Chapter 9
English in the Teaching of Mathematics: Policies, Realities, and Opportunities

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Abstract The transition from Bilingual Education Policy (BEP) to Mother Tongue-Based Multilingual Education (MTBMLE) policy has brought about many challenges for educators in the Philippines. In this new system, the prescribed medium of instruction (MOI) in mathematics in the first three levels of primary school is the mother tongue, and it shifts to English in the upper elementary levels. This chapter presents the highlights of my study on the role of English in teaching mathematics in the fifth and sixth grades of an urban public elementary school in the Philippines. Using the concepts of Discourses and cultural models (Gee, Social linguistics and literacies: ideology in discourses, 3rd edn. The Falmer Press, London, 1996, An introduction to discourse analysis: theory and method. Routledge, London, 1999) and building on the works of Moschkovich, (Math Think Learn, 4:189–212, 2002, Bilingual mathematics learners: how views of language, bilingual learners, and mathematical communication impact instruction. In Nasir N, Cobb P (eds), Diversity, equity, and access to mathematical ideas. Teachers College Press, New York, pp 89–104, 2007) and Setati (J Res Math Educ, 36:447–466, 2005, Access to mathematics versus access to the language of power. In: Novotná J, Moraová H, Krátká M, Stehlíková N (eds), Proceedings 30th Conference of the International Group for the Psychology of Mathematics Education. PME, Prague, pp 97–104, 2006), I uncovered realities of mathematics teaching and learning in two multilingual math classrooms. The results indicate that across mathematical and nonmathematical Discourses, teachers and learners use a combination of English, the prescribed medium of instruction; Tagalog, the children's home language; Taglish, the fusion of Tagalog and English; and other non-language resources. The main findings suggest that English serves mainly as the language of mathematics and assessment, while Tagalog and Taglish function primarily as the language of instruction, authority, and interpersonal communication. The majority of the students who participated in the study revealed that English was their least preferred

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language of instruction and assessment because they had difficulty understanding it. Possibilities for improving language-in-education policies are explored to empower teachers and learners in multilingual mathematics classrooms.

Keywords Bilingual Education Policy (BEP) · Mother Tongue-Based Multilingual Education (MTBMLE) Policy · Medium of Instruction (MOI) · Discourses · Cultural models

The Role of English in Mathematics: Impediments and Attempts

For many children, learning mathematics is a complex task. Learning mathematics in English may even be more complicated for them if it is not their first language (L1). A child's L1 or mother tongue may mean any language which he/she is most familiar with (Congress of the Philippines 2013; UNESCO, 2003), and it may refer to his/her home language (as used in Setati 2005).

Thus, English may be a hurdle for learners who are still in the process of learning it if it is used as a medium of instruction (MOI) and as language of assessment for mathematics. They face the double burden of unlocking the intricacies of mathematics in a language that they still have to master. If English serves as a block to the learning of mathematics, what options may be considered?

Simplifying linguistic items of math word problems in English is one way of addressing this problem. Word problems present and describe specific situations requiring mathematical solutions that students are expected to provide by using appropriate computations, operations, or formulae. Studies in the United States (Abedi and Lord 2001; Barbu and Beal 2010; Martiniello 2008) reveal that English language learners (ELLs) in multilingual classrooms are the ones who benefit most from this process of linguistic modification that employs familiar terms and phrases students can easily grasp. ELLs refer to students whose first language is not English in the United States (Uro and Barrio 2013). Findings suggest that when ELLs encounter challenging math word problems and procedures, their performance declines as linguistic complexity is usually associated with mathematical difficulty. However, ELLs perform better when they solve math word problems that use simple language and require basic arithmetic procedures. Teachers are, therefore, encouraged to consider linguistic scaffolding in helping learners understand mathematics.

Visualizing word problems and translating them to the learners' home language are other means of providing cognitive support for learners who find it hard to understand mathematics in English. Versoza and Mulligan (2013) employed these strategies to help Filipino primary learners in an economically disadvantaged urban area in Metro Manila understand math concepts and problems. Their work confirms that students whose L1 is not English have more difficulty learning mathematics if

it is taught in English, and it shows that sufficient English skills are essential for them to solve word problems competently. Thus, they also used Filipino, the children's mother tongue, as an MOI to make learning more comprehensible and appealing. (The term Filipino may refer to the country's national language which is based on Tagalog, a regional language, or it may also refer to the citizens and nationals of the Philippines.)

Using the mother tongue as an MOI in mathematics is, indeed, another useful alternative as shown in other local studies in the Philippines. For instance, the findings of Espada (2012) comparing the use of the home language and the use of English as the MOI for mathematics show that Filipino kindergarten learners who were taught in Waray, their home language, had a higher achievement level than those who were taught in English. The results validate other local findings cited in the study (e.g., Dekker 2003; Reyes 2000) revealing that the use of the children's L1 as an MOI is more effective in helping children perform better in mathematics. This choice is ideal in multilingual settings where teachers and students speak and understand the same local language.

Using more than one language or code-switching (CS) in multilingual mathematics classroom is another resource that may be considered. Sepeng's study (2013) illustrates how ninth grade mathematics learners in South Africa employed English, the MOI, when they interacted with the teacher and the whole class and switched to isiXhosa, their home language, when they accomplished group tasks. The children also favored the use of English together with isiXhosa in solving math problems. While their achievement level was higher in English in word problems which could be attributed to the use of English as an MOI, in the area of sensemaking, their performance was better in isiXhosa. Other studies (e.g., Vizconde 2006; Bernardo 2008; Choudhury and Bose 2011; Jegede 2011) reveal similar benefits of CS in multilingual classrooms.

All these aforementioned works indicate that, indeed, children find it quite challenging to solve math problems in a language that is not their own. However, when they are given sufficient linguistic and cognitive scaffolds, they perform much better. Thus, with the Mother Tongue-Based Multilingual Education (MTBMLE) Policy that prescribes the use of the children's L1 as the primary MOI in mathematics in the first three grades, children in the Philippines are expected to learn it more effectively. However, there are obstacles that math teachers have to overcome, given the constraints of this new policy.

