classroom. The excerpts presented and commented on represent but a small window into such classroom life in Malaysia. I have examined a tiny part of the complex social wor(l)d of two linguistically altered classrooms through my analysis of "way of being" in teacher-fronted classrooms, "language and mathematical repairs" as well as the use of laughter. In this section I summarise my findings around my final research question; how does the new medium of instruction alter the social wor(l)d of the mathematics classroom.

While I used Sinclair & Coulthard's (1975) adapted matrix to investigate the academic wor(l)d of the linguistically altered classroom, it was unable to help me make sense of the social wor(l)d of the same classroom. Therefore as mentioned in section 3.9.2, I draw upon principles of conversation analysis to investigate the linguistics and mathematical repairs while principles from critical discourse analysis help me unpack the social forces (for example positioning, identity/subjectivity, agency) inherent in the linguistically altered classroom.

5.6.1 Language and "way of being"

The class generally seemed to be aware of the expected and accepted "way of being" in the classroom, for instance, Asmirah and Monica. Asmirah considered the situation before initiating a repair. When it is absolutely necessary, she repaired her teacher's choice of term, "clothes-cloth" ("language repair"), otherwise, she refrained from initiating any repair (the absence of "mathematical repair"). Monica, who was sitting at her desk, stood up as a sign of respect when TM spoke to her.

However, this "way of being" was challenged when Charmaine and Aswa, seated at their desk, called out loudly. Charmaine called out the "language repairs" while Aswa summoned her teacher to come to her. The reaction from TM and her own classmates showed Charmaine that she had gone against the expected and accepted "way of being". Aswa too got reprimanded for going against the accepted and expected "way of being", but the language TR, used to reprimand her was Bahasa Melayu and not English, the new medium of instruction.

5.6.2 Positioning and (re)positioning

With the transition in the medium of instruction in the mathematics classrooms, from Bahasa Melayu to English, we see "language repairs" that is quite rare in teacher-fronted mathematics classrooms in Malaysia. TM and TR, have probably not encountered "language repairs" when the medium of instruction was Bahasa Melayu. TM and TR find themselves in the position of secondary knowers (Berry, 1981). This is a new position to be in for these primary school teachers when facing their young students (10-year-olds). TM and TR resent this new positioning and display varying intensity of resistance to the "language repairs".

"Mathematical repairs", on the other hand gives a different insight to that of "language repair". While these teachers may feel uncomfortable with this new positioning, TM welcomed her students into the temporary position of being the primary knower (Berry 1981) of mathematics when she asked them "correct or not?" before reclaiming the position when she put the tick or cross on the board (see section 5.4.1). Thus, when she made the error of marking the mistake as correct in Lesson 7 and this was brought to her attention by her students, she accepted and completed the necessary correction (see section 5.4.2). At that moment, she was cast as a secondary knower. Because she herself had accorded her students the temporary position of being the primary knower of mathematical knowledge in her classroom practice, she did not resist the (re)positioning by her students when they corrected her.

After the initial discomfort TR experienced when she was supplied with the correct term, "cloth" (lines 39-40), TR accepted the temporary displacement because she went on to use the corrected term another four times (lines 52, 56, 61 & 63) unlike TM who merely nodded when she received a "language repair" ("without getting wet") in TM:2:2[SW]. TM's turns of interaction after being supplied these repaired phrases revealed that she did not incorporate it orally but inherent in her avoidance seemed to be the message that these "language repairs" are unnecessary in a mathematics classroom. And when she received the "language repair" ("hair not tail") in TM:3:5[SW], TM's reaction to it further reinforced these sentiments, which was "incorrect language is not a problem in the mathematics classroom". When we reconsider TR's acceptance and usage of the repaired term "cloth", we might assume that TR had probably realised that the repair she received was not merely a "language repair", it was also a "mathematical repair". In this unit of length, measuring "clothes" might be confusing as well as conceptually wrong. Therefore using "cloth" would better fit her gesture of measuring with "arm span" (lines 15, 37) and "long ruler" (line 56).

In short, both the teachers displayed a reaction against "language repair". They seemed to resent, in varying degrees, the position as secondary knower in terms of language. However, TM seemed to accept the same position when it was mathematics.

5.6.3 Place-Space and discourse

The physical position of the students when the teacher was corrected also seemed to have an effect on teacher's acceptance and resistance of the correction. The demarcation of the physical space and student position is interesting to note. The class is a public place for the 40 students and their teacher with the space between the board mounted on the wall to the first row of desks seems to be the teacher's space while each student's desk is an individual's student's own space. Collectively, the students' space is of bigger proportion of the classroom than that of the teacher. Despite this, the teacher's smaller space seems to hold authority and power. When TM and TR stand in this space, the class becomes silent. When they start their teaching, they mostly do so from their teacher space. This physical and social space seems to symbolise authority and knowledge. When the repairs took place, TM and TR were in their teacher space.

When the students who initiated the "mathematical repair" approached TM in her space, they did so quietly and held their discussion in low, hushed tones and then quietly departed (see section 5.4.2). This denotes respect for the teacher, a feature that is highly regarded in teacher-fronted classroom. When Charmaine seated at her desk called out her correction loudly, she appeared to intrude disrespectfully and forcefully into the teacher's space. Firstly, Charmaine did not physically move to her teacher's space unlike the other three students who sought their teacher. Secondly Charmaine's loudness in contrast to the quiet tones of the three students seemed to indicate a response that would definitely be of resistance on the teacher's part. When Charmaine supplied the "language repair", "without getting wet" in an even and quiet tone of voice, there was no obvious resistance from TM who acknowledged with a nod. But when Charmaine supplied the "language repair" (hair not tail). She did it with a raised intonation. TM's resistance was obvious.

When TR was corrected, she too was standing in her teacher space, between the blackboard and students' desks. However she was standing closer to the front row of desks, just in front of Asmirah at the first desk. Asmirah spoke in a low voice that only TR heard. As soon as she had corrected the teacher, Asmirah's hands flew to her mouth as though she was astonished at herself for having corrected her teacher. Unlike Charmaine, Asmirah did not "announce" the correction from where she was seated. And unlike the three students who initiated the "mathematical repair", Asmirah did not step into her teacher's space to correct her teacher.

5.6.4 Reaction to repairs

Another intriguing aspect evident from the excerpts of classroom interaction is the difference between students' and the teachers' reaction when repair was initiated and received.

5.6.4.1 Students' reaction to repair

Let me begin with the students' reaction first. In TM:3:1[SW], we saw Charmaine's mistake being made public. Charmaine was silent when TM walked over to her desk, took hold of her exercise book, then moved to the board and used the mistake as a teaching point. In fact in excerpts TM:3:1[SW] to TM:3: [SW], we saw Charmaine gallantly accepting all the gentle reproach and teasing because of the error she had made.

When Asmirah corrected TR in Lesson 1 while she was teaching, Asmirah's hands flew to her mouth and she closed it. Asmirah seemed to be shocked that she had positioned her teacher as a secondary knower. Even though TR did not tell Asmirah "don't talk" (line 7, TM:3:5[SW]) as TM did, Asmirah reacts as though TR had done just that. She too, like Charmaine, became silent.

But Charmaine did not remain 'silent" for long. After being teased repeatedly for her careless mistake, we witnessed her retaliation in TM:3:5[SW]. Because Charmaine had copied wrongly, she was at the receiving end of all the teasing. TM took the opportunity that presented itself to tease Charmaine for her mistake. Charmaine seemed to have accepted it because in teacher-fronted classrooms in Malaysia, this was the expected and accepted "way of being". But when an opening came to put an end to the teasing, Charmaine took the action of correcting TM, "Teacher, actually it's not tail. It's hair". In Charmaine's earlier "language repair", "without *getting* wet", she did not specifically call out "teacher" to get her attention first. She merely supplied the language needed. But in this "language repair", she focused solely on TM by first getting her attention with "teacher". The word "teacher" is value laden in teacher-fronted classrooms in Malaysia. "Teacher" is loaded with expectations of being the primary knower and the knowledge provider. Therefore, when Charmaine called "teacher", she evoked all the implicit connotations mentioned above which placed the teacher as someone superior and then with her corrective remark ("actually it's not tail, it's hair") subtly "*made fun"* of these connotations. With "actually", Charmaine seemed to insinuate that TM should not be making such a simple error before finally going on to give the correct term (it's not tail. It's hair).

5.6.4.2 Teachers' reaction to repair

I now look at the teachers' reaction to correction. When TR's mistake was pointed out (TR:1:1[SW]), she incorporated the correction smoothly into her interaction, "ok…cloth" (line 39). In fact she apologised and repeated the correct word a second time, '"sorry….cloth…" (line 40) and continued with her lesson, using the term "cloth" another four times (lines 52, 56, 61 & 63). She nodded slightly to Asmirah as though acknowledging the correction but from then on ignored her. She looked away from Asmirah, avoided eye contact with her and when she finally looked towards Asmirah, TR looked over and above Asmirah's head to other students. Unlike TM, TR acknowledged her mistake through her nod to Asmirah and her "sorry" (line 40). However, it seemed that TR was unable to accept the "language repair" because she went on to ignore and avoid any eye contact with Asmirah. TR's action of easily incorporating the correction seemed to indicate that TR did not see herself as being positioned as a secondary knower, but her reaction of ignoring Asmirah for casting her as secondary knower says otherwise.

TM did not, like TR, acknowledge or accept her mistake. When TM's mistake was pointed out in Lesson 2, she nodded at Charmaine, acknowledging Charmaine's "language repair" and indirectly her own mistake. Because Charmaine's "language repair" was gentler in this incident, TM did not become defensive and indirectly reprimand her. It is interesting though to examine her reaction and notice her subtle retaliation – she turned from Charmaine, looked at the class and asked, "clear?" and "anything to ask?", showing Charmaine that her correction was unnecessary as the rest of the class still understood her despite her grammatically incorrect sentence.

In Lesson 3, when TM's mistake was pointed out, 'teacher actually it's not tail…. It's hair" (line 5 & 6) by Charmaine, TM retorts "Don't talk." (line 7) What Charmaine had done was to correct TM's wrong choice of word, a "language repair". But TM not only publicly but also authoritatively silenced Charmaine. This is strengthened when the class laughed loud after TM's comment. TM resented being positioned as a secondary knower. She downgraded Charmaine's English proficiency and repositioned herself, the teacher, as the primary knower of mathematics. It is as though TM seemed to be saying that this is after all a mathematics class, so language errors can be tolerated (see TM:2:2[SW]) but mathematics errors cannot be tolerated (see TM:3:1[SW] – TM:3:5[SW]) . She became defensive and retaliated by reprimanding Charmaine but did it with a smile and light tone.

However, TM's reaction was totally different when she was corrected for her mathematics error. There was no such reaction or retaliation. Having been informed of the mistake, TM corrected the mathematical error and carried on as usual.

In short, I noticed that students' reaction after supplying a "language repair" seemed to have an impact on the teachers' acceptance or rejection of it. TR noticed her student's reaction, where Asmirah covered her mouth with her hands, and interpreted that it was a genuine correction without malicious or ulterior intent to portray the teacher as less proficient in English. Charmaine, on the other hand, had no such reaction when she supplied her "language repair" to TM. TM thus responded differently than TR. But Asmirah refrained from initiating the "mathematical repair" while Charmaine continued calling out answers and "mathematical repairs" after this incident. But Charmaine too stopped calling out "language repairs".

5.6.5 Seizing the teaching moment

Charmaine is one of the students in 4R who is an academically good student. She is an overall top achiever and has no problem grasping the contents of mathematics and is proficient in English. Yet TM seemed to focus on her careless mistake and made it a point of teasing but more importantly a teaching point. In lines 37-45 of M:3:1 (see section 4.5), TM explained in detail where Charmaine had gone wrong. Perhaps TM's intent of teasing and bringing to public attention Charmaine's mistake was a noble one. She may have wanted to put Charmaine on guard so that Charmaine will not repeat this careless mistake that would cause her to lose marks in an exam. Perhaps she had also wanted to warn the class that if Charmaine, a top achiever, is vulnerable to careless mistakes, the others too could be caught in the same trap. She seemed to reinforce the point she was trying to make: in her own words, "it is very easy to make careless mistakes in mathematics, so they have to be very, very careful."

Charmaine's mistake also provided a teaching opportunity. It was quick of TM to identify this teaching opportunity and not let it pass by. TM's action of openly discussing Charmaine's mistake showed that TM did not highlight only the mistakes of those who were weak in her subject. Whenever TM nominated students to come to the board to solve a mathematical problem, she usually selected students who were struggling in mathematics. Many times, she used their mistake as teaching opportunity during her lesson. But by focusing on Charmaine and using her mistake as teaching opportunity and also teasing and gently chiding her, TM seemed to practice fairness in class. Although this casts TM as being fair, her act of getting the class to laugh at Charmaine did not seem so. Because of TM's comments, Charmaine was laughed at. However, Charmaine was not the only one laughed at. We see other students also being laughed at, only Charmaine seemed to be laughed at more often.

These conflicting messages from TM were also evident in her use of praise. TM gave Charmaine and her friends a "sarcastic praise". She called them "budak pandai [[clever children]]" (TM:3:1[SW] and TM:3:2[SW]) when obviously at that moment they were not displaying that trait. TM also praised Charmaine, "very good" (TM:3:4[SW]) for correctly following her instruction, "put your eyes bigger" (TM:3:4[SW]). TM's comments seemed to invite the other listeners in class to make the "expected inference" (Yule, 1996) and thereby show themselves to be a member of the community she was in – a community that teased Charmaine for her careless mistake.

Asmirah seized the moment to correct her teacher's wrong choice of term, "clothes" to "cloth" yet she did not seize the moment to correct TR's mathematical error when TR was helping Aswa although she was aware of it. TR had used the term "clothes" several times (TR:1:1) before she was corrected. Perhaps Asmirah realised that TR was genuinely not aware and will not become aware of her wrong choice of word. Therefore she corrected TR. However, she let the mathematical error pass probably because she realised that TR was distracted when she was helping Aswa and the few other nominated students solve the problems on the board. Perhaps she was sure that TR would detect the mistake when she does the whole-class marking. TR eventually did become aware of the mistake and corrected it herself.

5.6.6 Laughing *at* and Laughing *with*

The use of laughter in TM's classroom seems to have a pedagogical value. TM's teasing and laughter perhaps aim to reinforce and intensify the teaching and learning point she tried to make. TM's teasing got the rest of the students to laugh *with* her as they laugh *at* the one being teased. Excerpts TM:3:1[SW] – TM:3:4[SW] showed how Charmaine was laughed *at* for her careless mistake. Other students besides Charmaine, for example in TM:3:3[SW] (line 8) and TM:3:5[SW] (line 3), also got teased and laughed *at* for their mistake. However, in TM:9:2[SW], the identity of the student being teased was not revealed but whoever it was, knew she was being teased and laughed *at* for her mathematics mistake. This does reveal that TM used tease and laughter for pedagogic purposes and not merely to "*make fun*" of her students. This is further strengthened in TM:9:3[SW] where TM made a stand when it came to who initiated the tease and the invitation to laugh *at* her students. The class initiated a tease and invited TM to laugh *at* a fellow student for mathematics. Although they invited her to laugh *with* them, TM did not join them to laugh *at* the student being teased. Perhaps she questioned the pedagogical value of the tease because the inferred marketplace meaning of "mangkuk" [[bowl]] is used quite often in everyday language and it has quite a derogatory meaning.