From BEP to MTBMLE: Gains and Pains

In 2011, the K to 12 Program was launched to enhance the quality of basic education in the Philippines. The current K to 12 Program offers early learning education and additional 2 years of secondary education (SEAMEO INNOTECH 2012). Its implementation marked the official shift from the Bilingual Education Policy (BEP) that was reinforced in 1987 to the MTBMLE Policy that was institutionalized by the

Department of Education (DepEd) in 2009 (Department of Education 2010; Nolasco 2010; SEAMEO INNOTECH 2012).

The BEP prescribed English as the MOI for mathematics (Nolasco 2008), while the MTBMLE Policy requires the use of the L1 in teaching mathematics in the first three grades and the gradual use of English at the upper primary levels (Department of Education 2012a). The MTBMLE Policy is a product of a long-term project of DepEd (Cruz 2010), and it is based on studies (e.g., Walter and Dekker 2011) that prove that the use of the mother tongue as an MOI enables learners to develop literacy skills more efficiently, promotes learning in a second language and a third language more effectively, and hones cognitive abilities more successfully. It also is founded in a DepEd study that indicates that learners who were instructed in their L1 in mathematics and science achieved better in Trends in International Mathematics and Science Study (TIMSS) tests (Department of Education 2009, 2010).

As early as the 1950s, various local experiments revealed that the use of the mother tongue as the MOI helped maximize student participation and promote literacy; however, the lack of materials in the local languages and the inadequate training of teachers in using local languages in instructing their students caused difficulty (Cena 1958). Just the same, the use of the local language as an MOI was advocated in the first two grades in all public schools, while English was used as the MOI from the third grade onward with the local language as the auxiliary language of instruction in the third and fourth grades. Tagalog was used as the MOI in the fifth and sixth grades (Bernardo 2008; Brigham and Castillo 1999; Mindo 2008). This was also in line with the advocacy of United Nations Educational, Scientific, and Cultural Organization (UNESCO) in 1953 to use the mother tongue as the MOI for promoting literacy in the classroom (UNESCO 1953; Bernardo 2008; Brigham and Castillo 1999).

It is important to note that in 1940, Tagalog was declared as the national language of the Philippines because it was regarded as the most developed regional language in the country (Brigham and Castillo 1999). In 1959, the national language was renamed Pilipino which is based on Tagalog, and in 1987, it was replaced with the term Filipino (Cruz 2010). Tagalog is currently acknowledged as one of the mother tongues in the K to 12 Program. Filipino is offered as a separate learning area, and it is introduced as an MOI in the upper grades in some subjects (Department of Education 2012b). Thus, in this study, Tagalog, instead of Filipino, is used to refer to the L1 of student participants. There is an ongoing debate on the distinction between Tagalog and Filipino in the K to 12 Program because they are very similar.

The use of English as an MOI was opposed by nationalists (e.g., Constantino 1982) in the 1960s. However, in the 1970s, English reclaimed its position as the primary MOI, being considered by the government as a vehicle for economic progress (Tollefson 1991). The role of English was strengthened further in the 1987 Constitution as it was declared as an official language together with Filipino, the

national language, while regional languages were acknowledged as auxiliary official languages (Nolasco 2008). The BEP was promoted with the vision of uplifting the state of education through the use of Filipino and English as the primary MOI (Department of Education, Culture and Sports 1987).

With the era of globalization in the 1990s and the early 2000s, there was widespread preoccupation in the learning of English, especially with the constant need for overseas Filipino workers (OFWs) by various countries and a high demand for Filipino workers who were highly competent in English by the booming business process outsourcing (BPO) industry. Many lawmakers, therefore, proposed and supported an English-only bill (Llanto 2008) which was countered by other legislators and members of the academic community who advocated the MTBMLE Policy (Gunigundo 2008). The triumph of the MTBMLE Policy happened in 2009 when DepEd institutionalized it (Nolasco 2010) and in 2013 when the K to 12 Act that mandated the MTBMLE Policy was signed into law (Congress of the Philippines 2013).

On paper, the MTBMLE Policy seems ideal; however, the transition from the BEP to the MTBMLE Policy has not been a smooth one, especially that primary school teachers are accustomed to teaching mathematics in English. Mathematics classrooms are "common sites of resistance" (Burton 2013, p. 89) with the lack of mathematical terminology in the mother tongue and the habit of learners who are accustomed to using mathematical terms in English.

The continued use of examinations in Filipino and English also gives teachers qualms about using the mother tongue as an MOI. Moreover, teachers are not given sufficient training in MTBMLE and are not provided with adequate materials to aid them (Burton 2013; Paulson Stone 2012). These are the same problems that teachers faced back in the 1950s when the local languages were used as MOI.

Another fundamental barrier to the use of the mother tongue as an MOI is the perception that its use can deprive learners of having access to English which is perceived as the language of attainment. For example, teachers may be willing to follow the MTBMLE Policy, but they may face external pressure from other stakeholders such as parents who believe that using the mother tongue as an MOI may be a hindrance to students' achievements (Burton 2013; Paulson Stone 2012).

In Burton's (2013) study, one teacher argued that in reality, the mother tongue, Filipino, and English are used in their classrooms because one language is not enough for teaching and learning in multilingual settings. Thus, while the MTBMLE Policy is meant to help children learn much better with the use of their L1 and designed to elevate the position of local languages in the field of education, it poses several challenges that need to be addressed and overcome.

It is, therefore, crucial to look at classroom realities in the Philippines that may give a clear glimpse of the place of English in the teaching of mathematics along with the children's mother tongue. In determining its position, how it is used and why it is used that way have to be scrutinized considering the postcolonial condition of the Philippines.

Language in the Math Classroom: Discourses and Practices

Language use in the math classroom is often guided by powerful forces that are unseen. This is the reality that needs to be unveiled further in order to determine the other aspects of teaching and learning mathematics. Gee (1999) contends that language always carries a political element which is related to the access of social goods that are associated with power.

Therefore, the political role of language in mathematics classrooms cannot be ignored (Setati 2005). Because language may either empower or marginalize learners in the classroom, its use has to be examined critically. Moschkovich (2007) and Setati (2002, 2005, 2006) are among those who explored new grounds in understanding the relationship between language and mathematics. They adopted Gee's (1999) concepts of Discourses and cultural models that may serve as helpful research tools in inspecting the role of language in mathematics.