Excerpt TM:9:1, revealed laughter having a role other than the pedagogic one mentioned above. In this incident, we witnessed the students joking with TM and her playing along with them as she responded orally and also visually by smiling *with* them. The smiles and laughter between the students and their teacher here reinforced the solidarity between this community of mathematics students and teacher. It is important to note that the students *joked* with TM and not *tease* her and TM was able to accept this. But when Charmaine subtly "*made fun" of* the teacher's language through her repair ("Teacher, actually it not tail. It's hair" in TM:3:5[SW]), TM seemed not to appreciate being laughed *at*. The rest of the class also did not appreciate it for they did not laugh *with* Charmaine. In teacher-fronted classrooms, laughing *at* the teacher is not part of the cultural norm. Perhaps that is why there was a moment of silence after Charmaine had initiated the "language repair" for both the teacher and the rest of the class were probably surprised at her actions. Their silence revealed to Charmaine that she had broken the social norm of the class and she herself lapsed into silence.

It is interesting to note TM joking with her students about the term "operation" in Lesson 4 (TM:4:1 [SW]). Although her students answered her correctly as to what basic operation meant, she interrupted their response with her remark, "not the doctor operation" which caused the class to laugh.

Perhaps TM was showing her class that she was not intimidated by the new medium of instruction and that she can even joke about it. Her joke could be seen to display her ease and her comfortable feeling with the new language of instruction.

In short, I have found language central to "ways of being" and aspects of positioning and (re)positioning, place-space and discourse, reaction to repairs and laughter in the classroom. The classroom events and practices described in this chapter have shown that the new medium of instruction in the mathematics classroom does seem to have altered the social wor(l)d of the classroom to a certain extent. Teachers especially, and students generally, find themselves negotiating new "ways of being" within the new medium of instruction.

5.7 Discussion

With the implementation of ETeMS, little is yet known about how other aspects of the complex classroom life, besides teaching and learning, are jointly constructed and mediated through the new medium of instruction. Lantolf and Genung (2002) state that communities are rarely stable and smooth functioning entities and within them activities are also rarely stable and smooth. They claim that communities and activities, "are characterised by shifting motives, goals, and rules of behaviour and they normally entail struggle and conflict, including contestations of power, how it is deployed and potentially challenged" (p. 193). This is true in any classroom, not just the linguistically altered classroom. However, with the implementation of ETeMS, the new medium of instruction has added another dimension not just to the complexity of teaching and learning mathematics but to the social wor(l)d of the classroom.

My analysis has shown how language is central to (re)mediating "ways of being" and the joint construction of positioning and (re)positioning in the classroom as well as discourse in relation to place and space. The language used and the way it is used during repairs and laughter have also been analysed. I draw upon different scholarly work within sociocultural and sociolinguistic theories to illuminate particular aspects of my analysis of the social wor(l)s of the classroom, such as issues of subjectivity, identity, agency, laughter and how these contribute to the emotional climate of the linguistically altered classrooms, for they all recognise the fact that it is mainly through language and language use these aspects are mediated.

I discuss the theoretical reading of my data from the linguistically altered mathematics classroom beginning with issues of subjectivity and identity in section 5.7.1. In section 5.7.2, I explore the linguistically altered medium of instruction on agency and power relationships between teachers and their students. Although identity and agency are very much connected, they are discussed in isolation to enable not only a deeper exploration but also to enable me to illuminate particular aspects related to these two constructs. Other non-verbal aspects of communication like laughter and silence and how they contribute to the "way of being" in the social wor(l)d of the two linguistically altered classrooms in my study is inspected in section 5.7.3 and finally in section 5.7.4, the linguistically altered medium of instruction and its relation to the emotional climate in the classroom is examined.

5.7.1 Subjectivity and identity in the linguistically altered classroom

Both identity and subjectivity are inter-related and nested within the language used. Norton (1995) says that it is through language that a person negotiates a sense of self. "Identity", Venn (2006) claims, "refers to the relational aspects that qualify subjects in terms of categories such as race, gender, class, nation, sexuality, work and occupation, and thus in terms of acknowledged social relations and affiliations to groups – teachers, miners, parents, and so on" (p. 79). "Subjectivity", he says, "indexes the substantive acting, thinking and feeling being" (p. 79). Wetherell (2008) succinctly summarises the identity-subjectivity distinction:

> Identity becomes constructed as the public face: about groups and the external. It is about social categories, horrible cliche´s and modes of conduct derived from those social categories. It is how the person is known to others in the broadest, most general and least interesting ways. Subjectivity, on the other hand sums up the actual complex person and lived life. Subjectivity annexes the aesthetic and the experiential, the feeling stuff, the personal in contrast to the ready-made, and the ''real'' as opposed to the ideological (p. 77).

This means both identity and subjectivity must both be taken into account to get a complete picture.

TM and TR are both used to the teacher-fronted large classrooms of Malaysia. Teacher-fronted large classrooms have always been the norm in Malaysia. As students, they were in one. Now as teachers, they still are in one. Having experienced one as a student, TM and TR have certain expectation from their past of the "way of being" in such a classroom. Respect for teacher, not questioning authority, not challenging the teacher are some of the "ways of being" in many teacher-fronted large classrooms that still hold true in Malaysia. TM and TR, with the identity and subjectivity of a teacher, have been socialised to see themselves as primary knower (Berry 1981). And within the teacher-fronted classroom, the position and role of the primary knower is further accentuated. As mathematics teachers who have always taught in Bahasa Melayu, the language they themselves studied and were trained in, TM's and TR's social identity and subjectivity in the class during the time when Bahasa Melayu was the medium of instruction went through a process of socialisation that complemented their expectation as well as the expectation of each and every member in this particular social community called class. Furthermore, Bahasa Melayu and the use of Bahasa Melayu in teaching and learning activities as well as classroom interaction ensured this identity and subjectivity was kept intact and rarely challenged. Jaworski and Thurlow (2010) say that, "to 'place' someone, to 'know one's place': this language of social existence is unmistakably geographical" (p. 6). With their idea of "geography", comes the notion of territories, boundaries and space which also exists in a classroom and within them the notion of appropriate language as well as "ways of being" which had, until 2003, been mediated in Bahasa Melayu.

While TM and TR may see themselves in this way, their students have also been socialised to see their teachers as primary knower and themselves as emerging knowers. Hall (1995) explains that for each identity, we carry certain expectations about the other's behaviours, what each is expected to do and not do as a member of those groups, expectations which have been built up over time through socialisation and participation in own social groups. From the time children start school in Malaysian classrooms where teacher-fronted whole-class approach is the norm; students have been shaped to fit the mold. It is not surprising then to get reactions like Asmirah's who closed her mouth when she corrected her teacher. Hall (1995) says that, "when we interact with each other, we interact within and through them. That is when we come together, we see each other as we have been socialised to see each other" (p. 215). In the regular teacher-fronted classroom, Asmirah has not been socialised to see herself as the primary knower. Since the implementation of ETeMS, repairing her teachers' language in the mathematics classroom is something new for this student and her teacher.

My findings revealed TM and TR dealing with the need to (re)establish their identities and subjectivities in their linguistically altered classrooms. This is quite expected from the perspective of sociocultural theories for "activity" is not merely doing something, it is doing something that is motivated either by a biological need or a culturally constructed need (Lantolf, 2000). Lantolf goes on to say that, "*need* becomes motives and the motives are only realised in specific actions that are goal directed and carried out under particular spatial and temporal conditions and through appropriate means" (p. 8). TM's and TR's classroom talk and practices revealed their motive of (re)establishing their identities and subjectivities. These teachers were not just managing the teaching and learning of mathematical content, they were also managing classroom routine and procedures, social relationships (teacher-student, primary-secondary knower, older/elder-younger in age) and most importantly the implementation of ETeMS policy at the classroom level. All of these are now managed using the new medium of instruction, English and not Bahasa Melayu that has been in use for over 30 years in Malaysian classrooms.

Within this new medium of instruction, we saw TM's and TR's long held socialised identities and subjectivities under constraint. Hall (1995) also says that sometimes our socialised social identities are likely to constrain our participation in interaction. From being primary knower (Berry 1981), TM and TR found themselves positioned as secondary knower (Berry, 1981) by some of their students in terms of the language of instruction. This is not surprising because Day et al (2007) believe that reforms have an impact upon teachers' identities and because these are both cognitive and emotional, thus create reactions which are both rational and non-rational. They claim:

> Instabilities, whether of a personal, professional or situated nature, or a combination of these, create stresses in the fabric of identity. Identity is not a stable entity that people possess, but rather is constructed within given sets of social relations (p. 103).

Because of the instabilities created by the new medium of instruction, TM and TR struggled with the way they have been positioned as secondary knower in terms of the language. According to Davies & Harre (1990), positioning is the discursive process whereby selves are located in conversations as observably and subjectively coherent participants in jointly produced story lines. They explain that there can be interactive positioning in which what one person says positions another. And there can be reflexive positioning in which one positions oneself (p. 48). That means Charmaine's and Asmirah's utterances, through interactive positioning, placed their teachers as secondary knower and themselves, through reflexive positioning, as primary knowers.

TM resisted this positioning of secondary knower with her gentle rebuke to Charmaine in Lesson 3 (see TM:3:5[SW]) and by ignoring Charmaine in Lesson 2 (see TM:2:2[SW]). TM identified the downgraded positioning she was put in by Charmaine's utterance. She resisted this positioning and identity with her censure, "Don't talk" and reminded Charmaine of her own mistake in copying wrongly. With this censure and the rest of the class laughing *with* her over her remark belittling Charmaine, TM (re)constructed her position, not as a primary knower, but in the position of power. Hall (1995) explains that the more social authority there is embedded in who one is; the more likely s/he may be to either repackage the linguistic pieces to create his/her own response, or to twist the expected move to his/her own ends (p. 220). TR was also affected by this positioning as a secondary knower (TR:1:1[SW]). Her reaction was somewhat different from TM's, but she too struggled with this subjevtivity for she looked away and avoided eye contact with Asmirah who corrected her. However, we did not see a similar struggle when TM was corrected on mathematical content. In this incident, TM's transition from a primary knower (accorded to her by her status as teacher) to a secondary knower (when she is corrected) and back to a primary knower (as she continues with her correction) was a smooth and peaceful one. TM seemed to show more control and secure social authority when it came to mathematical content as the mathematical content did not cause "instabilities that creates stress in her fabric of identity" (Day et al, 2007, p. 103).

Looking at TM and TR through the lens of both identity and subjectivity gives us a more complete picture and understanding of how the new language of instruction (re)created and (re)mediated the social wor(l)d of the classroom. As a teacher of mathematics, TM's identity and subjectivity was stable. She did not mind being positioned as secondary knower and getting corrected by her students. However, we saw TM less comfortable in her subjectivity with regards to English as the medium of instruction. Having some students who were clearly more proficient in English than herself, we saw her unstable in her identity as a speaker *of* English and as a teacher teaching *in* English.

Subjectivity tells the story of how a specific self lives those available cultural slots, actively realises them, takes responsibility and owns them as "an agent" (Venn, 2006). The next section further explores the notion of agency which is also closely tied with identity and subjectivity.

5.7.2 Agency in the linguistically altered classroom

In this section, I discuss aspects of agency and power in the linguistically altered classroom. Lantolf and Pavlenko (2001) claim that "agency is never a property of a particular individual; rather it is a relationship that is constantly co-constructed and renegotiated with those around the individual" (p. 148) while Day et al (2007), claim that agency is mediated by interactions between the individual and the structures of a given social setting. Teacher agency, they say, impacts, and is impacted upon, by the structural and contextual features of the school and profession. Similarly, Gilmer (2007) says that agency and structure are constantly in dialectic tension; "I have the power to change the structure but the structure also influences me and what actions I take" (p. 134). But the very fact there is a notional idea of "power" and "influence" implies the concept of an "agent" or "agency", thus shifting the focus away from a being merely functioning under the control of social structures and practices (Pinkus 1996). In this section I intend to highlight how the change in the medium of instruction also altered teachers' and students' sense of agency and the classroom structures.

I found that the students' discourse in relation to place and space or territory can either affront or appease the teacher. This is probably because "space is not only physically but also socially constructed" and "people make sense of their social identity in terms of their environment" (Jaworski and Thurlow, 2010, p. 6). The classroom as part of the place in school has its own structure, norms, rules and "ways of being" which teachers and students have been socialised into. And within this particular place called classroom, there are physical spaces that are socially designated as belonging to the teacher and students and expected as well as accepted "ways of being". My findings reveal that these spaces and "ways of being" and socialised norms seemed to be challenged by the implementation of ETeMS. According to Johnstone (2004):

> speaking, writing, and other semiotic codes found *in space* index particular localities, orient us through different levels of territorial and societal stratification including identity claims, power relations, and their contestations

In teacher-fronted classroom, there are established territorial and stratified roles; for example, teacher as the primary knower (Berry 1981) with the knowledge to give and students as secondary knower (Berry 1981) with knowledge to receive. Within these territorial (i.e. Malaysian context) and societal stratification (i.e. the role and identity of teacher in Malaysian teacher-fronted classrooms) I explore ideas of agency and structure as I apply them to my linguistically altered mathematics classrooms because agency is jointly constructed and negotiated through different interactions in which the person is positioned at different times.

"Discourses position individuals" (p. 153) and "language is the force that molds their social standing and the relations with other" (p. 157) claims Vitanova (2005). We saw TM displaced from the position of a primary knower to a secondary knower in terms of English language proficiency. We saw Charmaine, the student, stepping into the teacher's shoes and taking the stance of a primary knower when she corrected the teacher. It is as though Charmaine now holds the power, the power made available to her by her higher level of English proficiency. In fact, Hall (1995) states that "when we select words in the process of constructing an utterance, we do not pull them from some neutral system." With the usage of "actually" in her utterance "Teacher *actually* it's not tail…. It's hair", Charmaine further strengthened her position as primary knower which Norton (1995) says is common because power relations play a crucial role in social interactions.

In addition to that, Charmaine's physical position, being seated at her desk, when she loudly corrected TM who was standing, leaning against the teacher's table added to the discord TM displayed. TM reacted as though Charmaine sought to place her as secondary knower, someone with the lesser knowledge of English, thus someone with lesser power. TM's resistance was evident. Davies and Harre (1990) say that we may be constituted in one position or another, or perhaps stand in multiple positions or negotiate new ones by "refusing" the ones that have been articulated by posing alternatives (p. 48). TM did not meekly accept the displacement or the denying of power. She used her status of social authority in the classroom, through the use of censure, to recapture the element of power and her sense of agency. In doing so she rectified the imbalance of power that Charmaine's utterance stirred as explained by Day et al (2007):

> a sense of agency is developed when an individual feels able to pursue their goals within the context of positive and negative interactions within and between internal situated and personal factors, and external professional factors (p. 111).

Charmaine's utterance caused a five second silence. Neither TM nor the rest of the class responded to Charmaine's "language repair". TM, by taking control of her turn, pursued her goal of (re)establishing her position of power and authority in the classroom

However Day et al (2007) observed that whenever there is a reform or an implementation of new policy in the education sector, "teachers have frequently come to occupy positions of increasing uncertainty and constraint. This need not imply that teachers have a reduced sense of 'agency' *per se* (p. 104)." And we saw this in TM's reaction when she was corrected for her mathematics mistake. TM accepted her displacement as primary knower rather graciously. When the three students pointed out her mistake, TM did not become defensive. She did not act as if she felt disempowered. She acted as if she retained her agency. But the three students abided by the already established structural and contextual features of the teacher-fronted classroom by respectfully approaching TM and in a low voice discussed with her the error. Vitanova (2005) observed that, "the subject can move between discourses; reflect on how they position him or her; and can negotiate, modify, or even resist them in the process of experiencing one's subjectivity" (p. 152). TM acknowledged the mistake, and accepted the temporary displacement as secondary knower. There did not seem to be a power struggle due to her displacement unlike during the "language repair" which Charmaine initiated in Lesson 3. Although the new language of instruction forced TM to "occupy positions of uncertainty and constraint" (Day et al, 2007), the mathematical content enabled her to occupy positions of certainty and liberation. The content knowledge, pedagogical knowledge and exam knowledge of mathematics gave TM a higher sense of agency and power in mathematics compared to her students. With this higher sense of agency and power in mathematics, we saw TM "building and sustaining solidarity" (Tobin, 2007, p. 58) when it was mathematical content that was at focus whenever she asked "correct or not?" before she examined the solutions on the board. Her invitation to check the mathematics problems on the board with her, showed that she was indirectly valuing their opinion and assessment and was building a sense of solidarity. Her students tapped into this and felt comfortable enough to initiate a "mathematical repair". Her acceptance of the "mathematical repair" sustained this feeling of solidarity.