According to Gee (1999, p. 17), discourse (with a small letter d) refers to "language-in-use or stretches of language (like conversations or stories)," while Discourses (with a capital D) include both verbal and nonverbal elements that are employed to project a certain identity and enact a particular activity. What helps shape Discourses are cultural models that have been constructed in people's minds through social interaction. The patterns that people have grown accustomed to usually develop into accepted and appropriate standards or cultural models that they adhere to.

Gee (1999) describes cultural models as given assumptions that are usually transmitted and bolstered through various means. They differ across cultures and communities, and they may evolve through time along with changes in society and culture. People may also hold on to competing cultural models which are fostered through various modes of communication and social interaction.

Using Gee's concept of Discourses, Moschkovich (2007) determined various mathematical Discourses that seventh and eighth grade bilingual learners engage in. Her study reveals that mathematical communication involves not only words and figures but gestures, visuals, and concrete objects as well. She contends that the focus should veer away from looking at the difficulty of bilingual mathematics students in learning vocabulary and unlocking meaning of concepts and shift to the ability of children to use creative strategies and resources such as daily experiences and CS in tackling problems.

CS involves the process of shifting from one language to another employed by bilingual and multilingual speakers (Edwards 1994). For instance, many Filipinos use Tagalog and English together or Taglish in their informal interactions. Dayag (2008, p. 50) defines Taglish as "the code-switching variety of Philippine English." McFarland (2008, p. 144), on the other hand, describes it as "a general label given to the mixing of English and Tagalog, which is available to all bilingual speakers," and it is commonly used in casual conversations.

McFarland (2008) distinguishes CS from borrowing that involves appropriating terms from another culture through intercultural contact or substituting existing

words with those from a more dominant culture. Bilingual and multilingual speakers often use CS and borrowing, but they also employ translanguaging for academic purposes.

Translanguaging involves "the process of making meaning, shaping experiences, gaining understanding and knowledge through the use of two languages" (Baker 2011, p. 288). García (2009a, b) extended its description and uses it to embody bilingual speakers' practices to communicate effectively. Translanguaging may include CS and translation, and it is meant to help speakers in multilingual contexts fulfill their learning goals. It is also associated with the concept of translingual practice (Canagarajah 2013) that views languages as complementary and hybrid. This position encourages learners to draw from their linguistic repertoire and other available resources to convey ideas and grasp meaning. While translanguaging focuses more on the cognitive aspects of language use, translingual practice emphasizes the social elements of communication (Canagarajah 2013).

The multilingual mathematics classroom, therefore, is one domain where different languages may come into contact as teachers and students from different cultural backgrounds interact to negotiate learning in the classroom resulting in various Discourses. A domain is a social space where members are defined by their social roles and relationships (Fishman 1972; Spolsky 2007). Among the mathematical Discourses that surfaced in Setati's (2005) investigation on mathematical Discourses in a South African primary classroom were procedural Discourses that refer to the steps taken to solve problems and conceptual Discourses that explain the processes learners follow to have a clearer understanding of mathematics.

Nonmathematical Discourses were also observed such as regulatory Discourse which was used by the teacher to manage students' behavior and contextual Discourse which was employed to enable children to understand the situation used in word problems. The cultural models that surfaced indicate that English served as the language of mathematics, authority, and assessment, while Setswana, the children's home language, functioned primarily as the language of solidarity. The study also showed the teacher participant's dilemma. As an African, she wanted to uplift the position of Setswana, the home language, but as a teacher, she considered the practical importance of English that her students could benefit from.

Setati looked at the cultural models that some eleventh graders from South Africa adhered to as well. What was prevalent in this study (Setati 2006, p. 99) was the cultural model of "English as an international language." Students equated English with attainment and desired to acquire it for future academic purposes and better work opportunities. The results also indicate that learners favored their home language as the MOI in mathematics, so they could understand concepts easily. At the same time, they wanted to have access to English which they regarded as their primary vehicle for obtaining social goods. The findings suggest competing cultural models that expose the complex relationship between language and mathematics education.

Teaching and Learning Math: Queries and Discoveries

Following the lead of Gee (1999), Moschkovich (2007), and Setati (2005, 2006), I investigated the place of English in the teaching of mathematics in a public elementary school in Quezon City, one of the biggest cities in Metro Manila. The study involved Teacher A, a fifth grade female math teacher with 8 years of teaching experience, and Teacher B, a sixth grade male math teacher with 3 years of teaching experience.

Three class observations were conducted in Teacher A's fifth grade class and in Teacher B's sixth grade class as well. Teacher A's lessons were about temperatures and line graphs, and Teacher B's lessons were about plane and solid figures. Post-observation interviews with Teacher A and Teacher B were conducted after each class observation. A video recorder was used for the class observations and a voice recorder for the interviews.

A survey asking Teacher A's and Teacher B's students to indicate their most and least preferred MOI, and language of assessment was also included in the study. The teacher and student participants are multilingual speakers coming from different cultural backgrounds, and they shared a common language: Tagalog, the children's home language and the lingua franca in Quezon City.

Thirty-eight students (79%) in Teacher A's fifth grade class and 33 students (70%) in Teacher B's sixth grade class agreed to participate in the study. Ten students (21%) in Teacher A's fifth grade class and 14 students (30%) in Teacher B's sixth grade class declined. I obtained the formal consent of DepEd, the participating elementary school, the teacher participants, the student participants, and their parents to conduct the study. The research procedures they agreed to and the ethical standards my university required were followed.

In transcribing the video recording of the class observations, I adopted Gee's (1999) and Setati's (2005) methods. One complete speaking turn was considered an utterance in this study, and stanzas indicated the different parts of the lessons. Utterances and stanzas were numbered sequentially per lesson. Some Vienna-Oxford International Corpus of English markup conventions (VOICE 2007) were also followed in transcribing the lessons. Student speakers who spoke in unison in the class observation were identified as SS. Individual speakers among the students were identified according to the sequence of their speech and their gender (e.g., Boy 1; Boy 2; Girl 1; Girl 2), and those individual speakers who were unidentifiable were marked SX, and those whose genders were identifiable were marked SX-f (female) and SX-m (male). Like Setati (2005), I indicated English translations in brackets. In this work, additional information is given in brackets.

Based on the stanzas, the types of Discourses were categorized, and utterances per stanzas were classified according to these categories and according to the languages used by the participants: English, Tagalog, and Taglish. Tagalog had two categories: Tagalog and Tagalog with borrowed terms from English (e.g., mathematical terms).

The findings echo the contention of one teacher from Burton's (2013) study that in a multilingual classroom, there is space for more than one language. In both the fifth and sixth grade mathematics classes, English was used along with Tagalog and Taglish. In Teacher A's fifth grade class, formal Tagalog was used as the main MOI, while in Teacher B's sixth grade class, conversational Taglish was the dominant MOI. Both appropriated English terms and expressions in conducting their math lessons. No single language was used by both teachers. They used a combination of English, Tagalog, and Taglish within and across Discourses in conducting their mathematics lessons.

Below is an excerpt from a fifth grade lesson that shows how Teacher A borrowed English scientific terms (e.g., #11-thermometer; mercury) into her formal Tagalog statements. Excerpts are numbered according to the order of presentation in this chapter, not according to the stanzas used in the original transcripts, and utterances are numbered sequentially per excerpt.

Excerpt 9.1

1. TEACHER A: Okay. *Bago tayo mag-start (balikan natin) yung* lesson *natin kahapon. Naaalala n'yo pa ba 'yon?* [Before we start, let's review yesterday's lesson. Do you still remember it?]
2. SS: *Opo*. [Yes. *Opo* is a Tagalog word indicating a formal and polite way of expressing agreement in the Philippines.]
3. TEACHER A: *Tungkol saan ang* lesson *natin?* [What was our lesson about?]
4. GIRL1: *Ma'am, pangsukat ng ano. Kung gaano kainit o kaya kung gaano kalamig.* [It's used for measuring how hot or cold something is.]
5. TEACHER A: Okay. Very good.
6. GIRL 1: Temperature *po,* Ma'am. [Temperature, Ma'am.]
7. TEACHER A: *And then, maliban doon, ano pa yung natutunan n'yo kahapon?* [What else did you learn yesterday?]
8. SX: Ma'am!
9. TEACHER A: *Magtaas na lang ng kamay.* [Just raise your hand.]
10. SX: (inaudible)
11. TEACHER A: *Pagsukat o pagbasa ng* thermometer. [Measuring or reading the thermometer.] Very good. Okay. *Kapag mainit ang panahon, anong nangyayari sa* mercury? [When the weather is warm, what happens to the mercury?]

The next excerpt illustrates Teacher B's use of Taglish in his sixth grade class and other non-language resources (e.g., use of sample figures) in explaining mathematical concepts.

Excerpt 9.2

1. TEACHER B: Okay. So, *anu-ano pa ang iba't ibang mga* solid figures *na makikita natin*? *Meron tayong tinatawag na* [So what are the different types of solid figures that we see? There is what we call]…{looks for his sample figure}…*Meron tayong tinatawag na*… [There's what we call a…]
2. SX: Cone.
3. TEACHER B: {shows a sample figure} *Yung parang don sa apa…Yung* ice…[It's like the ice cream cone…the ice…]
4. SS: Cone!
5. TEACHER B: Cone.{shows a sample figure} *Ngayon* [now] (unintelligible) {shows features of the sample figure} *na meroong* circular base. *Bakit* circular base? *Kasi bilog.* And then curved surface *at meron siyang* [that has a circular base. Why circular base? Because it's round]…{refers to the tip of the figure} *Anong tawag sa dulo?* [what do you call the tip?]
6. SX: Vertex.
7. TEACHER B: Vertex. *Isang…Isa lang, ha*? [one…just one, all right?] vertex. *Nasa dulo. Meron siyang* slant *na*…[It's on the tip. It has a slant that's…] {refers to that part of the figure}*Anong tawag dito*? [what do you call this?]
8. SX: Edge.

Having taught at private schools that prescribed English as an MOI for mathematics and following this mandate for teaching upper elementary grades firmly, Teacher A and Teacher B used English initially in teaching mathematics when they transferred to the participating public elementary school. Later on, they began using Tagalog and Taglish, respectively, because their students could hardly express themselves and understand the lesson. The following excerpt shows Teacher B's view.

Excerpt 9.3

TEACHER B:…*kasi ang napansin ko na kahit* English *ka ng* English *kung di naman naiintindihan ng bata, bakit pa? Ang importante naman* is *yung naiintindihan ng bata.* […because I noticed that even if I kept using English, if the students couldn't understand it, then, what's the point? What is important is that children understand it.]

The main factor, therefore, that guided their decision to shift from English to Tagalog and Taglish as the primary MOI was their pedagogical concern. They wanted learners to participate more actively in class and grasp math concepts more effectively through a nonthreatening and a familiar medium. What enabled them to make this choice was the school culture that allowed code-switching in the classroom. According to the school principal (2014, personal communication, 6 February), there had never been English-only policies that penalized students for using local languages. He asserted that such policies were not appropriate and effective. The school's language policy, therefore, mirrors a culture that fosters multilingual education and respects children's rights to use their mother tongue as espoused by UNESCO (1953, 2003).

The mathematical Discourses that were observed in the study include the following types. Sample excerpts are provided to distinguish them:

- **Whole-class discussion Discourse –** Involves question and answer activities to introduce, explain, and review concepts

Excerpt 9.4

1. TEACHER B: …*Tinatawag silang* 2D*. Ngayon, yung mga larawan na nakikita nyo naman, nahahawakan… na mayroon siyang dagdag…tinatawag nating* height. *Di ba sa* 2D *meron lamang siyang* length *at tsaka* width*?* So, *ngayon,*{shows a sample figure} *yung mga larawan na nakikita nyo… mga larawan na nakikita n'yo na meroong* length, width, *at tsaka* height*, ang tawag naman don ay*…[…They are called 2D. Now, the pictures that you can see and touch…that have something added… we call height. 2D figures only have length and width, right? So, now, the pictures you see…the pictures you see with length, width, and height are called…]
2. SX-m: Solid figure.
3. TEACHER B:…*tinatawag na*? [they are called?]
4. SS: Solid figure.
5. TEACHER B: {takes away previous visual aids on the board and writes on the board} solid?
6. SX: Figure. *Meron silang* [they have]…{shows a sample}length…
7. SS:… width…
8. TEACHER B: *May* [they have] width…
9. SS: Height!
10. TEACHER B:…*at mayroong* [and they have]?
11. TEACHER B AND SS: Height.