The two classes in this study are teacher-fronted which accorded the teacher more agency but instances of student agency were also evident. We saw TM's students "assume collective responsibility for practices and outcomes" (Tobin, 2007, p. 58) when they initiated "mathematical and language repairs". While TM appeared to acknowledge and accept their agency as they "assume collective responsibility for practices and outcomes" during the "mathematical repair", she seemed less accepting of Charmaine's agency during “language repair”. When TR was corrected, she accepted the “language repair”, incorporated it in her interaction and even said “sorry” compared to TM’s reaction of “Don’t talk”. TR seemed to have the agency to build a classroom practice that encouraged Tobin’s (2007) notion of “collective responsibility” when Asmirah repaired her language. But when TR became self-conscious, looked away and ignored Asmirah, it appeared as though she too was less comfortable with Asmirah’s agency during “language repairs”.

The incidents mentioned above may seem to portray TM as having a sense of agency within mathematics and a reduced sense of agency within English, the new medium of instruction. However, I noticed TM having an “emerging” sense of agency within English when she cracked a joke related to a homonym. In Lesson 4 (see TM:4:1), TM made a joke about “operation”, saying that it was not “doctor operation” but that it was basic operation in mathematics which is “plus, minus, times and divide”. Her students laughed at her joke before TM continued her lesson. Love and Suherdi (1996) say that “examination of conversational structure can tell us a great deal about how they (the participants) negotiate their roles as knowers” (p. 235). In Lesson 3, Charmaine’s “language repair” seemed to reduce TM’s position as primary knower and sense of agency and power within English but in Lesson 4, TM (re)established her position of primary knower and her sense of agency within English with her joke using the homonym.

Within this new linguistic and social landscape of the mathematics classrooms in Malaysia since the implementation of ETeMS, TM’s and TR’s agency was constantly being (re)negotiated in new ways. TM and TR are finding their footing, their voice, their agency and power all over again because as Davies (2000) states, “one can only be whatever the various discourses make possible, and one’s being shifts with the various discourses through which one is spoken into existence” (p. 57). And the discourses in the mathematics classroom have taken on a new level of complexity with the linguistically altered medium of instruction.

5.7.3 The revealing laughter and loaded silence in the linguistically altered classroom

"Laughter," claim Jefferson, Sacks and Schegloff (1977) "is indexical; it is heard as referring to something, and hearers will seek out its referent" (p. 12). They explain that being indexical, laughter can refer backwards (e.g. laughter can appreciate a joke which just occurred) and laughter can refer forwards (e.g. one sees the projected course of talk, and already knows and appreciates the outcome). When Charmaine suddenly exclaimed, "Teacher, actually it's not tail. It's hair", the class was silent. Even TM was silent before she said "Don't talk." The class broke the silence by *laughing at* Charmaine after TM's utterance. Glenn (2003) who studied laughter in interaction discusses at length how laughter conveys meaning. When we look at Charmaine, we saw her temporarily stepping into the teacher's role. The silence of the class and TM's silence and response made Charmaine realise that her new but temporary identity was not confirmed by the rest in the class. We saw Charmaine's "self" and the "situation" at the moment of correction were, in Turner and Stets' words, in disequilibrium.

> When self and situation are in disequilibrium because others have not confirmed an identity, the individual's impulses will revolve around finding ways to restore congruence between the self presented and the reaction of others to this self-presentation (Turner & Stets, 2005, p. 106).

In an attempt to resolve the disequilibrium she had caused and restore the congruence between the "self" she had presented (as the primary knower) and the reaction of the class (their silence and their laughter) as well as the teacher's response (of chiding her and reminding her of her mistake), Charmaine became silent. Her silence in accepting TM's reprimand and the class' laughter at her expense restored the equilibrium in class. Charmaine, having been socialised into the accepted "way of being" in school since Primary One (7-year-old) and also in Malaysian culture of not talking back to elders as a sign of respect, realised that her utterance had violated the accepted and expected code of conduct. In an attempt to bring back the sense of social solidarity with her teacher and again reinforce the long held code of conduct that goes with the "way of being" in class, Charmaine held her silence.

In her study of East European immigrants working in the United States, Vitanova (2005) illustrated what happened when subjects suddenly find themselves silent and when the positions assigned to them were unfamiliar. She said that it was the lack of language resources that positioned them in these new, uncharacteristic situations. She found "through discursive practices with others and through everyday acts of creativity, they re-establish their voices" (p. 166). When Charmaine uttered "Teacher, actually it's not tail. It's hair.", there was a 5-second silence. This silence was a loaded silence for neither TM nor the class responded to Charmaine's utterance. When TM finally broke the silence and responded, it was to (re)establish her lost voice. The class continued to hold its silence until they "re-heard" TM's lost voice. Then they joined TM by *laughing at* her remarks directed to Charmaine. Their affiliative *laughter with* TM helped TM (re)establish her social position in class. For Charmaine, the laughter of the class would seem dis-affiliative for it distanced her from the rest of the class. Glenn (2003) explains that:

> The phrases 'laughing at' (dis-affiliative laughter) and 'laughing with' (affiliative laughter) suggest a long-recognised distinction between the power of laughter to promote distancing, disparagement, and feelings of superiority; or, conversely, to promote bonding and affiliation (p. 112).

Similarly, Bakhtin (1968) finds that laughter can act as a means for lower classes and those in less-powerful positions to challenge the social order by making objects of derision out of those in power and the rituals and rules that maintain existing power relationships. When Charmaine initiated a "language repair", she had placed TM in a less powerful position. TM retaliated saying, "don't talk". In Bakhtin's words, TM made Charmaine an object of derision and this was further completed with the students *laughing with* TM *at* Charmaine.

Stillman, Baumeister & DeWall's (2007) main finding from their study of laughter and power was that low power workers laughed more at jokes told by the person who held power over them compared to the same jokes told by someone over whom the listener had power. More important for my study, Stillman et al found that low power also increased *laughing at* a fellow low-power co-worker. However, when TM's students "*made fun*" of another student (see TM:9:3[SW]), TM did not join in their laughter for by *laughing at* their joke on a fellow student, she would be acknowledging their power and higher position. If TM had *laughed at* their joke, it would seem that she is at the same level with them, *laughing at* someone of lower power. While the student being *laughed at* is of lower power comparatively to her as the adult and the teacher, the students she would be *laughing with* might seem to be given the power to be of same "status" as her. Besides that, TM had been using laughter in her classroom as a powerful pedagogical tool and to establish solidarity, bonding and affiliation.

Several other incidents (see section 5.5) reveal the different meanings laughter mediated in the social wor(l)d of the linguistically altered classroom. As a powerful pedagogic tool, TM used laughter as an intensifier to discourage carelessness. From excerpts TM:3:1[SW] to TM:3:4[SW], TM used laughter to "*make fun*" of Charmaine's mistake. Although she did the same in TM:9:2[SW], there was a noticeable difference; she did not reveal the identity of the student but focused instead on the mistake. Laughter had also been used in TM's class to establish solidarity and create an atmosphere of "bonding and affiliation" (Glenn, 2003, p. 112). In Lesson 4, TM cracked a joke using a homonym, 'operation' (see TM:4:1[SW]) while in Lesson 9, we saw her students tease her (see TM:9:1[SW]).

5.7.4 The emotional climate in the linguistically altered classroom

The (re)negotiated sense of identity and subjectivity as well as agency and power since the implementation of ETeMS have heightened the need to look at the emotional climate in the linguistically altered classrooms. Although the mathematics content they have to teach remains the same, the language that mediates the teaching and learning of the content is now different. TR and TM seemed uncomfortable when they were corrected by their students. This is hardly surprising, as Day et al (2007) found that:

> because of their emotional investments, teachers can experience a range of negative emotions when control of long-held principles and practices is challenged, or when trust and respect from parents, the public and their students is eroded (p. 105).

In her study of East European immigrants working in United States, Vitanova, (2005) found that “not only was the loss of voice a painful experience for all of them, but they also were cognizant of the social implications” (p. 157). TM and TR may not be in another country like the participants of Vitanova, but they are, to a certain extent, facing a similar struggle – a loss of their voice due to ETeMS.

The new medium of instruction evidently altered the whole interaction structure of the class and the people in it. We witnessed TM, TR and their students experiencing new emotions as they dealt with their new and emerging identities. “Experiences of emotion are interconnected with personal beliefs, context and culture,” state Day et al (2005), “and they play a key role in the construction of identity” (p. 104). With the implementation of ETeMS, the *belief* that as teachers they were the knowledge providers, the source of knowledge in the *context* of the classroom, especially a primary classroom of 10-year old students, in Malaysian *culture* that places a lot of importance on respect for elders got shaken when Charmaine and Asmirah repaired their English.

Students too find themselves in a strange situation. For example, Asmirah who corrected TR, struggled to keep quiet when TR used the word "clothes" (see TR:1:1). TR had used the wrong word, "clothes", four times before Asmirah, no longer able to keep quiet, blurted out the correct word "cloth". Asmirah, it appears, felt bad because her immediate reaction was to close her mouth with her hands in Lesson 1 and refrained from correcting her teacher's mathematical error in Lesson 6. When Charmaine repaired TM's incorrect language, the whole class which was laughing before immediately became silent. They seemed not to know how to respond. Only after hearing TM's response and "reading" into it, they *laughed with* her *at* Charmaine.

With the implementation of ETeMS in 2003 I observed letters of opinions, similar to the one below, become a common sight in the daily newspaper:

Teachers have to show the way

The Star
28 January, 2007
Pg. 4

by Concerned Student

I am now in Form Two and have always fancied learning Maths and Science in English, so when I got the chance to do so, I was quite excited.

However, throughout my first year in secondary school, I found that most of my English, Science and Maths teachers were not proficient in English.

In the first month, we had to attend the "Orientation Programme for Science and Maths in English" or OPSME. The purpose of the programme was to familiarise students with basic Science and Maths terms in English. I was shocked when the teacher who conducted the programme was unable to pronounce words such as "ascend" and "descend".

During Maths and Science and English classes held during the rest of the year, I frequently had to correct my teachers' pronunciation and grammar.

I had the same problem with English language teachers even during my upper primary years.

If English language teachers cannot speak English properly, how can we expect teachers of Maths and Science, who had previously taught in

> Bahasa Malaysia, to teach in flawless English?
>
> Having studied in a private school in lower primary, I have a good command of the language as I was taught by English teachers, mostly above the age of 55, who were "experts" in the language.
>
> The school environment also helped as the students conversed in English almost all the time.
>
> If teachers do not improve their proficiency in the language, all efforts to make Bahasa Malaysia globally competitive will just go down the drain, together with the government's money.

This Form 2 (14-year-old) student's concern was on the level of English proficiency of her teachers. Note that she did not comment on her teachers' content knowledge, pedagogical knowledge or even the exam knowledge. She makes strong statement regarding wasting "all the effort and money" in her last paragraph but they are related to the issues of proficiency level in the new medium of instruction.

Teachers like TM and TR attended the Ministry held ETeMS courses to help them deal with the transition. The ETeMS module has a syllabus that is similar to ESP (English for Specific Purposes) or EAP (English for Academic Purposes) which covers English grammar as well as science and mathematics content. Armed with the training the ETeMS module offered, teachers like TM and TR were pretty much left on their own to deal with the problem of evolving and emerging identities, sense of threatened agency and feelings of vulnerability. "The ways and extent to which reforms are received, adopted, adapted and sustained or not sustained, will not only be influenced by teachers' emotional selves but will exercise influence upon them" (Day et al, 2007, p. 105). If ETeMS is to succeed, then the emotional climate of the classroom that is the affective domain must also be taken into consideration.

5.8 Summary

I have applied ideas from both sociocultural and sociolinguistic theories to understand how classroom life is jointly constructed in two linguistically altered mathematics classrooms in Malaysia. My analysis found that language and language use is central in mediating social wor(l)ds in these two classrooms besides other "ways of being" steeped in Malaysian culture. As this study probed deeper to gain insights on how the new medium of instruction mediated classroom life, more emphasis was placed on language and language use. However, this study recognises the fact that classroom life is also made up of many other aspects. Thus, the use and role of laughter and silence in mediating this classroom life was also explored.

Yule's (1996) comment that "it is rather obvious that more is being communicated than is said" (p. 3) is very fitting because the classroom events and practices described in this chapter seem to indicate that the new medium of instruction does, to an extent, alter the social wor(l)d of the classroom in certain aspects such as positioning and (re)positioning, place-space and discourse as well as reaction to repairs. Teachers especially, and students generally, find themselves (re)negotiating new "ways of being" as the new medium of instruction (re)mediates the social wor(l)d of their linguistically altered classrooms. Teachers' and students' identity, subjectivity and agency, that is never static and always evolving, seemed to be (re)created in new, unexpected ways since the implementation of ETeMS. Having said that, the mediation of classroom life and "way of being" related to the "teaching and learning *of* mathematics" does not seem to go through a process or (re)negotiation compared to "teaching and learning *in* English."

CHAPTER SIX

My ETeMS Stories: A Conclusion

6.1 Introduction

In the previous chapters, I captured two stories from amidst the many stories of ETeMS through my study, "Mediating Wor(l)ds". Chapter Four with its focus on mediating academic wor(l)ds, narrates the stories of the teaching and learning *of* mathematics *in* English while Chapter Five, with its focus on mediating social wor(l)ds, tells the stories of teaching and learning in linguistically altered classrooms.

Many important insights were found in investigating ETeMS, specifically the teaching and learning *of* mathematics *in* English through the following research questions:

1. How does teacher talk mediate the learning of mathematical content and mathematical English?

   1a) What discursive practices are made available for the learning of mathematical content and mathematical English?

   1b) What opportunities are made available for the learning of mathematical content and mathematical English?

2. What other mediational tools, besides teacher talk, mediate the learning of mathematical content and mathematical English?
3. How does the new medium of instruction alter the social wor(l)d of the mathematics classroom?

The findings for each of my research questions discussed under two areas, the academic wor(l)d and the social wor(l)d in Chapters Four and Five were briefly summarised at the ends of the chapters. In this chapter, I relate the insights about the intertwined academic and social wor(l)ds of the two linguistically altered classrooms in Malaysia to the rationales that prompted the implementation of the ETeMS policy.

In section, 6.2, I summarise the key findings of this study. In section 6.3, I discuss briefly the rationales for the implementation of ETeMS and explore the inter-relationship between ETeMs policy on paper and ETeMs policy in practice. I also propose, in section 6.4, an adapted and extended "situated sociocultural model of linguistically altered mathematics education" from the model Khoon et al (2001) proposed (see Figure 1 in section 1.5). In section 6.5, I discuss some pedagogical implications concerning ETeMS and in section 6.6, I go on to suggest some directions for further research. Section 6.7 discusses the current status of ETeMS and in section 6.8, I conclude by considering some of the multiple layers of stories of ETeMS yet to be peeled.

6.2 Overview of key findings

The intertwined academic and social wor(l)ds of the linguistically altered classroom life have been analysed and discussed separately for the purposes of this study. The analysis of the inter-related cognitive and affective domains of the linguistically altered mathematics classrooms furnished evidence in different ways for the following conclusions.