- **Procedural Discourse** – Deals with the process of computations (Setati 2005)

Excerpt 9.5

1. TEACHER A: One by one. Five plus four?
2. SS: Nine!
3. TEACHER A: Nine plus six?
4. SS: Fifteen.

- **Conceptual Discourse** – Focuses on the reasons for choosing particular operations in a given problem or situation (Setati 2005)

Excerpt 9.6

1. TEACHER A: …*Anong* operation *ba ang gagamitin sa* number two? [What operation should you use for number two?]
2. SS: Subtraction.

3. TEACHER A: *Paano n'yo nalaman na mag-su*subtract *kayo*? [How did you conclude that you have to do subtraction?] {Various answers are given by students at the same time and the teacher calls on one student to answer.}
4. SF: Ma'am*, para maano. Para malaman kung gaano yung ki-nut n'ya o binaba n'ya.* [Ma'am, to find out how it has decreased.]

- **Illustrative Discourse** – Entails the use of visuals, gestures, concrete objects, and other resources (e.g., using actions) to make mathematical concepts more vivid in the minds of learners

Excerpt 9.7

1. TEACHER B: …*Anong* funnel? *Alam n'yo yung…ah…Yung nilalagay sa…sa* plastic. *Binubuhusan ng ano*…[What is a funnel? You know the…uh…The one in…in plastic. Where you pour the…]
2. SX: *Ayun!* [That one!]
3. TEACHER B: '*Yung malamig o kaya kung minsan ano. Embudo.* [Cold or sometimes the…Funnel.]
4. SS: Ah! *Ay!* [Oh!]
5. TEACHER B: *Embudo. Embudo. O 'yung iba*. [Funnel. Funnel. The others.] {raises the marker} *O para mas mabilis ilagay… isalin ang…yung tubig*. [Or so it's faster to place…to pour…water.]
6. GIRL 11: Sir, *ako*! [Sir, me!] {answers the next item}
7. TEACHER B: *Tama ba?* [Is it correct?]
8. SX: *Opo.* [Yes.]
9. TEACHER B: Funnel shaped *siya, di ba?* [It's funnel shaped, right?]{gets a sample figure of a cone} *Di ba, ito?* [This one, right?]… *gasolina* [gasoline]. {pretends to pour gas into the cone and students laugh} *Di ba*? [Right?]…

- **Explanatory Discourse** – Reflects instances when teachers offer supplementary input to clarify points

Excerpt 9.8

1. TEACHER A:…Group D. *Sasabihin ko para* aware kayo. Correction po *sa* eight p.m. *Dapat po ito ay* twenty eight point two degrees Celsius [I will tell you something to make you aware of it. There is a correction with the temperature at eight p.m. It should be twenty eight point two degrees Celsius.]
2. GROUP D REPORTER (F1): Ma'am, *nandito,* Ma'am. [It's here, Ma'am.] {gives their group paper to the teacher}

3. TEACHER A: Okay. {reads their paper} *Ah, medyo mali ang pagkasulat. Okay. Pero,* anyway, *tingnan natin.*{points to the items on the Manila paper} *Ano kaya ang mangyayari sa mga sagot ninyo dito sa bandang ibaba kung meron kayong maling* reading *sa* thermometer *ninyo na nasa taas?* [Oh, there is an error in the item written on the visual aid. Let us look at it. What would happen to your answers written in the bottom if you had a wrong reading of the thermometer as indicated above?]
4. SX: *Mali rin,* Ma'am *ang makukuha mo sa baba.* [You would also get the wrong answers.]

- **Evaluation Discourse** – Indicates the process of assessment

Excerpt 9.9

TEACHER A: {reads the test questions aloud}…Okay. Question number two. At what time is the temperature thirty five degrees Celsius? *Sa anong oras ang* temperature *ay* thirty five degrees Celsius? [At what time is the temperature thirty five degrees Celsius?] Okay. Number three. What is the difference between the temperature at six a.m. and eight a.m.? *Ano ang* difference *ng* temperature *ng* six a.m.*at tsaka ng* eight a.m.? [What is the difference between the temperature at six a.m. and eight a.m.?]…

- **Group Presentation Discourse** – Allows students to share their work with the entire class

Excerpt 9.10

1. GROUP A REPORTER (M): {reads the piece of paper} I am pupil (mentions his name) of Group 1. (Mentions his other group mate) is my assistant (member)…
2. GROUP A REPORTER (F): {continues to read the piece of paper} our member are…{introduces their group members}…now, listen to our report. According to the chart, at six o'clock in the morning, the temperature was twenty-six degrees Celsius…

Teacher A and Teacher B and their students also engaged in nonmathematical Discourses which include the following categories. Some excerpts are shown to illustrate them.

- **Preparatory Discourse** – Involves setting the tone for the session

Excerpt 9.11

1. TEACHER A: Okay. Ready *na tayo*? Ready *na kayo*? [Are we ready? Are you ready?]
2. SS: Opo. [Yes.]

3. TEACHER A: *Yung* ready, *pataas naman ng kamay*. [If you are ready, raise your hand.] {Students raise their hands.} Okay. Very good. {calls on a boy and talks to him directly} Ready *na rin po*? [Are you also ready?]
4. BOY 1: *Opo*. [Yes.]

- **Regulatory Discourse** – Includes monitoring and managing students' behavior in the classroom (Setati 2005)

Excerpt 9.12
TEACHER B: …*Tahimik nga* [Silence]…{directs groups to their areas} Group one. Group two. Group three. Group four. Group five. *Tsaka* [And] group six. {Students go to their respective areas for the group task} *Upo na. Upo na*. [Sit down. Sit down.]…

- **One-on-one Discourse** – Shows direct communication between the teacher and the students

Excerpt 9.13

1. GIRL 7: {finishes her computation, goes to the back, and looks at the computations on the board} Sir, *tama yung sagot ko*? [Sir, is my answer correct?]
2. TEACHER B: *I*-check *natin pagkatapos ni* (*first name of the boy*) *at ni ano* (*the other girl*).. [We'll check it after (*first name of the boy*) and (*the other girl*)]…*I*-che-check *natin mamaya.* [We'll check it later.]