6.2.1 Teaching and learning *of* mathematics *in* English

- Teacher talk plays a crucial role in mediating the learning of mathematical content, concepts and terms, especially those not found in the textbook. The shorter conversion methods, not evident in the prescribed official textbook, were made available by both the teachers through their talk in the classroom.
- Other mediating tools such as the physical objects also mediate the mathematical content and mathematical English.
- Both talk and tools play complementary mediating roles. Mere teacher talk was insufficient to mediate the teaching and learning "conversion of units" until the teachers used mediating tools to jointly construct mathematical knowledge. Mediating tools like the notes/formula on the board were also insufficient for the students to carry out the conversion task until they were accompanied with

teachers' or other students' talk. When Shu Yen was called to the board to solve the conversion task, TM gave her a few prompts to guide her. But Shu Yen was unable to carry out the task. She kept looking at the notes TM had written, and still was unable to complete the task. When TM once again stepped in and guided her with the notes and oral prompts, Shu Yen was finally able to solve the task.

- Both the teachers employ code-switching strategies as and when they think is necessary.
- Teacher talk seems to vary in degrees of control. Once the content and concept has been jointly constructed, students feel empowered to take some ownership of the classroom interaction. While beginning lessons of the unit on "Length" or the beginning of a set of activities, for example the ribbon activity, the teacher seems to control the classroom discourse. In later lessons and later stages of activity, the amount of teacher talk visibly reduces and student participation increases.
- Despite the seemingly single directional talk and mostly triadic dialogue, both the teachers were employing several discursive practices like recasting/revoicing students' responses, revisiting key ideas, relating to/drawing on students' previous knowledge, using cued elicitation to encourage joint construction and encouraging/seeking elaboration and justification of responses as they jointly constructed mathematical content/concept and mathematical English with their students.
- There was more of an emphasis on teaching for testing rather than teaching for understanding, hence more attention on procedural fluency compared to conceptual understanding, thus more calculational discourse than conceptual discourse.

6.2.2 Teaching and learning in linguistically altered mathematics classrooms

- The new medium of instruction in the mathematics classroom altered the already established social wor(l)d of the classroom. Teachers especially and students generally find themselves negotiating new rules and new "ways of being" within the altered medium of instruction.
- Both teachers' and students' were (re)creating and (re)negotiating their subjectivity and identity as well as agency and power relationships as participants within the new medium of instruction. While teachers were comfortable in the teaching *of* mathematics, they were less comfortable teaching *in* English.
- The new medium of instruction has positioned teachers and students in new roles which changed the dynamics of the everyday classroom life. Teachers who have been used to being the primary knower in the classroom now find themselves being positioned as secondary knower in terms of the new medium of instruction.
- Laughter and silence have also been used as pedagogical tools in maintaining not only the academic but also the social wor(l)ds of the linguistically altered classroom.

My aims in this research have been to investigate and share the stories of ETeMS. I have shared the stories of two teachers managing the teaching and learning *of* mathematics *in* English to 10-year-old students. I have used the explanatory power of sociocultural and sociolinguistic theories to make sense of both academic and social wor(l)ds being mediated by the change in the medium of instruction. I have furnished evidence of ETeMS policy in practice where I analysed ways the new medium of instruction altered the teaching and learning of mathematics and classroom life. In the next section, I discuss the inter-relationship between the policy and practice of ETeMS

6.3 ETeMS policy and practice: The inter-relationships

I begin by briefly revisiting the rationales for the implementation of ETeMS (see section 1.2 for a detailed discussion) before discussing the policy and its practice. Towards the end of 2002, there was a sudden change in this language policy. Content subjects, mathematics and science, which were being taught in Bahasa Melayu were to be taught in English from the following year onwards. The education world in Malaysia was jolted and wondered why the sudden focus on English. Chap & Presmeg (2011), Gill (2005) and Choong (2002) identified several rationales that prompted the implementation of the ETeMS policy:

- The significant role of the English language as an international language for knowledge acquisition and communication
- To arrest the decline of the English language proficiency levels among students, both at school and at tertiary level
- To equip the future generation with a language that enables them to access new developments and advances in science and technology to meet the challenges of globalization
- To overcome the increasingly challenging task of translating the latest technological developments into Bahasa Melayu.

Having observed two teachers implementing ETeMS policy in their mathematics classes, it is crucial to explore the inter-relationship(s) between the policy on paper and the policy in practice. The nature and focus of the teaching and learning activities, classroom discourse, the kind of mathematical knowledge emphasised, teachers' perception towards ETeMS are key factors of the inter-relationship between the policy and its implementation.

The mathematics teaching and learning activities in this study showed a heavy reliance on calculational discourse compared to conceptual discourse. In the attempt to create a nation towards K-economy, classrooms should emphasise conceptual discourse. The question then arises whether the heavy reliance on calculational discourse is brought about because of the change in the medium of instruction or whether this way of teaching mathematics using calculational discourse, with its emphasis on procedural knowledge, has always been the norm. If the latter is true, then a review of the mathematics teaching pedagogy (which is beyond the scope of this study) is vital for this methodology might not be able to help the nation move towards K-economy it is striving towards. If the former is true, then we can assume that the new medium of instruction is an obstacle for it hinders conceptual discourse that is deemed important in creating "thinking" students who will eventually fill the workforce. But my study reveals that TR spent some time mediating conceptual understanding *of* mathematics *in* English before emphasising procedural knowledge.

TM seems to focus directly on procedural knowledge while TR deals with the conceptual knowledge first before proceeding to the procedural knowledge. TM seems to place more importance on her "bowl system" than on long division or multiplication when it came to converting units of length. Despite the recommended "partition method" in the Ministry prescribed textbook, TM chooses to teach extensively and validate the "bowl system" in the school chosen supplementary book. Although TR starts off by spending some time on the conceptual knowledge, she too at the end stresses procedural knowledge through her "jumping method". According to TR and TM, they need to prepare their students for the school prepared tests and the state education department prepared exams and eventually the public exam, UPSR, in two years time. This is the driving force behind their teaching of the "bowl system" and "jumping method". The knowledge that counts is the exam "way of knowing". At the end of six years of schooling, students have to sit for the public exam, UPSR. The UPSR exam, and not the new medium of instruction, seems to control TR's and TM's teaching of mathematics. The exam "way of knowing" seems to encourage calculational discourse rather than conceptual discourse during the teaching and learning of the unit on "Length". TR eventually, and TM from the beginning, use calculational discourse in their classroom interaction. Despite the new language of instruction, the structure of interaction in the classroom remains calculational in nature.

Both the teachers in my study are positive about the change in the language policy. They do not deny that it is a big change for them and still being in the initial phase, the implementation of ETeMS is, as TM mentions during her interview, "ETeMS masih baru, lama-lama akan menjadi lebih mudah" [[ETeMS is still new, as time goes by, it'll become easier]]. Both TR and TM say that they code-switch as and when they think it necessary, for example, when they think their students do not seem to understand or when they themselves get stuck and cannot remember the terms/vocabulary. However, both TR and TM claim that they feel their talk in the classroom has become a bit "jerky" (TR) and not so "licin" [smooth] (TM), but that they are confident that with time they will be able to achieve a certain level of fluency. Both TR and TM show positive attitudes towards ETeMS.

English possess linguistic power and thus is seen to have high commodity value (Choong, 2002). Both TM and TR also echo this during their interviews. They realise that more language is needed especially for mathematics questions that are "problem solving" in nature. According to TM, when the students go on term breaks, she gets them to borrow English storybooks to read over the holidays for it will help improve their proficiency level. TR, on the other hand, says that she tries to use common everyday language, like "change" and not quickly resort to code-switching to "tukar" when her students find it hard to remember the concept of "conversion". And even when she introduces the Bahasa Melayu term, "besarkan" she repeats it in English, "enlarge". Besides concentrating on the content and concept of mathematics, both TR and TM have begun to seriously look at and problematise the new language for the teaching and learning of mathematics. They said that sometimes they feel like they are playing the role of an English teacher. Looking at the bigger picture and in comparison with the aims of

ETeMS which is to encourage more English usage, then the efforts of these two teachers and the aims of ETeMS policy are not at odds with each other.

6.4 An adapted and extended "situated sociocultural model of linguistically altered mathematics education"

Khoon et al (2001, p. 113) proposed a "situated sociocultural model of mathematics education" (see Figure 1 in section 1.5) in an attempt to offer a broader perspective for examining how several factors can work together to affect mathematics education. According to them, research on mathematics education so far has mostly focused on specific factors in depth, for example, the politics of mathematics education, the development of a mathematics reform, the nature and development of ethnomathematics, gender differences, philosophies of mathematics, or sociological histories of Western and non-Western mathematics. As mentioned in section 1.5, Khoon et al explain that sociocultural factors such as history, politics, ethnic composition, languages, cultural values and ways of life, customs, different gender roles and others have different impacts on the nature and practice of mathematics education of a country. Their proposed "situated sociocultural model" delineates the influences of and inter-relationships among many of these sociocultural factors which they go on to apply as they explore mathematics education in three ASEAN countries; Brunei, Malaysia and Singapore.

My study on ETeMS, focused mainly on one factor depicted in the model Khoon et al proposed, that is on "language issues" in Malaysia. During colonial times, English was the main official language and competence in English was a prerequisite to gain admission to higher education and civil service. After independence, Brunei, Malaysia and Singapore developed their own language policies that reflect the political aspirations and practical needs of their people. Malaysia implemented Bahasa Melayu as the main medium of instruction from primary to university levels. This is based on the government's political agenda to use Bahasa Melayu as the language to unify people of different ethnic backgrounds and as a tool to reduce British influences in the postcolonial period. Thus mathematics was taught in Bahasa Melayu at all levels in national schools.

My study which has focused mostly on language issues, namely linguistically altered teacher talk within the academic wor(l)d of the two mathematics classrooms, sits comfortably within the model proposed by Khoon et al However, having also investigated the social wor(l)d of the same two linguistically altered mathematics classrooms, my study on ETeMS reveals interesting insights which have not been taken into consideration in the model proposed by Khoon et al. I suggest that the model would benefit from the inclusion of these insights.

In section 6.2, I have summarised my findings of the teaching and learning *of* mathematics *in* English. I have elaborated how "talk" (proposed by Khoon et al as "chalk and talk" in Figures 1 & 24) mediates the joint construction of mathematical knowledge. I have also elaborated on other mediational tools besides "talk" in the joint construction of the teaching and learning processes. The influence of assessment (proposed also by Khoon et al) on the kinds of "talk" celebrated in the mathematics classrooms, that is calculational and conceptual discourse, was also discussed.

In section 6.2, I have also summarised my findings of the affective domain of the teaching and learning in linguistically altered classrooms which are not included in the model proposed by Khoon et al. I have found that the new medium of instruction altered the dynamics and "way of being" in the classrooms. I have elaborated on issues such as subjectivity and identity, positioning and (re)positioning as primary and secondary knower(s), agency, the use of laughter and silence and reaction to repairs in the linguistically altered classrooms. These aspects are not evident in the sociocultural model of mathematics education proposed by Khoon et al (see Figure 1 in section 1.5). Therefore an adapted and extended model is proposed based on my study on ETeMS in Figure 24.

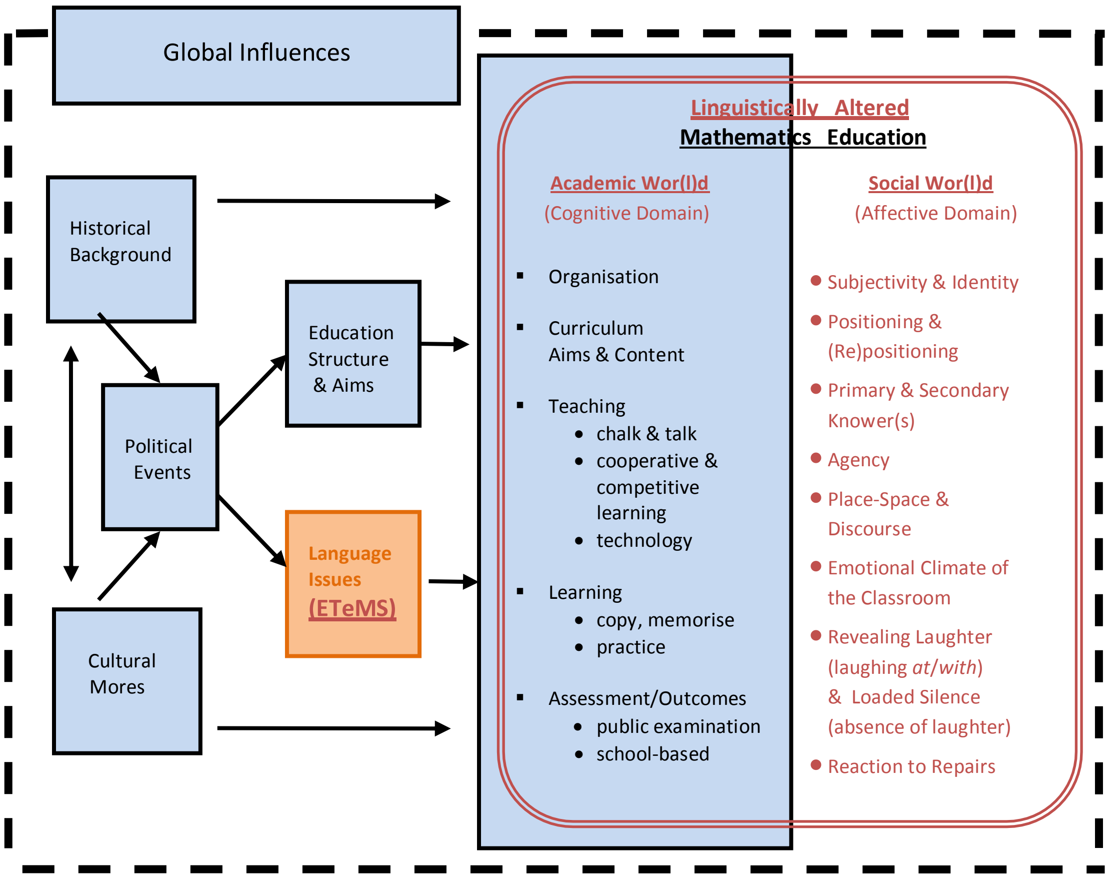


Figure 24: An adapted and extended situated sociocultural model of linguistically altered mathematics education after Khoon et al (2001, p. 113).

The adapted and extended "situated sociocultural model of linguistically altered mathematics education" as shown in Figure 24 includes the social wor(l)d of the classroom to provide a more comprehensive picture. This is because both the academic wor(l)d and the social wor(l)d of the classroom impact and affect the teaching and learning processes within the classroom. While the model proposed by Khoon et al recognises the cognitive dimension or the academic wor(l)d of the mathematics classroom, this adapted and extended model recognises and includes the affective dimension or the social wor(l)d of the mathematics classroom as well. In the reality of the everyday life in the classroom, both academic and social wor(l)ds or the cognitive and affective domains are intertwined and inseparable.

In short, my stories of ETeMS reveal that the teaching *of* mathematics *in* English is not a simple matter. Although the content of mathematics remains the same, changing the medium of instruction alters the structures of the already complex teaching and learning processes in the classroom. My study also reveals that research focusing simultaneously on both the academic wor(l)d (cognitive dimension) and the social wor(l)d (affective dimension) of the classroom yields a more enriching and comprehensive picture of the reality of teaching and learning in classrooms.

6.5 Pedagogical implications

Based on my study of two teachers teaching mathematics *in* English, I look at some important issues and implications concerning the change in language policy for policy, practice and inter-disciplinarity in mathematics education and applied linguistics.

6.5.1 On implementation of the ETeMS policy:

The ETeMS policy, implemented in 2003 saw Malaysian classrooms adopt English as the medium of instruction in a move to keep abreast with scientific and technological development as they are mostly recorded in English Language. This is supported by Cope & Kalantzis (2000) who say that English Language, being the *lingua mundi* (a world language) and *lingua franca* (a common language of global commerce), is also the language of the world's knowledge. The change to ETeMS policy is basically the government's strategic response to current needs.

Before ETeMS was implemented, training programmes were quickly drawn up and teachers were trained to teach in English almost overnight. A quick survey of the training module reveals that much of the content and many of the activities focus largely on science. This is not surprising as Krashen (1982) says that learning mathematics in English does not require as high a level of language proficiency as subjects like social studies, language arts or science. Tevebaugh (1998) also found that many students in her study felt that they do not need much English proficiency to do mathematics problems. In fact many ESL teachers and students believe in the myth that mathematics needs little language (Paredes, 2000). Actually, limited English proficiency is a discouraging obstacle to learning (Tevebaugh, 1998) and it would be detrimental for both students and teachers. Crandall's (1995) research on monolingual English speakers shows that (i) there is a close relationship between language proficiency and mathematics achievement and (ii) high positive correlations between (English) reading ability and mathematics achievement. She also shares her research on ESL speakers which show (i) similar positive correlations between language skills and mathematics achievement (ii) positive correlation between mathematics achievement and second language ability. She concludes that language is a factor both in the learning and the assessment of mathematics. TM and TR have participated in various in-service courses, such as the Language Immersion Programme besides the ETeMS course, held in various teacher training colleges throughout Malaysia to help mathematics and science teachers with their own English proficiency but found that these courses focused more on the teaching and learning *of* science *in* English than the teaching and learning *of* mathematics *in* English. They highlighted the need to assist mathematics teachers with the linguistic demands of the ESL mathematics class. Therefore, for the ETeMS policy to succeed, TM's and TR's concerns should be taken into consideration.

Presently in Malaysia, most of the local research of this new phenomenon of language transition seems to study the academic wor(l)d or the cognitive domain of teaching and learning *of* mathematics *in* English. My findings from the social wor(l)d or the affective domain of teaching and learning in linguistically altered mathematics classroom reveal important insights such as evolving and emerging identities, sense of threatened agency and feelings of vulnerability. While the many in-service programmes TM and TR attended gave them assistance and ideas to deal with the cognitive dimension of teaching and learning *of* mathematics using the new medium of instruction, they received neither help nor ideas to deal with the affective dimensions of teaching and learning *in* English. If ETeMS is to succeed, then the affective domain of teaching and learning *in* linguistically altered classrooms must also be taken into consideration.

6.5.2 On practice:

Bodrova and Leong (2007) say that, "a teacher may take part in a shared activity in two different ways: teacher as planner and teacher as partner" (p. 83) as they mediate the joint construction of knowledge during the process of teaching and learning. As a planner, the teacher promotes, plans and creates mediators to facilitate the learning processes. As a partner, the teacher encourages her students to express their own understandings, a give and take among all participants. When we look at TR and TM, we may see them more as planners because the cultural and environmental setting they are in, the teacher-fronted classroom, accords them this big role. Teacher-fronted classrooms with the transmission model encourage teacher as planner rather than teacher as partner. But a close look at the linguistically altered classroom interaction in the chosen excerpts reveals that there is a certain amount of give and take between TM and her students especially Charmaine and Monica perhaps because of the teacher's competency in English compared to their students. Perhaps with the implementation of ETeMS, teachers as planners are moving towards teachers as partners as we see more investment in the classroom interaction by students like Charmaine, Monica and Asmirah.

Wells (2002) says that planning teaching at the macro level involves the overall design of the unit of work to achieve specific outcomes. If we take Wells's macro level of teaching analysis and examine the way TR and TM have structured their lessons, we see that they start off introducing basic concepts and building, step by step, on the concept as they move into the content of the lesson. From introducing the units orally, TR goes on to showing it on the rulers and then to teasing out the relationships between units and to reinforcing these relationships with her ribbon activity and finally to jointly constructing the conversion formula. TM uses her notes on the board to jointly construct this knowledge. We see that in their planning, they move their students from simple tasks to complex tasks as they help them move through their ZPD. Wells's (2002) micro level analysis of teaching refers to the moment by moment interactions within the lesson. Taking Wells's micro level of investigating teaching we see that mathematical concepts and mathematical English were mediated through both the teachers' talk, through their discursive practices and through the opportunities (Lantolf, 2000) and affordances (van Lier, 2002) made available.

There appears to be a paucity in recent research on non-proficient speakers of English teaching content subjects in English. While there may be research on non-native English speakers as teachers of English as subject (Ellis, 2002), there is hardly any research into the teaching and learning of content subject in a linguistically altered setting like Malaysia. However, being not fully proficient in the medium of instruction, these teachers experience the struggles their students experience and understand their students' likely problems which informs their teaching in a positive way. A teacher who is fully proficient in the new medium of instruction may not be quite aware of the struggles their students go through and may thus be less informed in their teaching and learning endeavour.

6.5.3 On inter-disciplinarity:

This thesis sees the world of mathematics teaching and learning through the eyes of an English teacher. In teaching English as a subject, I have only been concerned with the complexity of reading writing, speaking, listening (the four skills) in English. I found the teaching and learning of mathematics complex in a rather different way although it still involves all the four skills. I found both these subjects adopt different dialogic styles. I had thought that mathematical discourse would hardly be dominated by the rich kind of classroom interaction an English class would have. But unpacking TM's and

TR's classroom discourse through a linguistic tool (Sinclair & Coulthard's Discourse Analysis Framework), I realise that both disciplines, English and mathematics can inform each other. As Barwell et al (2005) say, a linguistic analysis of interaction patterns leads mathematics educators to explore how language related to mathematics is used in the classroom. They say that by working together, both the discipline of English and the discipline of mathematics can be enriched by the diversity of perspectives and insights.

Furthermore, from the 1970s until 2002, the teaching *of* English as a subject in Malaysian schools mainly concentrated on the kinds of language needed for social interaction and the reading of narrative texts. This scenario is not surprising because Allen (1993) observes that traditional second language teaching focused on the study of language per se. This was also noticed by Crandall (1995) who observed that traditional language teaching focused on grammar, literature, communicative competence as well as language use in an oral and interpersonal sense. The students in Malaysia have neither been exposed to nor taught the kind of language or strategies needed to cope with academic language. For limited English proficiency students who are already facing problems with the learning *of* English, learning *in* English may be doubly difficult.

This means that the teaching *of* English and the teaching *in* English, in Malaysia, has to intentionally problematise the language used for academic tasks, especially in mathematics in order to find teaching-learning solutions. Rather than language learning being a natural process of osmosis, as suggested for example by Bizzell (1986), I strongly believe that it has to be highly mediated for students. This is because students will not pick up "mathematical English" (Clarkson, 2004) subsconsciously by talking to their friends or learning English as a subject because "mathematical English" is not used in casual conversation or English lessons. This means that the *teaching of English* and the *teaching in English*, in Malaysia, has to intentionally problematise the language used for academic tasks, especially in mathematics in order to find teaching-learning solutions. This means all teachers of mathematics are to a certain extent teachers of language.

6.6 Directions for future research

The ETeMS policy placed many teachers in the position of "secondary knowers" (Berry 1981) of English, the new medium of instruction. This study has captured the intertwined academic and social wor(l)ds of the linguistically altered classroom where the students may be more expert in the mediating language than the teachers. It would be interesting to compare this research with research in other settings where students assume the role of primary knower (Berry 1981) like the use of computers in the classrooms. Jones (2010) captures in his study the mismatch between the students' and teachers' ability and orientation towards computer mediated communication. However his study examined the ways teenagers in Hong Kong use computers at home and in school and the effect it has on the ways they orient themselves towards the physical and discursive space. Having said that, Jones' study gives us brief glimpses into three mismatches: (i) the mismatch between students' and teachers' knowledge and ability with computers, (ii) the mismatch between the real life use of computers and the use of computers in classrooms as well as (iii) the mismatch between the aims of the policy and practice in the reality of the classroom.

When we look at the teaching and learning of mathematical content and concept, it would be useful to make a comparison of the teaching and learning processes when the medium of instruction is in the Bahasa Melayu. It would be interesting, illuminating and vital to see if the issues and concerns raised in the study differ and if they do differ, in what ways and to what extent is there a difference.

It would also be useful to further explore if the change in the medium of instruction is encouraging a more discursive or student-centered pedagogy rather than the regular teacher-centered pedagogy that is common in teacher-fronted classrooms. Charmaine and Monica from TM's class and Asmirah from TR's class have begun to show more ownership in the joint construction of meaning in the classroom which is a positive step towards creating independent students who would be better prepared to face the challenges of globalization.

This study has only captured the stories of ETeMs from the perspective of two teachers of different ages and different experiences teaching mathematics to 10-year-olds in an urban area. Both sociocultural and sociolinguistic theories place a lot of importance on the situatedness of the context under study. TM, in her mid-twenties, is a young teacher in the early years of her teaching career while TR, in her early forties, has more administrative responsibilities and fewer teaching periods. TM and TR are two different individuals with two different teaching experiences. TM began her teaching career in the primary school while TR has only been, in the past three years, teaching in primary school after having taught 15 years in secondary schools. For more complete stories, the voice of the students would also need to be heard. A study of teachers teaching in a rural area would probably yield totally different stories of ETeMS. If this study had been conducted in secondary schools, where the students are in between the ages of 13 to 17, different stories of ETeMS would have unfolded. Having teachers from around similar age group or teaching experiences would have perhaps depicted different stories of ETeMS.

This study has been narrated through the eyes of an "English as a subject" teacher looking at the content classroom, mathematics *in* English. Teaching and learning *of* English and teaching and learning *in* English have different stories to tell. And this study of ETeMs had focused only on the linguistically altered mathematics classroom. Perhaps if a study is narrated through the eyes of a mathematics teacher, different ETeMS stories may emerge. And had this study looked at the linguistically altered science classroom, different stories would have probably emerged and different implications for ETeMs could have been explored.

6.7 Status of ETeMS

At the time of completing this thesis, the Malaysian Cabinet decided that the teaching of science and mathematics will revert back to Bahasa Melayu in the primary and secondary schools from the year 2012 (Chapman, 2009). This news was received with mixed feelings. While some were of the view that the ETeMS policy was adversely affecting students' performance in mathematics and science subjects (Faizah, Marzilah & Kamaruzaman, 2011), others considered that the performance in these two subjects had increased significantly (Ihsan, 2009) after the implementation of ETeMS policy.

Ihsan (2009) found that teaching and learning *in* English does not obstruct the teaching and learning *of* mathematics using the data envelopment analysis (DEA) model to measure school performance and Malmquist index to measure the change in school performance over time. My study found that teachers and students used several compensatory practices whenever they considered the new medium of instruction hindered their sense making process. If the performance in mathematics is affected, perhaps it might be due to the kinds of mathematical knowledge celebrated in these classrooms, which is procedural knowledge rather than conceptual knowledge.

Upon the abolishment of ETeMS, the Malaysian Cabinet announced another policy, "Memartabatkan Bahasa Melayu dan Memperkukuhkan Bahasa Inggeris" (Dignifying the Malay Language and Strengthening the English Language) to be implemented from 2012. However, the (PAGE) Parent Action Group for Education Malaysia (Noor Azimah, 2011), point out that the objective of ETeMS was not to *learn English* through mathematics and science. Instead the knowledge that is found in mathematics and science is to be *learnt through English*. PAGE calls for a continuation of the ETeMS policy. My study reveals that while mathematical knowledge was jointly constructed *in*

English, TM's initiative of getting her students to borrow and read English story books during school holidays and TR's effort of translating her Bahasa Melayu back to English indirectly encourages the learning of English. Therefore, learning *through* English promotes the learning *of* English which could help to arrest the decline of the English language proficiency levels among students.

6.8 Concluding comment

This study provides a brief glimpse of the stories behind ETeMS. They are but stories from a single storyteller. Throughout the implementation of ETeMS and my study, I have in Adichie's words, "seen and heard different versions of this single story". Chimamanda Adichie, a writer whose first two novels won literary awards, in her presentation at the TED Talk (October 2009) talks about the danger of a single story:

> It is impossible to talk about the single story without talking about power. There is a word, an Igbo word, that I think about whenever I think about the power structures of the world, and it is "nkali." It's a noun that loosely translates to "to be greater than another." Like our economic and political worlds, stories too are defined by the principle of nkali. How they are told, who tells them, when they're told, how many stories are told, are really dependent on power. Power is the ability not just to tell the story of another person, but to make it the definitive story of that person.

This thesis has tried to reveal two stories of ETeMS, the stories from the academic wor(l)d and the stories from the social wor(l)d and life in two linguistically altered mathematics classrooms. I humbly take heed of Adichie's caution, "They make one story become the only story. The consequence of the single story is this: It robs people of dignity". I realise that there are many more stories yet to be unravelled from this study and that my stories are not the "definitive" stories of ETeMS.

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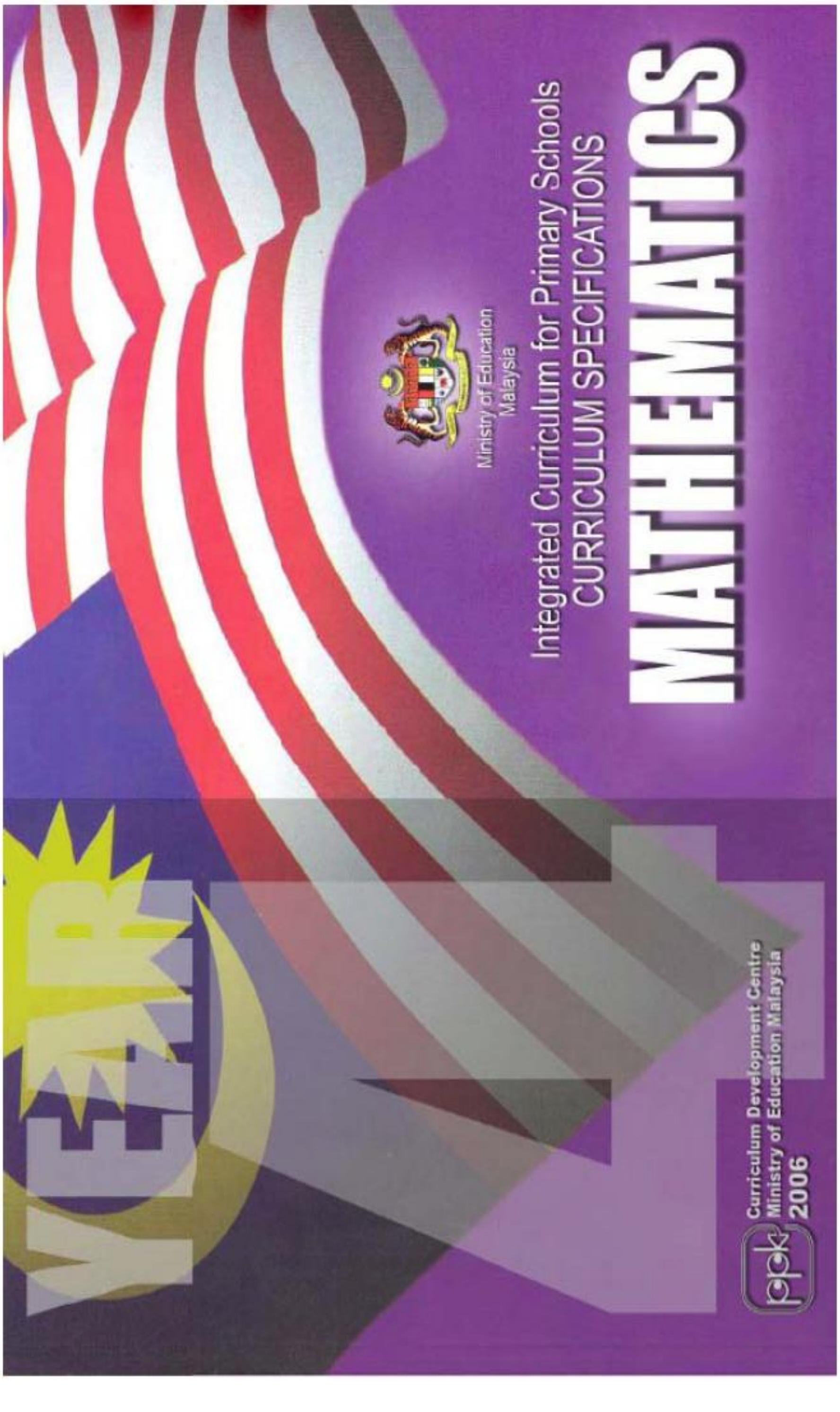
Appendix A