- **Congratulatory Discourse** – Reflects personal acknowledgment by the teachers and the class

Excerpt 9.14

1. GROUP FOUR REPRESENTATIVE (F): {counts the edges} It has twelve edges.
2. TEACHER B: Twelve edges. Okay *na?* [Okay now?]{The female group representative hands him the green prism.}*Palakpakan natin*. [Let's give them a round of applause.] {The teacher and the students give them a round of applause as the group representatives go back to their seats.}…

- **Personal sharing Discourse** – Entails narration of personal experiences to inspire learners

Excerpt 9.15

1. TEACHER A: … {points to the graph}*so etong* graph *na 'to, sinasabi sa atin na mabilis siyang lumalaki dahil 'yung* line *ay pataas*. Okay. So, actually zero *hanggang siya ay maging* nine years. *Totoo 'yon. Kayo nga eh. 'Di nga lang kayo* nine years old. *Ilang taon na ba kayo?* [This graph tells us she grew up fast because the line is ascending. From zero to nine years. That's true. Like you. You're not just nine years old. How old are you now?]
2. SS: Eleven!
3. TEACHER A: Ten. Eleven. *Pagdating n'yo sa* grade six *sa* June. Okay. *Ganyan ang itsura n'yo ngayon…Tuwing* June, *nakikita ko 'yung mga estudyante ko nung* grade five, *pagdating ng* June, they feel *na ang bilis lumaki. 'Yung iba, mas matangkad pa sa akin. 'Di ba?* Okay, so *ang bata, talagang mabilis ang paglaki*. Okay. *Natutuwa ba kayo 'pag sinasabing "Uy, matangkad ako?"* [When you reach grade six in June. That's how you look now. When…When June comes, I see my former grade five students who feel they grow so fast. Some are even taller than I am. Right? Children really grow fast. Do you feel glad when you say, "Hey, I'm tall?"]
4. SS: *Opo*. [Yes.]

- **Emotive Discourse** – Mirrors the expression of emotions

Excerpt 9.16

1. TEACHER B: Number six. {calls on a girl to answer the sixth item on the board in the matching activity}…{The girl chooses the wrong label which she pastes on the board.}
2. SX: *Ay, Ginoo*! [Oh, my God!] {The girl realizes her mistake and replaces the wrong label with the correct one because of her classmate's exclamation.}

- **Farewell Discourse** – Requires a formal exchange of goodbyes to end classes

Excerpt 9.17

1. TEACHER A: …Okay. So, that's all for today. Goodbye…
2. SS: Goodbye, Ma'am (surname of teacher). Goodbye, Ma'am (nickname of the researcher).

The results indicate that 58% of Teacher A's utterances were in Tagalog with borrowed terms from English, 18% were in Tagalog; 16% were in English; and 8% were in Taglish. Most of her utterances (76%) involved mathematical Discourses,

and the others (24%) reflected nonmathematical Discourses. On the other hand, 28% of Teacher B's utterances were in Taglish; 26% were in Tagalog; 26% were in Tagalog with borrowed terms from English; and 20% were in English. Most of his utterances (80%) also indicate mathematical Discourses, and the others (20%) show nonmathematical Discourses.

Teacher A's utterances were spread across the following Discourses (whole-class discussion Discourse (64%); regulatory Discourse (18%); conceptual and explanatory Discourses (10%); and other mathematical and nonmathematical Discourses (8%)), while Teacher B's utterances were divided among the following Discourses (whole-class discussion Discourse (46%), illustrative Discourse (21%); regulatory Discourse (17%); procedural and explanatory Discourses (12%); and other mathematical and nonmathematical Discourses (4%)).

Most of Teacher's A utterances in whole-class discussion Discourse were in Tagalog with borrowed terms from English (62%), followed by English (15%), Tagalog (1%), and Taglish (10%). In regulatory Discourse, her utterances were primarily in Tagalog with borrowed words from English (47%) and Tagalog (37%) and seldom in English (15%) and Taglish (1%). 88% of Teacher A's utterances in conceptual Discourse were in Tagalog with borrowed terms from English, and 12% were in English.

Teacher B's whole-class discussion Discourse were mainly in Taglish (30%), followed by Tagalog (27%), Tagalog with borrowed terms from English (22%), and English (21%). 31% of his utterances in illustrative Discourse were in Taglish, 35% were in Tagalog with borrowed terms from English; 27% were in Tagalog; and 7% were in English. He used Tagalog with borrowed terms (35%), Tagalog (33%) and Taglish (22%) frequently, and English (10%) sparingly for regulatory Discourse.

As the figures indicate, both teachers devoted much time to whole-class discussion Discourse which Teacher A conducted primarily in Tagalog with borrowed terms from English and Teacher B in Taglish. Their frequent use of Tagalog and Taglish in these mathematical Discourses suggests the cultural model that the *mother tongue or the local language is the language of learning and teaching.* However, Teacher A and Teacher B borrowed English mathematical terms and incorporated them in their Tagalog statements regularly. They also used English primarily for procedural Discourse suggesting the cultural model that *English is the language of mathematics* similar to Setati's (2005) findings. Most mathematical terms and expressions used by the teachers and students were in English because they had grown accustomed to it.

When asked if they were in favor of translating English mathematical terms and expressions to Tagalog, Teacher A opposed it, believing that they are originally in English, while Teacher B supported it, asserting that it would help learners understand concepts better. Despite this difference in opinion, both teachers showed a level of appropriating these English terms and used them as resources. In Teacher A's case, her integration of these English words into formal Tagalog statements made them sound as part of her Tagalog repertoire. On the other hand, Teacher B's use of these English expressions in his conversational Taglish mode made the class-

room atmosphere more "Filipino" as it approximated real-life Filipino conversations outside the classroom.

Both teachers also employed English mainly for evaluation Discourse indicating the cultural model that *English is the language of assessment* parallel to Setati's (2005) findings. However, while Teacher A and Teacher B used English mainly for evaluation, Teacher A provided an English version followed by a Tagalog version of the test, while Teacher B gave Tagalog clarifications of the instructions when needed. Teacher A also began designing tests in Tagalog that was more consistent with the primary language of instruction she used in her math class.

In the initial interview, Teacher A said that she did not focus much on standardized examinations in English, but later on, she admitted that my presence as an observer made her remember the need to for her students to be exposed to English somehow because it is the language of assessment for standardized periodical examinations. Hence, another important factor that helps shape Discourse is the language of standardized tests.