Key for transcript

..	pause for 2 seconds
…	pause for 3 seconds
. . . . .	pause for 5 seconds
↑	rising pitch
↓	falling pitch
→	level pitch
( )	description of how some utterances were said
[ ]	description of what participants were doing
{ }	description of researchers observation/interpretation/comments
[[ ]]	translation to English
(( ))	contextual reference
=	latching (contiguous utterances)
Underline	overlapping utterances (teacher and students speaking at the same time)
WORD	increased volume
italics	stressed word
:	elongated pronunciation

Appendix B


Ministry of Education
Malaysia
Integrated Curriculum for Primary Schools
CURRICULUM SPECIFICATIONS
MATHEMATICS
YEAR
4
Curriculum Development Centre
Ministry of Education Malaysia
2006

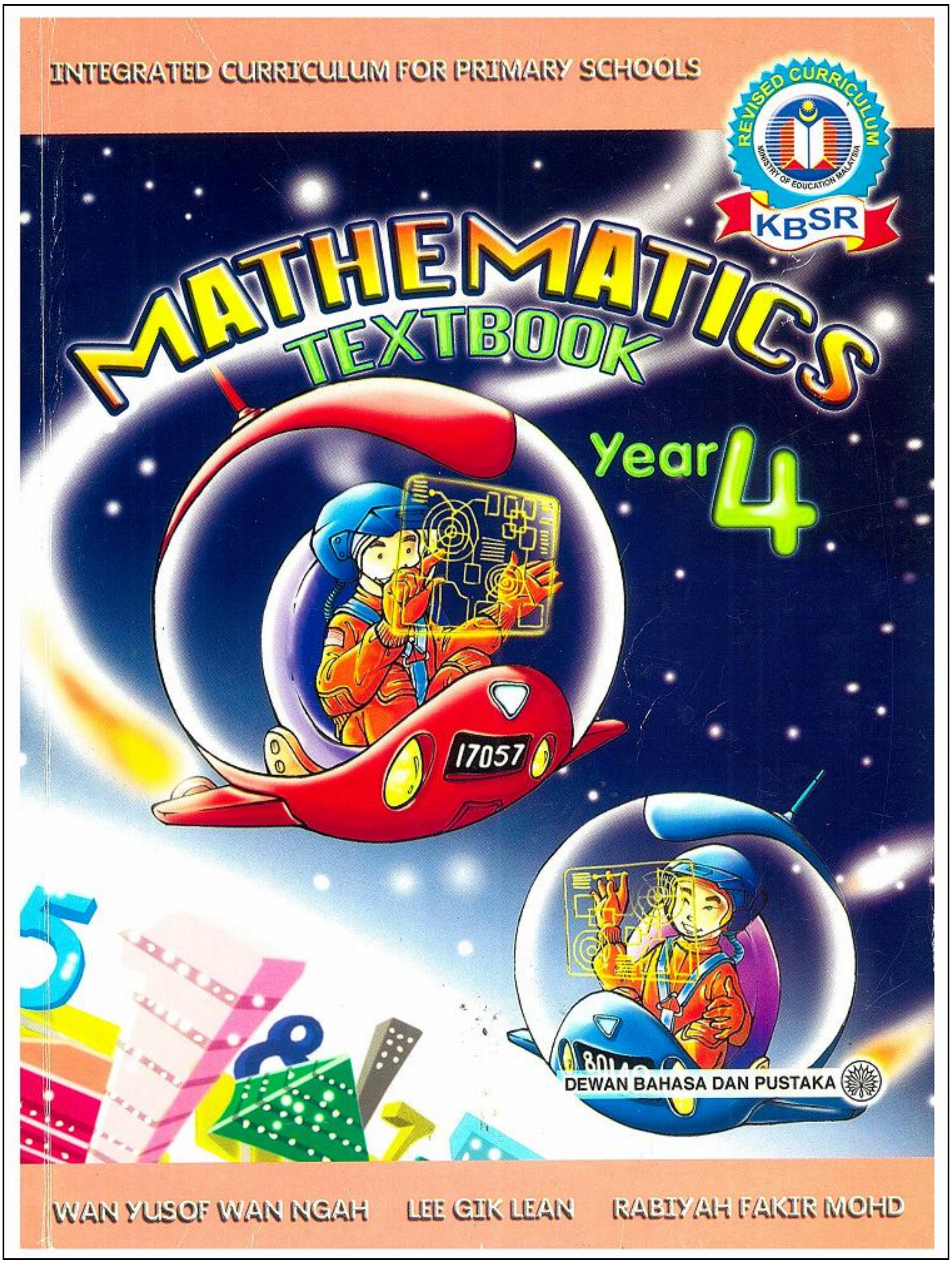
Topic 6: LENGTH

LEARNING OBJECTIVES *Pupils will be taught to…*	**SUGGESTED TEACHING AND LEARNING ACTIVITIES**	**LEARNING OUTCOMES** *Pupils will be able to…*	**POINTS TO NOTE**	**VOCABULARY**
Measure lengths using standard units.	Pupils measure, read and record lengths of objects. The following tools are used to measure lengths: • metre ruler, • small ruler, • measuring tape.	(i) Read measurement of length using units of milimetre.	Depth and height are examples of length.	read scale measure
		(ii) Write measurement of length to the nearest scales of tenth division for: o centimetre, o metre.	Emphasise that measuring should start from the '0' mark of the rule. Remind pupils that the symbols for the units of length are: • m for metre, • cm for centimetre, • mm for milimetre.	measuring tape divisions length width height depth compare measurement
		(iii) Measure and record lengths of objects using units of o millimetre, o centimetre and milimetre, o metre and centimetre.	Measurements are made to the nearest metre, centimetre and milimetre. Include compound units.	record compound
		(iv) Estimate the lengths of objects in o millimetre, o metre and millimetre, o centimetre and millimetre.	Encourage pupils to check for reasonableness of estimations.	

Topic 6: LENGTH

LEARNING OBJECTIVES *Pupils will be taught to…*	SUGGESTED TEACHING AND LEARNING ACTIVITIES	LEARNING OUTCOMES *Pupils will be able to…*	POINTS TO NOTE	VOCABULARY
Understand the relationship between units of length.	Pupils construct tables of relationship between units of length. Pupils use conversion tables to convert from one unit of length to another.	(i) State the relationship between centimetre and milimetre. (ii) Convert units of length from: o milimetres to centimetres and vice versa, o compound units to a single unit.	Emphasise these units of length relationships: 1 m = 100 cm 1 cm = 10 mm Examples of conversion exercises for units of length: 200 cm = 2 m 2 m = 200 cm 5 cm = 50 mm 50 mm = 5 cm 1 m 50 cm = 150 cm = 1.5 m 5 m 30 cm = 530 cm = 5.3 m	measurement relationship

Appendix C


INTEGRATED CURRICULUM FOR PRIMARY SCHOOLS
REVISED CURRICULUM
MINISTRY OF EDUCATION MALAYSIA
KBSR
MATHEMATICS
TEXTBOOK
Year 4
17057
DEWAN BAHASA DAN PUSTAKA
WAN YUSOF WAN NGAH
LEE GIK LEAN
RABIYAH FAKIR MOHD

Contents

iii

UNIT 6 LENGTH

I will learn to :

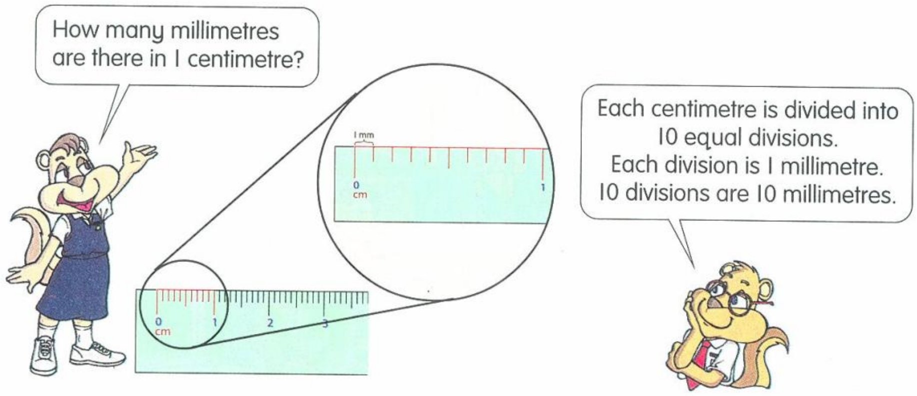
- measure lengths using standard units,
- understand the relationship between units of length,
- add and subtract lengths, and
- multiply and divide lengths.

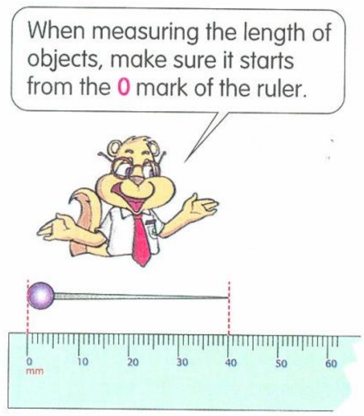
MyCD Animation

Measuring lengths

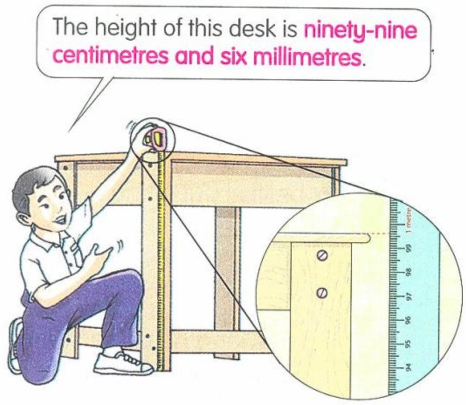
(A) Measure the lengths and write the scales

Let's learn about it

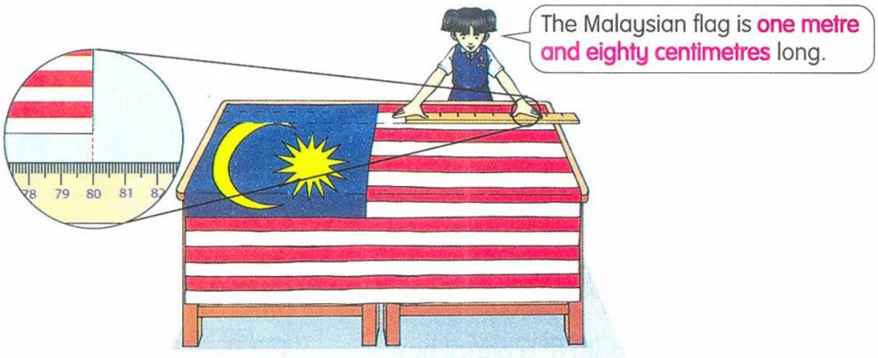




The pin is **forty millimetres** long.
We write it as **40 mm**.



We write it as ☐ cm ☐ mm.



We write it as ☐ m ☐ cm

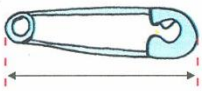
Let's try it out

1 Write the scale.

The width of the stamp is about ☐ cm.

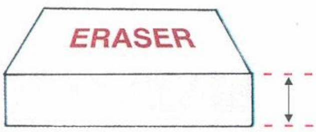
2 Measure.

a



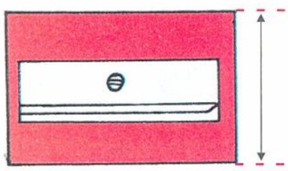
The length of the safety pin is ☐ mm.

b



☐ mm

c



☐ cm ☐ mm

3 Measure the breadth of your class cupboard in m and cm.

Let's work it out

1 Estimate and record.

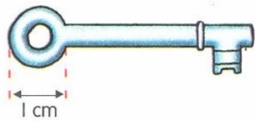
a

Estimated length : ☐ mm

Actual length : ☐ mm

or ☐ cm ☐ mm

b



Estimated length : ☐ mm

Actual length : ☐ mm

or ☐ cm ☐ mm

2 Estimate the length of a bench in your school canteen.
Then, measure the actual length.

3 Measure and record the length.

Objects	Measurements
Thickness of an exercise book	
Length of a paper clip	
Width of a stamp	
Height of a chair	
Length of a Malaysian flag	

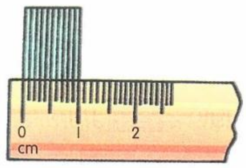
4 Estimate and find the actual length.

Objects	Estimate	Actual	Difference
Width of a duster			
Length of a chalk			
Height of a netball post			
Width of a door			

Relationship between units of length

(A) State the relationship between units of length

Let's learn about it



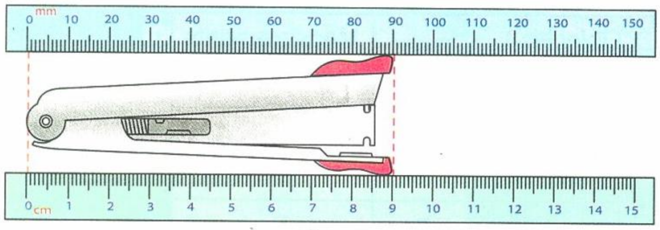
10 plastic rulers are arranged on a ruler.
The thickness of 1 plastic ruler is 1 mm.
The thickness of 10 plastic rulers is 10 mm.
10 mm makes 1 cm.

10 mm = 1 cm

Let's work it out

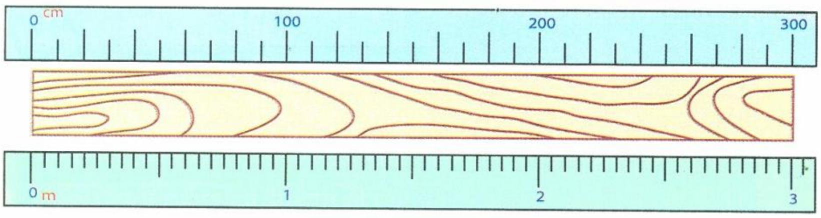
What are the measurement of these objects?

a



☐ mm = ☐ cm

b



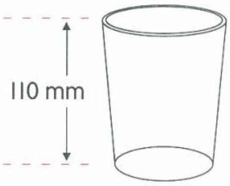
☐ cm = ☐ m

(B) Convert units of length

Let's learn about it

1 Millimetres to centimetres

What is the height of the glass in centimetres?