The case of Teacher A illustrates the dilemma that most teachers go through, and this tension represents competing cultural models that Gee (1999) describes. Teacher A favored the use of Tagalog, her students' mother tongue, as the MOI and also preferred it as the language of assessment; however, she could not ignore the reality that standardized examinations are in English. This dilemma reflects the same predicament that other teachers go through as indicated in previous studies (e.g., Setati 2005; Paulson Stone 2012; Burton 2013).

The illustrative Discourse that Teacher B engaged in as shown in Excerpt 9.7 was quite remarkable. He used gestures, drawings, illustrations, concrete objects, and even humor to enable his students to have a more practical grasp of math concepts and make math lessons more meaningful and exciting. In one session, for instance, an "aquarium" made of hard paper was placed in his classroom. Fish-shaped cutouts with concealed questions filled it for students to pick, open, read, and answer as a form of review. The class participated enthusiastically. He also asked them in groups to produce their own solid figures using hard paper in different colors (e.g., a black cone; a blue pyramid; a green rectangular prism; a red cylinder; a violet sphere; and a yellow cube).

Thus, teaching mathematics is also not just a matter of using the right words or expressions. Teacher B's strategies show how non-language resources may be used in mathematics classrooms to develop learners' mathematical competence as Moschkovich (2002, 2007) proposed. Teacher B's use of conversational Taglish also established a friendly atmosphere that encouraged children to participate enthusiastically in the series of activities he conducted.

Personal Discourses (one-on-one; congratulatory; personal sharing; emotive; and farewell Discourses) transformed the mathematics classrooms from mere venues for cognitive development into settings for enjoyable learning and class bonding. All nonmathematical Discourses Teacher A and Teacher B engaged in were primarily in Tagalog and Taglish except for farewell Discourses that were usually done in formal English suggesting the cultural models that *Tagalog and Taglish are the languages of authority* and *interpersonal communication.*

Both teachers also gave the children the freedom to use the language of their choice in their math classrooms. Their belief in the value of this freedom was a major factor that guided their language practices in class. In one instance, Teacher B's student exclaimed, "Ay, Ginoo!" [Oh, my God!], an expression in Bisaya (a general term referring to the language used in various provinces in the Visayas and Mindanao), when a classmate posted the wrong label beside an illustration of a solid figure in a visual aid posted on the blackboard as shown in Excerpt 9.16. Upon hearing the Bisayan expression often used in Metro Manila, the girl who made the mistake used the linguistic signal and corrected her answer. This is an evidence of how multilingual children may employ verbal cues to support their learning in the math classroom. It also shows how they use their home or local languages to express their strong feelings, suggesting the cultural model that the *home language is the language of emotions*.

The combined use of different languages including CS and translation for pedagogical purposes may be considered an instance of translanguaging. Teacher A and Teacher B made use of linguistic resources to enable learners to grasp math concepts and procedures more effectively. They also demonstrated to their students how to use these linguistic tools which their students employed. Translingual practice was, therefore, apparent in these multilingual mathematics classroom.

However, English was used for farewell Discourses that formally ended classes suggesting the cultural model that *English is the language of academic settings*. Students also used English primarily for group presentation Discourse as indicated in Excerpt 9.10, another instance that reflects this cultural model. What was interesting in the fifth grade class was that students were actually reminded by their teacher that they could continue using Tagalog for the group presentation if they were more comfortable with it. However, on the day of the observation, they opted to use English. The following excerpt shows the group reporters' responses when asked why they chose English for their group presentations.

Excerpt 9.18

1. STUDENT 1: *Para mataas ang grade*. [To get a high grade.]
2. STUDENT 2: *Yung tanong po namin…yung tanong* English. [Our questions were…the questions were in English.]
3. STUDENT 3: *Para po mahasa din ang utak…[*So, we can also hone our minds…]
4. STUDENT 4: *Para mahimasmasan po.* [To regain consciousness or wake up.] {laughter}

Their statements suggest the cultural models that *English is the language of reporting in the classroom* and *English is the benchmark of achievement; the gauge of communicative competence*; *the sharpener of the mind*; *and the carrier of power.* However, while the reporters used English for the group presentations, it was carried out more in a mechanical manner than a spontaneous way. Students looked at

their visual aids instead of establishing audience contact and spoke in soft and shy tones. There seemed to be an absence of ownership in using the language.

It was a manifestation that many public elementary school students in the upper grades still grapple with the English language as results of achievement tests suggest. Math achievement tests in English conducted by the Ateneo Center for Educational Development (ACED) among public elementary schools show that a significant number of students score below 50%, and English was regarded as a "stumbling block" to word problems (ACED 2009, pp. 8–9, 2011, 2012, 2013). Thus, in many instances, mathematics teachers in the upper elementary grades, observing their learners' difficulty in learning mathematics through English, use the language that they think could best help them achieve their teaching goals.

The results of the student survey confirmed the teachers' claim that the children found it difficult to learn math through English. The most preferred MOI of fifth grade student participants for mathematics was Tagalog (58%) followed by Taglish (34%) and English (8%), while the most preferred MOI of sixth grade student participants for mathematics was Taglish (61%) followed by Tagalog (33%) and English (6%).

The majority of the fifth and sixth student participants chose English as their least preferred language of instruction, and the main reason they gave was that they could hardly understand it. As one sixth grade participant described her experience of tackling math in English: "dahil para akong nanonose blid at para akong nahihilo at nakakapagod itagalog" [because it's like I experience a nose bleed and I feel nauseous and it is exhausting translating it to Tagalog].

The majority of the fifth grade participants identified Tagalog as their most preferred MOI, while the majority of sixth grade participants indicated Taglish as their most preferred MOI. The main reason they gave was that they could easily understand these languages. Their preferences matched the MOI used by their teachers. It was possible that their preferences were shaped by their teachers' language practices as well.

The difference in the preference between the majority of the fifth grade participants and their sixth grade counterparts was that the latter were probably anticipating the academic challenges that they would meet in high school that requires them to be more proficient in English. Some respondents pointed out that Taglish would allow them to learn English, and they saw it as a bridge between Tagalog and English (Sample answer: "Kasi para matuto ako ng tagalog at English." [Because it will allow me to learn Tagalog and English]). Taglish, therefore, may be viewed as a means of reducing linguistic complexity and as a link to English which they perceived as the language of success.

Taglish was also regarded very positively by some students as indicated by this response: "dahil maganda itong pakinggan" [because it is pleasant to the ears]) in contrast to Tagalog which was considered quite negatively by some children as illustrated by this statement: "Mapanget pakinggan ito [Tagalog]… It does not sound nice…]. Being a hybrid social language, Taglish is usually not an acceptable language in formal settings that dictate the use of pure Tagalog or English. However, in reality, "Among Filipinos, 'pure' Tagalog or English is seldom heard, and Taglish

is the usual order of the day…" (McFarland 2008, p. 144). Moreover, Taglish is the popular language of media (Dayag 2008) which children may be exposed to. This is probably one reason why some students see Taglish more positively than Tagalog.

The most preferred language of assessment of fifth grade student participants for mathematics was Tagalog (69%) followed by Taglish (18%) and English (13%), and the most preferred language of assessment of sixth grade participants for mathematics was Tagalog (52%) followed by Taglish (42%) and English (6%).

The majority of the fifth and sixth grade student participants indicated that English was their least preferred language of assessment, and again, the primary reason they gave was their difficulty in understanding it. At the same time, the survey reveals that some fifth and sixth grade student participants desired to learn English through mathematics. The use of English as an MOI and as a language of assessment in mathematics was seen as a means of giving them greater access to the language of opportunity and the language of the world. Moreover, some participants had more positive views toward English than Tagalog.

For instance, one interesting reason given for choosing Tagalog as the least preferred language of instruction was that there should be a shift in the language use since Tagalog is not understood by foreigners who may be around as indicated by this response "dahil para maiba ang salita kunyari may isang Amerikano e hindi niya maiintindihan ang sinasabi" [so the language may differ for example if there is an American, he/she will not understand what is being said]. The concern reflects the students' desire to be able to communicate with foreigners and reflects the cultural model that *English is an international language* (Setati 2006).

Moreover, some student participants used the word "maganda" (beautiful) for English (e.g., "Because the english ay maganda para marunong silang mag english" [Because English is nice so that they will know how to use English]) and used its antonym "pangit/panget" (ugly) for Tagalog (e.g., "'Tagalog' kasi makita mo sa exam ang panget" ["Tagalog" because when you see it in the exam it is so unappealing"]) to indicate that English is the appropriate MOI and assessment and Tagalog is not.

The responses indicate that there are children who consider Taglish as the bridge between Tagalog and English since the use of these two languages may facilitate better comprehension. Some students also see it as a means of gaining more access to English which they view as the benchmark of achievement, a prominent cultural model among them.

Turning Obstacles into Opportunities: Implications and Recommendations

The findings, thus, indicate that while English is the prescribed MOI for the upper grades, Tagalog and Taglish are used along with it. English is the main language used for procedural and evaluation Discourses suggesting the cultural model that

English is the language of mathematics and assessment, while Tagalog and Taglish are used primarily for whole-class discussion and personal Discourses indicating the cultural models that *Tagalog and Taglish are the languages of instruction, authority, and interpersonal communication*.

This study also confirms that teaching mathematics does not simply have to be limited to words, but it can be expanded through the use of illustrations, gestures, concrete objects, and other creative resources that may be used to make it more concrete in the minds and lives of learners. The results support Moschkovich's (2002, 2007) advocacy to use non-language tools to enhance learners' mathematical competence.

Therefore, being the current language of mathematics that many teachers and students use in public elementary school in the Philippines, English may serve as a building block for facilitating learning in the classroom if it is appropriated and utilized together with the mother tongue and other linguistic and nonverbal resources. The freedom to use all these learning tools in the mathematics classrooms may be the key to empowering teachers and learners.

However, if English is imposed on children who are struggling with it, it may become a hindrance to their learning. The findings suggest that many fifth and sixth grade learners in public elementary schools in the Philippines are still in the process of developing their comprehension and communication skills in English. The call for extending the use of the mother tongue as an MOI in the upper primary levels to maximize its impact on learning (Agcaoili et al. 2013) may be considered by policymakers.

An evaluation of the language of assessment also needs to be conducted as this study confirms that the language of assessment is one primary factor that public elementary school teachers consider in carrying out their classroom tasks (see Paulson Stone 2012). It is a source of predicament as math teachers have to choose between the children's mother tongue that they understand and English, the language used for standardized tests in the upper grades.

This dilemma may be solved by simplifying assessment instruments as proposed in previous studies (Abedi and Lord 2001; Martiniello 2008; Barbu and Beal 2010) or giving translations for difficult words or phrases as Teacher A and Teacher B did in their classes (see Versoza and Mulligan 2013). Using the students' home language and incorporating familiar English mathematical terms is also an option as Teacher A demonstrated in her class. In an interview with Ms. Evelyn Francisco (2014, personal communication, 23 August), a teacher who has extensive experience in mathematics teaching in the Philippines and the USA, she pointed out that an alternative would be to train math and English teachers in developing children's skills in understanding basic instructions, word problems, and math texts more effectively.

Furthermore, studies may be pursued on how mathematics can be localized both in content and language to make it more relevant and meaningful for learners. Various strategies may be investigated: "developing mathematics registers in the local languages and…borrowing from mathematical English" (Kazima 2008, p. 56); borrowing from English that may simply entail using the very same terms and

expressions as demonstrated by Teacher A and Teacher B in their mathematical Discourses; or utilizing existing mathematical terms and concepts in local languages (Tirol 2009, 2010).

Further studies also have to be conducted on school policies (e.g., English-only policy) that promote a colonial legacy, violate the rights of children and members of the school community to use local languages, and penalize them for doing so. Linguistic equality has to be fostered in multilingual classrooms. Translingual practice (Canagarajah 2013) in the classroom should be seen not as an academic threat but as an instructional device that may help facilitate learning. This study mirrors the sentiments of teachers who acknowledge the reality that multilingual learners use different languages to communicate in the classroom and enable them to understand lessons (see Sepeng 2013; Burton 2013).

These are some possibilities that may help turn obstacles into opportunities. The use of English in mathematics may, therefore, be enhanced with other linguistic resources and non-language tools to empower teachers and learners in multilingual classrooms. Teaching and learning may be more significant and enjoyable if teachers and children are given more space to think freely and communicate creatively as they discover the treasures of mathematics.

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