110 mm = ☐ cm

110 mm = 100 mm + 10 mm
= 10 cm + 1 cm
= 11 cm

110 mm = 11 cm

10 mm = 1 cm
100 mm = 10 cm

2 Centimetres to millimetres

7.5 cm = ☐ mm

7.5 cm = 7 cm + 0.5 cm
= 70 mm + 5 mm
= 75 mm

1 cm = 10 mm
0.5 cm = ? mm
0.5 × 10 mm = 5 mm
0.5 cm = 5 mm

7.5 cm = 75 mm

3 Centimetres and millimetres to millimetres

2 cm 4 mm = ☐ mm

2 cm 4 mm = 2 cm + 4 mm
= 20 mm + 4 mm
= 24 mm

1 cm = 10 mm
2 cm = 20 mm

2 cm 4 mm = 24 mm

MyCD The Fishing Game

3 Centimetres and millimetres to centimetres

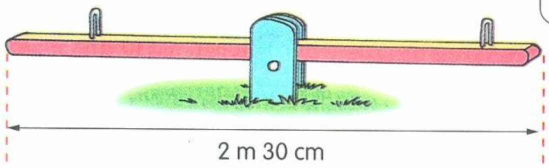
1 cm 6 mm = ☐ cm

1 cm 6 mm = 1 cm + 6 mm
= 1 cm + 0.6 cm
= 1.6 cm

1 cm 6 mm = 1.6 cm

10 mm = 1 cm
6 mm = ? cm
6 mm out of 10 mm is $\frac{6}{10}$.
$\frac{6}{10} = 0.6$
6 mm = 0.6 cm

4 Metres and centimetres to centimetres



2 m 30 cm = ☐ cm

2 m 30 cm = 2 m + 30 cm
= 200 cm + 30 cm
= 230 cm

1 m = 100 cm
2 m = 200 cm

2 m 30 cm = 230 cm

5 Metres and centimetres to metres

4 m 25 cm = ☐ m

4 m 25 cm = 4 m + 25 cm
= 4 m + 0.25 m
= 4.25 m

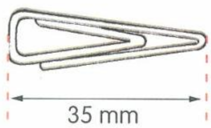
100 cm = 1 m
25 cm = ? m.
25 cm out of 100 cm is $\frac{25}{100}$.
$\frac{25}{100} = 0.25$
25 cm = 0.25 m

4 m 25 cm = 4.25 m

Let's try it out

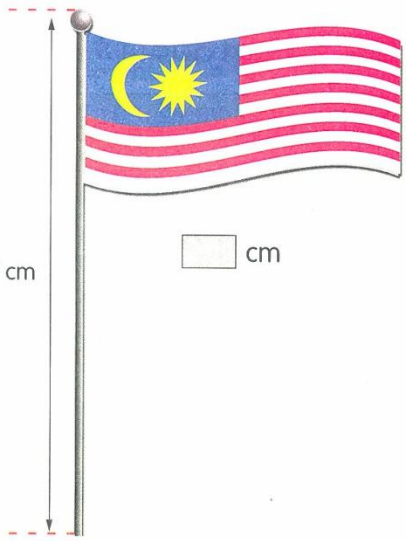
Convert.

a



☐ cm

b



☐ cm

c

☐ m

Let's work it out

Convert these units of length.

a 6 m = ☐ cm	**b** 900 cm = ☐ m
c 750 cm = ☐ m	**d** 1 200 mm = ☐ cm
e 420 mm = ☐ cm	**f** 270 mm = ☐ cm
g 13 cm = ☐ mm	**h** 8.4 cm = ☐ mm
i 1 cm 8 mm = ☐ mm	**j** 4 cm 3 mm = ☐ cm
k 20 m 5 cm = ☐ cm	**l** 12 m 7 cm = ☐ m
m 6.8 cm = ☐ mm	**n** 93.5 cm = ☐ mm
o 0.25 m = ☐ cm	**p** 75 cm = ☐ m

Appendix D


INTEGRATED CURRICULUM FOR PRIMARY SCHOOLS
REVISED CURRICULUM
KBSR
MATHEMATICS
TEACHER'S GUIDEBOOK
Year 4
17057
80149
DEWAN BAHASA DAN PUSTAKA
WAN YUSOF WAN NGAH
LEE GIK LEAN
RABIYAH FAKIR MOHD

INTRODUCTION

THE Mathematics Year 4 package comprises of the Textbook, the Teacher's Guide Book and the CD-ROM or MyCD. The content is based on the revised KBSR (Integrated Curriculum for Primary Schools) Mathematics Curriculum Specifications for Year 4. It is designed to be used during the daily Mathematics lesson.

The topics covered in the Textbook are:

Unit 1 : Whole Numbers
Unit 2 : Fractions
Unit 3 : Decimals
Unit 4 : Money
Unit 5 : Time
Unit 6 : Length
Unit 7 : Mass
Unit 8 : Volume of Liquid
Unit 9 : Shape and Space
Unit 10 : Data Handling

TEXTBOOK

The Textbook is supplemented with a bilingual dictionary to help pupils in understanding the contents of the Textbook. Several selected website addresses are given to enable pupils, teachers and parents to gain access to a variety of exercises on the topics taught. Links to MyCD are given to enable pupils, teachers and parents to explore further exercises on the topics.

The Textbook presents a pair of mascots, which pose questions intermittenly. They also give pupils useful mathematical tips and brief notes whenever the need arise.

Specific icons have been included for easy reference when using the Textbook.

For the learning area as shown in the curriculum specifications.

In "Let's learn about it", a sample teaching and learning process pertaining to each learning outcome is presented.

In "Let's try it out", a few questions pertaining to the learning outcome are given for pupils to assess their understanding of the learning outcome.

"Let's work it out" consists of exercises pertaining to a combination of learning outcomes in the lesson.

"Let's wrap up" consists of exercises pertaining to the whole unit.

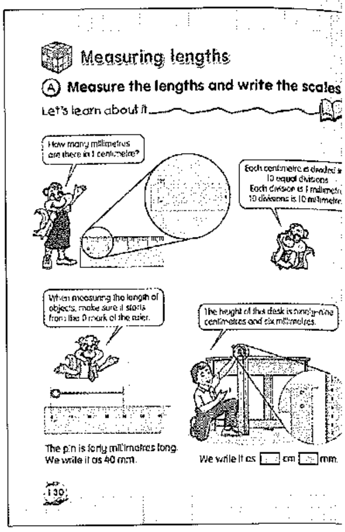
"Let's revise" consists of exercises pertaining to combination of 5 units.

The content covers the needs of the curriculum specifications. It is presented in context and related to real life situations. Simple English is used to ensure pupils understanding of Mathematics in English. On the whole, the Textbook is designed for pupils to work independently.

A stimulus page introduces pupils to the different topics in the Mathematics curriculum. It correlates each topic to the real life experiences of the pupils.

Teaching and Learning Activity (TB pg. 130 – 131)

1. Introduce units of millimetre by asking pupils to observe the 10 equal divisions in every centimetre on a ruler.
2. Point to pupils that each small division is 1 mm.
3. ~~Guide pupils to measure the length of small objects in millimetres,~~ e.g. pins, erasers, paper clips, etc.
4. Ask pupils to align the object along the ruler. Emphasise that measuring should start from the "0" mark on the ruler.
5. Guide pupils to read the scales in millimetres.
   e.g: The pin is 40 millimetres long.
6. Guide pupils to measure and read the length of objects in centimetres and millimetres. Then guide pupils to write the scales.
   e.g: The height of the desk is 99 cm 6 mm.
7. Explain that "cm" is used for centimetre and "mm" is used for millimetre.
8. Proceed with other objects which can be measured in metres and centimetres, e.g. flag, blackboard, table, etc. Use metre ruler or measuring tape to measure the objects.
9. Ask pupils:
   What is the length of the Malaysian flag? (1 metre 80 centimetres)
10. Guide pupils to write the scales. e.g. 1 m 80 cm. Explain that "m" is used for metre.



TB pg. 130

Alternative Activity

1. Guide pupils to read the scales in millimetres using transparency.
   a. Draw a ruler with mm markings on the transparency.
   b. By using overhead projector, guide pupils to observe the 10 equal divisions in every centimetre and read the scales in millimetres.
2. Guide pupils to measure the length of small objects by using a paper strip.
   a. Cut the paper strip to the exact length of the object.
   b. Place the paper strip on a ruler. Guide pupils to read the measurement in millimetres.
   c. Proceed with other objects, e.g. books, pens, pencils, table, cupboard, etc. Guide pupils to measure, read and write the length, height or width of the objects in centimetres and millimetres, and in metres and centimetres.

Vocabulary

- Align – menyebariskan.
- Display – pamerkan, paparkan.
- Markings – tanda.
- Measuring tape – pita pengukur.
- Proceed – teruskan.
- Required – dikehendaki.
- Scale – ukuran skala.

Assessment

1. Group activity.
   a. Mark the required heights and lengths on walls, benches, floor, etc.
   b. Each group measures, reads and records the measurement in millimetres, centimetres or metres and centimetres.
   c. Observe pupils during the activity and make sure that the ruler is aligned with the objects. Remind pupils to measure from the "0" mark.
2. The exercise in Let's Work It Out (TB pg.133), Question 1, may be used to assess pupils.

Moral Values

- Cooperative.

RELATIONSHIP BETWEEN UNITS OF LENGTH

Learning Objective: Understand the relationship between units of length.

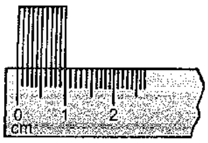
Concept: An inverse relationship between the number of units and the size of the unit.

A State the Relationship between Units of Length

Learning Outcome: State the relationship between centimetre and millimetre.

Teaching and Learning Activity (TB pg. 134)

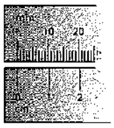
1. Tie up the 10 plastic rulers with a rubber band. Place the rulers from A to B on a ruler.



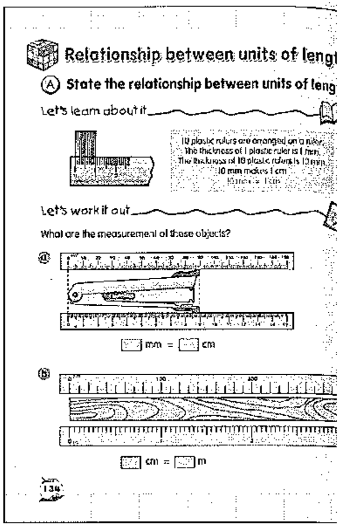
2. Ask pupils:
   What is the length from A to B? (1 cm)
   How many plastic rulers are used? (10 plastic rulers)
3. Explain to pupils:
   The thickness of each plastic ruler is 1 mm.
   So, the thickness of 10 plastic rulers is 10 mm.
4. Relate that 10 mm = 1 cm.

Alternative Activity

1. Provide pupils with two paper strips with markings. One paper strip is marked in centimetres and the other paper strip is marked in millimetres.
2. Ask pupils to align the paper strip with mm markings along the paper strip with cm markings.



3. Discuss with pupils about the markings on both paper strips. Stress that 1 cm = 10 mm or 10 mm = 1 cm.
4. Ask pupils to measure the length of a pencil using the paper strip with cm markings.
5. Ask pupils to measure the same pencil using the paper strip with mm markings.
6. Ask pupils:
   e.g: What is the length of the pencil in cm?
   What is the length of the pencil in mm?



TB pg. 134

Vocabulary
- Relate – kaitkan.
- Thickness – ketebalan.
- Tie up – ikat.

Moral Values
- Confidence.
- Cooperative.

Materials

- 1-metre ruler.
- Measuring tape.
- Paper strip.
- Plastic rulers.
- Pencil.
- Rubber band.

Assessment

1. Pupils measure each object provided by a teacher using rulers marked in mm and cm. Ask pupils to record the answers in their exercise books.
2. Proceed with measuring other objects using rulers marked in cm and m. Observe pupils during activity.
3. The exercise in Let's Work It Out (TB pg. 134) may be used to assess pupils.

Enrichment

Group activity.

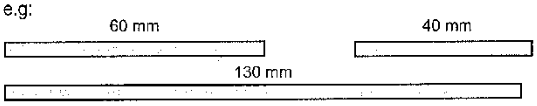
a. Pupils are divided into 4 groups.
b. Provide each group with measuring tape and 1-metre ruler.
c. Ask pupils to measure the length of their friends fingers and their height in cm and mm.
d. Ask pupils to write the measurement in both units cm and mm.

Key Notes

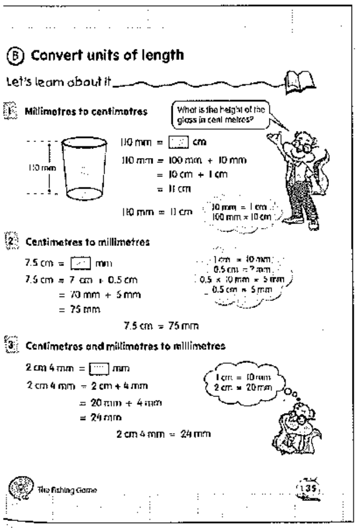
- Oral drill using conversion table.

Remedial

1. Provide pupils with paper strips of exact measurement.
   e.g:



2. Ask pupils to paste the paper strips in their exercise books.
3. Ask pupils to measure the strips in mm and cm, then record the measurements.


Ⓑ Convert units of length

Let's learn about it

1 Millimetres to centimetres

What is the height of the glass in centimetres?

110 mm = ☐ cm

110 mm = 100 mm + 10 mm
= 10 cm + 1 cm
= 11 cm

10 mm = 1 cm
100 mm = 10 cm

110 mm = 11 cm

2 Centimetres to millimetres

7.5 cm = ☐ mm

7.5 cm = 7 cm + 0.5 cm
= 70 mm + 5 mm
= 75 mm

1 cm = 10 mm
0.5 cm = ? mm
0.5 × 10 mm = 5 mm
0.5 cm = 5 mm

7.5 cm = 75 mm

3 Centimetres and millimetres to millimetres

2 cm 4 mm = ☐ mm

2 cm 4 mm = 2 cm + 4 mm
= 20 mm + 4 mm
= 24 mm

1 cm = 10 mm
2 cm = 20 mm

2 cm 4 mm = 24 mm

The Fishing Game

135

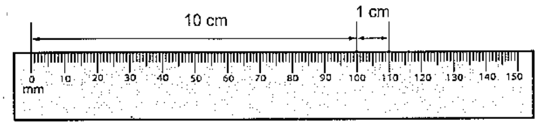
TB pg. 135

B Convert Units of Length

Learning Outcome: Convert units of length from:
(a) millimetres to centimetres and vice versa
(b) compound units to a single unit

Teaching and Learning Activity (TB pg. 135 – 136)

1. Ask pupils to measure the length of any object using a millimetre ruler and ask them to read the measurement.
   e.g: The height of the glass is 110 mm.
2. Guide pupils to convert 110 mm to cm. Ask pupils:
   How many millimetres are there in 1 cm? (10 mm)
3. Show the conversion by partitioning and with the help of a diagram.



110 mm = 100 mm + 10 mm
= 10 cm + 1 cm
= 11 cm

4. Proceed with other measurements, e.g. 85 mm, 230 mm, etc.
5. Guide pupils to convert compound units to a single unit.
   i.e. a. cm and mm to mm, and cm and mm to cm.
   b. m and cm to cm, and m and cm to m.
6. Use partitioning to convert cm and mm to mm.

   e.g: 2 cm 4 mm = $\boxed{}$ mm

   Partition 2 cm 4 mm into 2 cm + 4 mm

   Guide pupils to convert 2 cm to mm mentally.
   1 cm = 10 mm
   2 cm = 20 mm

7. Show the workings on the board.
   2 cm 4 mm = 2 cm + 4 mm
   = 20 mm + 4 mm
   = 24 mm

8. Proceed with conversion of cm and mm to cm.

   e.g: 1 cm 6 mm = $\boxed{}$ cm

   1 cm 6 mm is partitioned into 1 cm + 6 mm

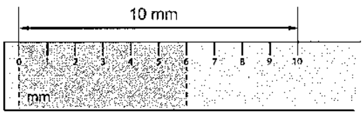
   Guide pupils to convert 6 mm to cm. Revise the concept of fractions and decimals learnt, and show the diagram.

   6 mm out of 10 mm is $\frac{6}{10}$.

   $\frac{6}{10}$ = 0.6

   So, 6 mm = 0.6 cm

   1 cm 6 mm = 1 cm + 0.6 cm
   = 1.6 cm



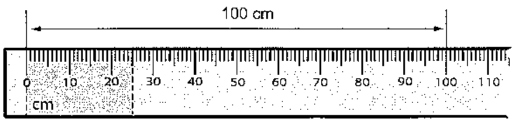
9. Proceed with conversion of m and cm to cm, and m and cm to m as in the Textbook. Use the same idea to convert centimetres to metres.

   e.g: To convert 25 cm to m

   25 cm out of 100 cm is $\frac{25}{100}$.

   $\frac{25}{100}$ = 0.25

   So, 25 cm = 0.25 m

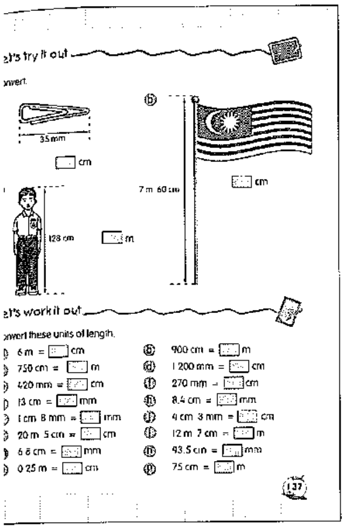


Vocabulary
- Partition – cerakin.
- Revise – ulangkaji.

Moral Values
- Cooperative.
- Careful.

Materials
- Ruler.
- Measurement cards.
- Diagram.

Key Notes
- Use multiplication to convert bigger units to smaller units.
- Use division to convert smaller units to bigger units.


et's try it out
onvert.
35 mm
cm
7 m 60 cm
cm
128 cm
m
et's work it out
onvert these units of length.
6 m = ☐ cm
750 cm = ☐ m
420 mm = ☐ cm
13 cm = ☐ mm
1 cm 8 mm = ☐ mm
20 m 5 cm = ☐ cm
6.8 cm = ☐ mm
0.25 m = ☐ cm
900 cm = ☐ m
1 200 mm = ☐ cm
270 mm = ☐ cm
8.4 cm = ☐ mm
4 cm 3 mm = ☐ cm
12 m 7 cm = ☐ m
43.5 cm = ☐ mm
75 cm = ☐ m
137

TB pg. 137

Alternative Activity

1. Guide pupils to convert mm to cm using division.
2. Ask pupils:
   How many millimetres are there in 1 cm? (10 mm)
3. Explain that, to convert mm to cm, we need to divide by 10. (10 mm = 1 cm).

   e.g: 110 mm = ☐ cm

   $$\begin{array}{r} 11\ \text{cm} \\ 10\ \overline{)\ 110\ \text{mm}} \\ -\ 10\downarrow \\ \hline 10 \\ -\ 10 \\ \hline 0 \end{array}$$

   110 mm = 11 cm

4. Proceed with other examples.
5. Guide pupils to convert cm and mm to mm.

   e.g: 2 cm 4 mm = ☐ mm

   a. Partition 2 cm 4 mm to 2 cm + 4 mm.
   b. Convert 2 cm to mm using multiplication.

   $2 \times 10\ \text{mm} = 20\ \text{mm}$

6. Show the workings on the board.

   $$\begin{aligned} 2\ \text{cm}\ 4\ \text{mm} &= 2\ \text{cm} + 4\ \text{mm} \\ &= 20\ \text{mm} + 4\ \text{mm} \\ &= 24\ \text{mm} \end{aligned}$$

7. Guide pupils to convert cm and mm to cm, followed by m and cm to cm, and m and cm to m, as in the Textbook.
8. Emphasise that:
   a. To convert smaller units to bigger units, we need to divide.
      e.g: Convert 6 mm to cm

      6 mm ÷ 10 = ☐ cm

      $$\begin{array}{r} 0.6\ \text{cm} \\ 10\ \overline{)\ 6.0\ \text{mm}} \\ -\ 6\ 0 \\ \hline 0 \end{array}$$

      6 mm = 0.6 cm

      Convert 25 cm to m

      25 cm ÷ 100 = ☐ m

      $$\begin{array}{r} 0.25\ \text{m} \\ 100\ \overline{)\ 25.00\ \text{cm}} \\ -\ 20\ 0\downarrow \\ \hline 5\ 00 \\ -\ 5\ 00 \\ \hline 0 \end{array}$$

      25 cm = 0.25 m

   b. To convert bigger units to smaller units, we need to multiply.
      e.g: To convert 2 m to cm
      $2 \times 100\ \text{cm} = 200\ \text{cm}$

Assessment

1. Informal assessment through observation should be carried out daily or whenever possible.
2. Teacher notes pupils performance during activity and record it for future reference.
3. Written exercises involving conversion of units of length.
   e.g:
   a. 3 cm = $\boxed{}$ mm   b. 45 mm = $\boxed{}$ cm
   c. 700 cm = $\boxed{}$ m   d. 8.9 m = $\boxed{}$ cm
4. The exercise in Let's Work It Out (TB pg. 137) may be used to assess pupils.

Enrichment

1. Matching activity.
   a. Provide 2 sets of measurement cards to each group for pupils to match.
      e.g:
      | 8 m | 18.9 cm | 800 cm | 189 mm |
   b. The cards are jumbled up and spread out on the table.
   c. Pupils work in pairs and match the cards correctly.
      e.g:
      | 8 m | 800 cm |
      | 18.9 cm | 189 mm |
   d. The first couple to complete the game correctly is the winner.
2. The Interactive Activity (*The Fishing Game*) can be used for further activities or exercises.

Remedial

1. Oral drills on conversion of units using conversion table.

mm	cm
10	1
9	0.9
8	0.8
7	0.7
6	0.6
5	0.5
etc.	

cm	m
100	1
90	0.9
80	0.8
70	0.7
60	0.6
50	0.5
etc.	

2. Pupils are divided into 2 groups, A and B.
3. A pupil from group A calls a measurement and a pupil from group B converts the units using conversion table.
4. Activity is repeated until all pupils have participated.

Appendix E

VICTORIA UNIVERSITY OF WELLINGTON
Te Whare Wananga o te Upoko o te Ika a Maui

Mediating Wor(l)ds:
Teaching & Learning Mathematics in a Second Language

Information Sheet
(for teachers)

Greetings! I am a PhD student at Victoria University in the Schools of Primary and Secondary Teacher Education as well as Linguistics and Applied Language Studies.

My study seeks to investigate how teacher talk and language use in the Malaysian mathematics classroom supports and scaffolds the learning of mathematics in English. Besides that, my study also seeks to discover and explicate other necessary conditions for successful learning of mathematics in English.

I am inviting you to be a part of my study. I would like to become a participant-observer during your mathematics lessons. I would make audio/video recordings of your mathematics class in progress and transcriptions of the classroom discourse and language use. I would also interview you based on the audio/video recordings and/or transcriptions. I would like to assure you that your participation will not influence your Annual Performance Appraisal in any way.

Your personal identity as well as the identity of your school and pupils will be protected and pseudonyms will be used in presenting the findings. Only my supervisors and I will have access to the data in the form of video recordings. I expect to report the research findings in scholarly publications and conferences. However, I wish to assure you that only the audio recordings, transcriptions of the classroom discourse and photographs of the environmental print around the classroom will be used. No images that may identify you and/or your pupil(s) will be used for these purposes. A brief report of the findings will be given to the Educational Planning and Research Development Unit under the Ministry of Education.

Your participation is totally voluntary and hence, you may withdraw from participating in this study now or at any time until I have completed collecting data in your classroom should you feel the need to do so. However, I would like to seek your cooperation and assurance to keep in confidence and not reveal the identity of any of the participants in my study.

If you have any questions, please ask me now or kindly contact me later at assunta.antonysamy@vuw.ac.nz. This research has been approved by the Victoria University of Wellington Human Ethics Committee and the Educational Planning and Research Development Unit, Ministry of Education, Malaysia.

Thank You.

Assunta Carolina Antonysamy

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VICTORIA UNIVERSITY OF WELLINGTON
Te Whare Wananga o te Upoko o te Ika a Maui

Mediating Wor(l)ds :
Teaching & Learning Mathematics in a Second Language

Consent Form
(for teacher)

Please tick the appropriate box to show that you agree to take part in this study:

I have read and clearly understood the information found in the Information Sheet. I am also aware of the time needed from me to participate in this study. I agree to my classroom instruction and interaction to be saved in an electronic form as long as my identity as well at the identity of my pupils is kept secured to the researcher and her supervisors.

I understand that the research findings will be reported in scholarly publications and conferences. I have been assured that no images that may identify either my pupil(s) and/or I will be used for these purposes. I am aware that a brief report of the findings will be given to the Educational Planning and Research Developmental unit, Ministry of education, Malaysia.

I have been provided with sufficient descriptions about this project and I am satisfied with the explanations. I understand the confidentiality of the research and thus will not reveal the identity of the participants in this research, specifically the identity of my pupils, my school and myself.

I agree to take part in the study. ☐

I do not wish to take part in this study. ☐

Signed: ____________________

Name of Participant: ___________________________

Date __________

I would like to receive a brief summary of the findings after the research has been completed.
Please send it to the following address:

VICTORIA UNIVERSITY OF WELLINGTON
Te Whare Wananga o te Upoko o te Ika a Maui

Mediating Wor(l)ds :
Teaching & Learning Mathematics in a Second Language

Information Sheet
(for parents) *

Greetings! I am a PhD student at Victoria University in the Schools of Primary and Secondary Teacher Education as well as Linguistics and Applied Language Studies.

My study seeks to investigate how teacher talk and language use in the Malaysian mathematics classroom supports and scaffolds the learning of mathematics in English. Besides that, my study also seeks to discover and explicate other necessary conditions for successful learning of mathematics in English.

I am inviting your child to be a part of my study. I would become a participant-observer during your child's mathematics lessons. I would make audio/video recordings of the mathematics class in progress and transcriptions of the classroom discourse and language use. I wish to assure you that no demands will be made on your child other than the normal class activities being observed, audiotaped and videotaped. Your child's participation will not influence his/her grades in the mathematics class or tests/exams in any way.

Your child's personal identity as well as the identity of the school will be protected and pseudonyms will be used in presenting the findings. Only my supervisors and I will have access to the data in the form of video recordings. I expect to report the research findings in scholarly publications and conferences. However, I wish to assure you that only the audio recordings, transcriptions of the classroom discourse and photographs of the environmental print around the classroom will be used. No images that may identify your child will be used for these purposes. A brief report of the findings will be given to the Educational Planning and Research Development Unit under the Ministry of Education.

Your child's participation is totally voluntary and hence, your child may withdraw from participating in this study now or at any time until I have completed collecting data in your classroom should he/she feel the need to do so. However, I would like to seek your cooperation and assurance to keep in confidence and not reveal the identity of any of the participants in my study.

If you have any questions, kindly contact me at assunta.antonysamy@vuw.ac.nz. This research has been approved by the Victoria University of Wellington Human Ethics Committee and the Educational Planning and Research Development Unit, Ministry of Education, Malaysia.

Thank You.

Assunta Carolina Antonysamy

** This Information Sheet will also be printed in Malay so that parents will have the option of reading it in the language of their choice.*

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VICTORIA UNIVERSITY OF WELLINGTON
Te Whare Wananga o te Upoko o te Ika a Maui

Mediating Wor(l)ds :
Teaching & Learning Mathematics in a Second Language

Consent Form
(for the pupil & his/her parents) *

Please tick the appropriate box to show that you agree to take part in this study:

I have read and clearly understood the information found in the Information Sheet. I understand that no demands will be made on my child other than the normal class activities being observed, audiotaped and videotaped. I agree to my child's interaction in the classroom to be saved in an electronic form as long as his/her identity is kept secured to the researcher and her supervisors.

I understand that the research findings will be reported in scholarly publications and conferences. I have also been assured that no images that mayidentify my child will be used for these purposes. I am aware that a brief report of the findings will be given to the Educational Planning and Research Developmental unit, Ministry of Education, Malaysia.

I have been provided with sufficient descriptions about this project and I am satisfied with the explanations. I understand the confidentiality of the research and thus will not reveal the identity of the participants in this research, specifically the identity of my child, his/her school and his/her teacher(s).

My child wishes and agrees to take part in this study	☐	I agree to allow my child to take part in the study.	☐
My child does not wish to take part in this study	☐	I do not wish my child to take part in the study	☐

Name of Child: ________________ Name of Parent :____________________

Signature of Child: ______________ Signature of Parent: ________________

Date: __________ Date: __________

I would like to receive a brief summary of the findings after the research has been completed.
Please send it to the following address:

** This Consent Form will also be printed in Malay so that the parent and his/her child will have the option of completing it in the language of their choice.*

VICTORIA UNIVERSITY OF WELLINGTON
Te Whare Wananga o te Upoko o te Ika a Maui

Mediating Wor(l)ds :
Teaching & Learning Mathematics in a Second Language

Information Sheet
(for the school principal)

Greetings! I am a PhD student at Victoria University in the Schools of Primary and Secondary Teacher Education as well as Linguistics and Applied Language Studies.

My study seeks to investigate how teacher talk and language use in the Malaysian mathematics classroom supports and scaffolds the learning of mathematics in English. Besides that, my study also seeks to discover and explicate other necessary conditions for successful learning of mathematics in English.

I am inviting your school, particularly the year 3 and/or year 4 mathematics classrooms, to be a part of my study. I would become a participant-observer during the mathematics lessons. I would make audio/video recordings of the mathematics class in progress and transcriptions of the classroom discourse and language use. I wish to assure you that no demands will be made on your pupils other than the regular mathematics class activities being observed, audiotaped and videotaped. However, I would be interviewing the teacher, basically a stimulated reflection of the mathematics lessons, to gain a better understanding besides seeking explanation and clarification of the classroom talk. The participation of your school, teacher(s) or pupil(s) will not influence the performance or ranking of your school at the district, state or national level in any way.

The identity of your school, teacher(s) and pupil(s) will be protected and pseudonyms will be used in presenting the findings. Only my supervisors and I will have access to the data in the form of video recordings. I expect to report the research findings in scholarly publications and conferences. However, I wish to assure you that only the audio recordings, transcriptions of the classroom discourse and photographs of the environmental print around the classroom will be used. No images that may identify your teacher and pupil(s) will be used for these purposes. A brief report of the findings will be given to the Educational Planning and Research Development Unit under the Ministry of Education.

The participation of your school, teacher(s) and pupil(s) is totally voluntary and hence, your school, teacher(s) and pupil(s) may withdraw from participating in this study now or at any time until I have completed collecting data in your classroom should he/she feel the need to do so. However, I would like to seek your cooperation and assurance to keep in confidence and not reveal the identity of any of the participants in my study.

If you have any questions, kindly contact me at assunta.antonysamy@vuw.ac.nz. This research has been approved by the Victoria University of Wellington Human Ethics Committee and the Educational Planning and Research Development Unit, Ministry of Education, Malaysia.

Thank You.

Assunta Carolina Antonysamy

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VICTORIA UNIVERSITY OF WELLINGTON
Te Whare Wananga o te Upoko o te Ika a Maui

Mediating Wor(l)ds :
Teaching & Learning Mathematics in a Second Language

Consent Form
(for the school principal)

Please tick the appropriate box to show that you agree to take part in this study:

I have read and clearly understood the information found in the Information Sheet. I am also aware of the time and effort needed from my school, teacher(s) and pupil(s) to participate in this study. I agree to my teacher's classroom instruction and interaction to be saved in an electronic form as long as his/her identity as well as our pupil(s) identity is kept secured to the researcher and her supervisors.

I understand that the research findings will be reported in scholarly publications and conferences. I have also been assured that no images that may identify my school, teacher and pupils will be used for these purposes. I am also aware that a brief report of the findings will be given to the Educational Planning and Research Developmental unit, Ministry of education, Malaysia.

I have been provided with sufficient descriptions about this project and I am satisfied with the explanations. I understand the confidentiality of the research and thus will not reveal the identity of the participants in this research, specifically the identity of my teacher(s), his/her pupils and my school.

I agree to my school, teacher(s) and pupil(s) taking part in the study. ☐

I do not wish my school, teacher(s) and pupil(s) to take part in this study. ☐

Signed: ____________________

Name of Principal: ___________________________

Date __________

I would like to receive a brief summary of the findings after the research has been completed.
Please send it to the following address: