

Frequency, Significance and Clarity: Factors Supporting the Learning of Mathematical Vocabulary in Bilingual Classrooms

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Abstract: A crucial part of mathematics education is the teaching and learning of mathematical language, which includes subject-specific vocabulary. In a study carried out in two Maltese primary classrooms wherein mathematics was taught through the students' L2 (English), and a teacher-directed 'whole-class' approach was used, it was noted that three conditions for vocabulary use - frequency, significance and clarity - appeared to be necessary for teaching new topic-related vocabulary. In this paper, I explain these conditions as they emerged from my empirical data and then conjecture on their relevance to other classrooms wherein both Maltese and English might be used, since code-switching is the most common approach used in Malta for teaching mathematics. I suggest that while frequency of use of words is likely to depend on the teaching methods employed, code-switching might further promote the significance of mathematical words; furthermore, I suggest that using both languages might actually support clarity of the meaning of the topic-related words. Finally, if we wish to make a shift away from traditional whole-class teaching, we will need to equip students with the language necessary to engage differently with mathematics, irrespective of the medium of instruction used.

Keywords: Mathematical vocabulary; mathematics and English Language Learners; Code-switching; Primary mathematics

Introduction

Mathematics in Maltese primary classrooms is taught through the use of Maltese, the local language, and English. The most common strategy is code-switching between the two, while another strategy used in some schools is teaching mathematics almost exclusively through English. In this paper I start by giving a brief background to language use in Malta, explaining the arguments commonly put forward with regard to mathematics education. I

then focus on the general importance of enabling students to understand and use mathematical vocabulary, irrespective of the medium used. Drawing on empirical data collected from two primary school classrooms in which English was used as a medium of instruction, I present three ‘conditions’ that appeared to be necessary for new topic-related mathematical vocabulary to be learnt by the students in a ‘whole-class’ teaching approach. Given that many local teachers make use of a whole-class approach but switch between Maltese and English, I then reflect on the application of the three conditions to such classrooms. Hence, the aim of the paper is to offer a way to think about promoting mathematical vocabulary in bilingual contexts wherein lessons are generally teacher-directed.

Language in Maltese mathematics classrooms

In Malta, English increasingly gained relevance during the 164 years of British colonial rule that ended in 1964, during which time the language was important for the civil service and military economy of the period. Maltese, however, remained the language of the people, and was established as the national language in 1934. Both Maltese and English are the country’s official languages. Camilleri Grima (2003) explains that while Maltese is widely spoken as a means of daily communication and is the official language of parliament and the courts, English is essential for international communication, the tourism industry and in local education.

Camilleri (1995) points out that it is not possible to talk about language compartmentalisation in Malta, since Maltese and English frequently overlap. Generally, a Maltese person may use the two languages to different extents depending on their backgrounds, preferences, and the context in which they find themselves. Hence code-switching between Maltese and English is a common phenomenon. Baker (2011) defines code-switching as the practice of alternating between two or more languages and uses the term to describe any switch within a conversation, whether at word or sentence level, or at the level of blocks of speech. Baker (2011) explains 13 over-lapping reasons why one might code-switch, including using a familiar word in one language when one does not know it in the other language and expressing a concept that has no equivalence in the other language.

Locally, code-switching as a medium of instruction is commonly used by teachers. Camilleri Grima (2013, p.556) explains that the most conspicuous “division of labour” between English and Maltese is the written/spoken divide. It should be noted that in Malta, all written mathematics is in English, including textbooks, handouts, whiteboard work, on-screen texts, students’ notes and exam papers. Indeed, in her study of various Maltese secondary school classrooms, Camilleri (1995) found that linking with written English texts was the most common reason for code-switching. Furthermore, code-

switching occurred when subject specific words were used: for the various subjects she observed, including mathematics, Maltese equivalents of some technical words did not exist and when they did, the Maltese versions were more commonly used in ‘every day’ life, rather than as part of the ‘academic’ classroom talk.

While code-switching has in the past been viewed as a language deficit, García (2009) explains that more recently this negative connotation is being questioned by scholars. Indeed, García states that bilingualism is not a deviation from the norm, but a common communication repertoire used by most people in the world. Citing Van der Walt, Mabule and De Beer (2001), García (2009) stresses that code-switching should be ‘responsible’ in that it is used to offer meaningful instructional support, and not merely to give orders, call attention and so on.

An example of a code-switching stretch of interaction in a Primary mathematics classroom is given below; it illustrates how the class teacher used both languages with purpose as she guided her 8-year-old students to focus on money coins and their values. This particular teacher (indicated by T, students indicated by S) tended to start interactions in English, in an attempt to promote English, and then switch to Maltese to support understanding. This is yet another reason for code-switching mentioned by Baker (2011). This data, like all other excerpts presented in this paper, was collected as part of a study I carried out in order to focus on language in primary mathematics classrooms (Farrugia, 2007). In the transcript, the original spoken text is shown on the left-hand side, with Maltese speech shown in **bold**, while a translated version is presented on the right-hand-side.

T:	I’m going to ask you some questions and then we’re going to write them down. How many Maltese coins are there? How many?	I’m going to ask you some questions and then we’re going to write them down. How many Maltese coins are there? How many?
S1:	Seven.	Seven.
T:	Very good. There are seven Maltese coins. Which coin has the smallest value? What does ‘value’ mean? Jekk nistaqsikom ‘which has the smallest value?’	Very good. There are seven Maltese coins. Which coin has the smallest value? What does ‘value’ mean? If I ask you ‘which has the smallest value?’
S2:	Daqs.	Size.
T:	Ghad-daqs qed nghid?	Is it the size that I’m referring to?
Ss:	Le!	No!
T:	In- ...	The ...
S3:	Number.	Number.
T:	Number, alright. Allura qed	Number, alright. So which coin

	nistaqsi għal liema coin? X'inhi l-kelma bil-Malti? Which coin has the smallest value?	am I asking for? What's the word in Maltese? Which coin has the smallest value?
S4:	Kemm tiswa.	How much it's worth. [It's value]
T:	Kemm tiswa, brava. Liema tiswa l-inqas?	How much it's worth, good girl. How much is the least one worth?
S4:	One cent.	One cent.

In some local classrooms, English is used as a medium of instruction and often, this is the second language of the students, although it must be stated that for different children in the same classroom, familiarity with English may vary greatly according to their life experiences. The method generally adopted is closest to that described as by Tedick, Christian and Williams Fortune (2011) as one-way immersion. This is because the students had the characteristics of being linguistically homogeneous and dominant in the majority language (Tedick et al, *ibid*); furthermore, it may be considered an immersion approach since usually the motivation for such an approach is to strengthen the second language, and thus the aim is additive bilingualism (Cammarata and Tedick, 2012). The drive to promote an ex-colonial language is not unique to Malta; for example, Halai (2009) reports a government policy in Pakistan whereby English was to be used as a medium of instruction for mathematics, science and computer science, as part of a belief that a crucial aspect of the ongoing curriculum reform was proficiency in the global language. Hornberger and Vaish (2009) note that in such situations, the stigma of a colonializing English is replaced by a positive attitude about the multinational functionality of English.

In Farrugia (2009), I highlight the issues that may arise when an English immersion method is used with students whose home language is Maltese. Briefly, these include issues of understanding for students not proficient in the language, and hence an issue of inclusion; difficulties with expecting student collaborative work to be done through English and the negative message that might be given with regard to the Maltese language itself. However, my personal experience with local educators indicates that English as a medium of instruction may find support due to a number of reasons: first, using English supports children's learning of the language; English is the language of written texts, including school based and national tests; it is believed to be beneficial to high achieving students who then go on to follow academic paths; English allows for the inclusion of non-Maltese students who may be familiar with English but not Maltese. (Recent statistics give 6% to be the fraction of students who have one or both parents who are not Maltese (Ministry for Education and Employment, 2104)). Finally, another reason given is that since mathematical words are often stated in English, one 'might as well' conduct all the conversation in English.

Perhaps surprisingly, exclusive use of Maltese is not a medium of instruction for mathematics. Indeed, some local educators and linguists promote this idea and I (Farrugia, 2015), have discussed the development of a standard Maltese mathematics register. However, the option does not appear to be seriously considered by practitioners and policy makers in general. The reasons cited for this are the dominance of English as a global language, the financial implications of producing resources in Maltese and the necessity to establish a standard Maltese mathematics register, since some terminology does not as yet exist. A common view is that this effort would not be 'worth it' and hence a waste of time, a view that concurs with that cited by Setati and Adler (2000) for South African teachers with respect to African languages.

I now turn my attention to mathematical language, highlighting the importance of verbal communication in mathematics and the need for students to learn topic related vocabulary to be able to do this.

General use and development of mathematical language

The importance of verbal communication in the mathematics classroom has long been recognised. For example, Pimm (1987) notes the value of student talk as a means for talking things through and organising one's thoughts, while Griffiths and Clyne (1994) state that through talk, understandings can be clarified and misconceptions addressed. Similarly, Clemson and Clemson (1994) and Kamii (1994) believe that open-ended questions encourage children to articulate their own thoughts, offer various methods, reflect on their answers and on those of others, and to participate in an exchange based on possible disagreement; Hancewicz (2005) calls this a "discourse-friendly classroom" (p.74). Finally, Lee (2006) considers student talk as a means for a teacher to assess understanding. Recently, due to the increasing importance being given to student participation in, and experience with, the various discourses and genres relevant to mathematics, the promotion of 'literacy strategies' has become popular in relation to the mathematics classroom. For example, Sammons (2011) mentions, among other points, the importance of students understanding why and how questions can be asked to aid their understanding, how students can be taught to synthesize mathematical ideas, infer and predict and how to determine 'importance' in a mathematical text. Metsisto (2005) applies reading strategies to mathematical texts, Tuttle (2005) focuses on writing strategies while Benjamin (2011) includes in her strategies reading comprehension and note-taking.

The talk used in a mathematics classroom is likely to consist of a mix of 'everyday' and 'mathematical' vocabulary such as *shape, angle, graph, axis, twenty, multiplication, addition, length, metre* and so on. According to Harvey (1982), 'technical' language is not always essential and pupils may very well

use informal language to express themselves. For example, a child might call an *angle* a *corner*, or refer to the *perimeter* of a shape as the *outside line*. However, Harvey (1982) also states that more technical language is convenient, since standard words or expressions increase the potential of more effective communication with others in, and beyond, the immediate classroom, and also reduce the chances of ambiguities. Hence it is useful that teachers help pupils to use more conventional language (Miller, 1993) which, according to Pimm (1995), allows us to talk about things and to 'point' with words. This eliminates the need to use indicatives like *that* or, as suggested by Murray (2004), using the word *thing*. Hence, mathematics educators, and recommend that mathematical vocabulary needs to be taught explicitly and suggest ways in which this can be done (see, for example, Zaskis, 2000; Murray, 2004; Bruun, Diaz and Dykes, 2015 and Pace and Ortiz, 2015).

With regard to second language learners, it is strongly recommended that students experience systematic support, in the sense that the teacher should plan specifically to focus on mathematical language (Brodie, 1989; Cuevas, 1991). Some teachers and researchers have described specific classroom practices in this regard. For example, Appleby (2003) describes her method of introducing new vocabulary to her Grade 3 ethnic minority pupils, whereby she encouraged them to identify such words in problems and then practice the words by writing out their own simple problems. Other classroom tasks suggested by MacGregor (1993) include card games, fill-in-the-gap exercises, text reconstruction and describing a picture; similarly, Moschkovich (1999) reports how a teacher helped his Hispanic students in the U.S as they offered informal or incomplete mathematical language. This teacher focused on the mathematical content of the students' contributions, asking them for clarifications, and accepting and building on them by re-voicing statements. Van Eerde and Hajer (2005) designed activities for immigrant 12 to 14-year-olds in Holland with the specific aim of addressing both mathematical ideas and language concurrently. This explicit attention to both language and subject is known in Europe as Content and Language Integrated Learning (CLIL) or as Content Based Instruction (CBI) in the U.S. (Tedick and Cammarata, 2012). A comprehensive bank of activities that support learning English and learning mathematics at the same time is provided by Bresser, Melanese and Sphar (2009), Melanese, Chung and Forbes (2011) and Coggins, Kravin, Coates and Carroll (2007). Finally, Deller and Price (2007) offer examples of lesson plans for mathematics and other subjects.

While a teacher needs to expose the students to new vocabulary explicitly, the students should also be given opportunities to use these words in activities where their attention is on the mathematical task itself rather than on the words. In relation to this, Adler (2001) talks about a dilemma of 'transparency', a notion drawn from Lave and Wenger (1991) who first used it in relation to an apprentice learning to use a tool. Adler (2001) applied the

idea to mathematical language. She explains that on the one hand, a teacher may wish to focus explicitly on language (the 'tool') thus making the mathematical language 'visible', while on the other hand the teacher also needs to ensure that the language is available enough to the students to allow them to talk about ideas and focus on tasks. In the latter situation, the language would be 'invisible' in the sense that students 'see mathematics through it'. Murray (2004) offers a number of examples of how this may be achieved, whereby mathematical vocabulary becomes a necessary tool for students to write journals that would include keeping notes, documenting thinking, writing self-evaluations and mathematical reflections.

The approaches outlined above promote an explicit attention to mathematical language which relies on a particular pedagogic style that 'hands over' a lot of thought and activity to the students. This is quite distinct from a teacher-directed 'whole-class' teaching approach. The latter tends to utilise an 'IRF'-style of interaction (Initiation - Response - Feedback) where the structure of the interaction is mainly determined by the teacher (Sinclair and Coulthard, 1975). In Malta, the latter style is very common, with students often following a teacher's explanation and then working through tasks - often textbook exercises - at roughly the same pace. Thus, the necessity for supporting the learning of mathematical expression in order for students to engage in language rich activities such as cooperative investigations and journal writing may not be encountered as much as recommended in the literature. (A notable exception to this was the recent EU-funded FP7 research project *Promoting Inquiry in Mathematics and Science Education across Europe* (PRIMAS 2010-2013) (see <http://www.primas-project.eu/>). In the local implementation of the project, a number of secondary level teachers were supported to use an inquiry-based learning approach, thus moving away from typical whole-class teaching).

Still, from my personal experiences with trainee and practising teachers, I can say that teachers do appreciate that 'key' mathematical vocabulary needs to be encountered and understood by learners. In such teaching-learning contexts, what are factors that support the learning of mathematical vocabulary? In the next section I will explain three factors or 'conditions' that I noted as part of a study carried out in two primary school classrooms.

Factors supporting the learning of mathematical vocabulary through a whole-class approach

As part of a study I carried out focusing on language (Farrugia, 2007a), I observed two primary school classrooms and focused on when and how 'key' topic-related words were used during a series of lessons. The classes were Grade 3 and Grade 6 (7-8 year olds and 10 - 11 year olds respectively) and the method used by both class teachers was 'whole class teaching'. Both teachers

used English as a medium of instruction which was the second language of the students. I started by asking the teachers about their objectives for the lessons, especially with respect to the vocabulary they considered 'key' for the topic and I then observed lessons for two topics per class (a total of 34 hours of lessons). The topics were 'Multiplication and Division' and 'Length' in Grade 3, and 'Graphs' and 'Length' in Grade 6. After each set of lessons, I interviewed six children per topic to check if they recalled certain mathematical words used during the week, and if they could explain their meanings. Once I established the students' ability to recall and explain the words, I then revisited the lesson transcripts in order to attempt to identify what factors appeared to be necessary for successful recall and explanation. Three factors or 'conditions' emerged: frequency of use of the word by teacher and/or students, what I refer to as 'significance' of use of the word, and the clarity of the meaning of the word as expressed (generally) by the teacher. I consider each in turn below, giving a summary of the evidence that led me to identify these factors.

Frequency

The first factor that appeared to be necessary for students to be able to recall and explain appropriately a new mathematical term was if the word was used frequently in the classroom. I tracked the number of times a word was used in total, that is, by both the teacher and the students collectively. The range of frequency of use was from 5 times (*height*) to 664 times (*centimetre/s*) in Grade 3, and 4 times (*metric*) to 560 times (*centimetre/s*) in Grade 6. The words *centimetre* and *metre* were used a lot due to work done on converting units in Grade 3 or to find perimeter and similar exercises in Grade 6. For example:

(*The Grade 3 class is working out a conversion exercise together*).

T: What if I have four hundred and nineteen centimetres? How many metres and centimetres is that?

S: Four metres and nineteen centimetres.

In a whole-class approach the words are more likely to be used by the teachers than the students, since they are likely to do more talking overall. Indeed, each of the two teachers I observed used the key mathematical words *more than four times as much* as the all the students did collectively during the lessons. This was the case even though the Grade 6 teacher encouraged her students to talk and express themselves more than her Grade 3 counterpart who stuck very rigidly to the I-R-F style.

Words that were heard or used little during the course of the lessons were not recalled by the students afterwards. In order to distinguish between 'frequently' and 'infrequently' used words I chose an arbitrary number of 30. My choice was made after examination of the data and influenced by the fact that, for both age groups, this number appeared to mark a cut-off point between those words recalled and explained appropriately, and those words that were not. Interestingly, I have since come across a similar point made by Murray (2004), who reported that while attending a professional workshop, she had learned that for a vocabulary word to become part of one's personal repertoire, it must be used in meaningful ways close to thirty times.

Significance

Another condition for sharing meaning of a word is what I referred to as 'significance'. Two types of situations appeared to render a word significant. The first was when a word was a key component of the task at hand. For example, if the activity was a unit conversion activity, then the words *centimetre* and *metre* were significant – the talk was actually *about* these units; if Grade 6 students were finding the perimeter of rectangular regions, the exercise was *about* perimeter. Words that were significant in this manner were recalled later by the interviewed students, and explained suitably. On the other hand, a mathematical word may have been used in passing by the teacher and in such cases, the students did not recall the words. For example, in Grade 3, when the words *width* and *height* were used in relation to a table, the main point of the task at hand was using the measuring tape accurately, so that the words *height* and *width* themselves were not significant at that point; the teacher used them, together with gestures, only to draw initial attention to the relevant dimensions to be measured. The teacher's and students' attention was then focused on the practical action of measuring and correct use of the measuring tape.

A second element that appeared to render a word significant was the fact that it could not be replaced by another word. For example, the word *kilometre* could not be replaced nor could *multiplication*. On the other hand, in the Grade 3 lessons the word *estimate* was frequently replaced by the word *guess*. The teacher herself explained:

With regards to metres and centimetres, well, that is the word. I couldn't replace those words. (...) [but] when we talk about verbs, I can say [replace with] an action, doing something, a 'doing' word".

While students were later able to give appropriate explanations for the 'non-replaceable' types of words, this was not the case for ones that had been replaced. Alternatives play an important role in supporting the meaning for a

new word, so in practice, a fine line exists between using alternatives and bringing the new word to the fore.

Although for some words there appeared to be a correlation between significance and frequency, that is, a 'significant' word was also used frequently, this was not the case for all words. There were some words that were used in what I interpreted to be a 'significant' way, yet they were not used frequently. Hence, I concluded that significance was a factor worth considering in its own right.

Clarity

Mercer (2000a) states that teachers introduce technical words to pupils by using them in contexts that render their meanings clear. When a word serves as a reference or name for something (that which Vygotsky, 1981, refers to as a primary role), the word is temporary and spatially co-present with the object (Wertsch, 1985). In such a case, there is a perceptually evident link between the word and a symbol or some other representation. As a result of my observations, I considered the naming role of the words to be 'clear' and noted that this was easily 'shared' with students. Examples are *times* for the symbol x (Grade 3), and *axes* for the relevant parts of a graph diagram (Grade 6).

On the other hand, if the object to which a word refers is not present, then it becomes harder to establish the meaning of the word. For example, in my observations I noted that the Grade 6 teacher intended the word *data* as a collective name for information given in the textbook that was to be plotted on a graph. However, no data was actually collected by the students' themselves and three of the six students did not recall the word being used during the lessons. The students who did recall the word associated it with any written text on their copybook, for example their own written scale and their workings in answer to textbook questions. This may have happened because it was this written work that was 'tangible' or readily perceivable to the students, and it was during periods when students were working on interpreting the graphs that the teacher tended to use the word *data* as she spoke.

A meaning for a word generally goes beyond reference so that understanding multiplication, for example, goes beyond recognising and naming the symbol x , but involves 'chains of signification' (Presmeg, 2001) between the language used by the teacher, and the pictures, diagrams and/or mathematical notation where applicable (for sign systems, see for example, Duval, 2001; Steinbring, 2005). In Farrugia (2007b) I explain how the concept of multiplication as repeated addition was rendered clear through associations between the vocabulary *multiplication*, *multiplied by* and *repeated addition*, and

objects, pictures or notation. For example, the Grade 3 teacher stated ‘each monster has three legs each’ in relation to a picture in the textbook that the students were looking at; she used the expression ‘*repeated addition*’ in association with the notation $3+3+3+3$ written on the whiteboard, touching the notation as she did. Thus a semiotic chain was established between the pictures, the mathematical notation of addition and the new mathematical word *multiply* and other words/expressions that were already known to the students such as *number of monsters*, *three legs each*, *how many*, *addition* and so on. Thus the words *multiply* and *multiplication* were ‘glued’ (Hewitt, 2001) with the mathematical idea. Another example I can give here briefly is that of the verb *measuring*: both teachers rendered clear the meaning of the procedure of *measuring* through demonstration, the students’ own engagement in activity and an explicit exposition of the purpose of measuring.

In cases when semiotic links were evident, I considered that the use or application of the word was ‘clear’; these were words that the interviewed students recalled and explained appropriately. On the other hand, there were other words that the students could not recall or explained incorrectly. My examination of the data showed that in these cases, the links between the word and other sign systems such as pictures, notation, gestures, and so on, were not evident during the lessons (see Farrugia, 2007b for more details). Hence, I concluded that the meanings for such words were not rendered clear.

Admittedly, the three conditions – frequency, significance and clarity – are interrelated to some extent. For example, I noted that for a number of words, frequency, clarity and significance went together, so that for example, the word *graph* was used frequently, clearly *and* in a significant way. I noted that for a new word used with all three conditions satisfied, all pupils recalled the word and gave an appropriate explanation. On the other hand, if a word lacked either one or the other of these conditions when used in class, then the word was not recalled by all the pupils, or not explained satisfactorily. Since lack of clarity or significance was generally accompanied by lack of frequency, it is difficult to say with certainty which condition had the most bearing on sharing of meaning. However, my data strongly suggests that, certainly for a ‘whole-class’ L2 context, it would be beneficial for teachers to try to maximise the three conditions both in their own usage and that of the students.

Applying the conditions to code-switching contexts

Through my observations and discussions with the teachers and a number of students from each class, I concluded that the use of the mathematical words was influenced more by pedagogic approaches and teacher awareness than by the fact that the lessons were carried out in English. Of course, I cannot

exclude the fact that the teachers' approach itself was influenced by the use of English, but I am not in position to say to what extent this may have happened. Furthermore, although some students expressed some reservation about the use of English for mathematics, the students in general appeared to 'follow' the lessons. Thus I am quite confident in my conclusion that successful 'sharing' of meaning of the words can be explained by factors that go beyond the use of English itself.

I now wish to consider the application of the three conditions for classrooms where both Maltese and English are used to teach mathematics through a 'whole-class' approach. I wish to do this since the latter is a common situation in Malta and hence I believe that hypothesising this point could be helpful. I must stress that at this point these forthcoming reflections are conjectural, but I offer them as an extension of my empirical research and as a starting point for further investigation.

In code-switching classroom contexts in Malta it is common practice for the 'mathematical' vocabulary to be retained in English. This had been noted by Camilleri (1995) for a number of secondary school subjects, including mathematics. I can also confirm it from personal experience working with trainee and practising teachers. So for example, the following excerpts taken from data I collected from different contexts are quite typical:

T:	Number, alright. Allura qed nistaqsi għal liema coin?	Number, alright. So which coin am I asking for?
T:	Kif ser niftakru li 'y-axis'?	How are we going to remember that [it's called] 'y-axis'?
S:	Din il-gimgha tkellimna dwar il-length u l-breadth. Em ... is-sides tax-shapes [rectangles], u bihom nistgħu nsibu l-perimeter.	This week we talked about length and breadth. Em ... the sides of the shapes [rectangles], and with those we can find the perimeter.
S:	Multiplication huwa times ... U tista' tagħmel, perezempju, three multiply [multiplied] by three.	Multiplication is times ... And you can do, for example, three multiply [multiplied] by three.

Hence, I suggest that frequency of word use in Maltese primary classrooms where a whole-class approach is practised, may be independent of the medium of instruction used. Rather, I conjecture that how much mathematical vocabulary is actually used by the teacher and the students depends on the pedagogical style utilized by a teacher and his or her awareness of how mathematical vocabulary may be addressed.

With regard to significance, again, I conjecture that this may be more strongly influenced by the general teaching approach used than by whether L2 or a

mix of both languages is used. I suggest that it depends mainly on whether the teacher stresses or includes the word as a key part of the activity, or whether he or she replaces it by another word that might take attention away from the new mathematical word.

However, it may be the case that using both languages might actually *help* to render a mathematical word significant by promoting its ‘visibility’ by virtue of it being in English, while the surrounding language is in Maltese. Thus, code-switching might actually offer a third element related to significance. For example, in the examples offered above, the mathematical words ‘stand out’ simply because they are in English, thus affording them a particular status. Furthermore, another way in which code-switching might highlight a mathematical word is by translating it. This is best explained through an illustration as shown below. In the following stretch of interaction, the teacher took the opportunity to highlight the new English word *change* (in relation to money) by contrasting it with its direct translation **bqija**, with which the students were familiar. This is what Camilleri Grima (2013) refers to as ‘explicit translation switching’ (p.562).

(The students have been introduced to the word ‘change’.The children are working on a handout that shows priced items and a set of coins. The children are expected to work out the change in each case).

T: Question number 2. Jekk jiena jkolli flus u ma jkollix eżatt, anzi jkolli iżjed ... tal- hanut irid itini xi haga?	Question number 2: If I’ve got money, but not the exact amount; actually, I’ve got more... does the salesman need to give me something?
Ss: Bqija.	Change.
T: Right. And in English, what is it?	Right. And in English, what is it?
Ss: Change.	Change.
T: How do I know how much CHANGE the shopkeeper has to give me? X’inhi s-somma li rrid nagħmel biex niskopri kemm irid jagħtini bqija? David?	How do I know how much CHANGE the shopkeeper has to give me? (...) What is the sum [operation] that I need to work out to find out how much change he’s got to give me? David?
S: Minus.	Minus.
...	
T: <i>(A short while later).</i> Change. Very good. Irrid nagħtik change, bqija, hux vera?	<i>(A short while later).</i> Change. Very good. I need to give you change, change, right?

With regard to clarity, here perhaps the choice of using either English or a mix of both languages may have a stronger impact. As stated by Mercer (2000b): “words gather meanings from ‘the company they keep’ - that is, from

the influence of the meanings of other words which are used with them" (p.67). Certainly, it is crucial that the students understand the 'accompanying' words, something that might be harder to assume in a second language classroom. For example, in my study one indication I had regarding a misunderstanding was the case of a student whose explanation of the expression *repeated subtraction* indicated that she was confusing the English word *repeat* with *revise*. Therefore, while of course the teaching approach used is important (type of explanation, examples used and so on), it is also important that students understand the words that are used to explain or support the meaning of a new mathematical word. Hence it may be the case that code-switching may support the aspect of clarity.

Conclusion

In this paper I have outlined my interpretation of the three 'conditions' that appeared necessary for students to be able to later recall and explain mathematical words. These were frequency, significance and clarity. Since the lessons were carried out in the students' L2, I then conjectured the application of these conditions to Maltese classrooms wherein both Maltese and English are used, since code-switching contexts are more common locally. I suggest that a lot would probably depend on the teacher's general approach to teaching mathematics, especially in relation to frequency of word use. However, I suggest that code-switching may help to render a word significant, while possibly supporting clarity. Certainly, further research is needed in local contexts to explore these conjectures.

As a final reflection I would like to draw attention to the fact that the lessons I observed were ones organised in a 'whole-class' approach, and hence the conclusions and reflections presented in this paper are based on such an approach. However, as indicated earlier in the paper, it is desirable for students to engage in more language-rich activities, including collaborative and investigative work. Various authors already cited earlier in this paper recommend suitable oral and written activities that promote not only more mathematical reasoning and collaboration, but also the use of mathematical vocabulary. Ideally, mathematical words that have been introduced to the students and rendered clear and significant - and hence very 'visible' - may then become tools ('invisible') to be used in mathematical tasks. This in turn would ensure that the words are used more frequently, and this time by the students themselves; the language used would be more contextualised and heard and used in appropriate contexts (Gibbons, 2015), thus rendering it significant for the task at hand; furthermore, student-use of vocabulary can also serve to show the teacher how clear the meaning of the vocabulary is to the students.

Keeping the ideal of increased student participation and self-direction in mind, it may be the case that the use of both languages might be more appropriate than the exclusive use of English, since students are likely to find general discussion easier if they are offered flexibility. As stated by Halai (2009) in relation to the Pakistani context, code-switching appears to offer a resource for enabling mathematics learning. Indeed, in the very limited opportunities to work in groups that I observed during my study, the students immediately reverted to a code-switching strategy. On the other hand, when it comes to any work to be done in writing, such as reflective journals, note taking and so on, a Maltese teacher would still need to give specific attention to the 'mathematical English' needed for these genres, since code-switching is not a standard way of *writing* and written mathematics in English remains the norm for the foreseeable future.

To sum up, I suggest that irrespective of the medium of instruction chosen for a whole-class approach to teaching mathematics, conscious attention needs to be given to key terminology so that mathematical vocabulary is used frequently, significantly and clearly, by both teacher and students. Even if code-switching is preferred for oral work, still, attention should also be given to English mathematical expression which would be needed for written work and other language-rich activities during which vocabulary becomes a tool for carrying out a reflective or investigative task. Through such tasks, the teacher would hope to promote both mathematical reasoning (which can be done in both languages) and written expression (which would be done in English). Giving attention to language in this way would help to equip students with the language needed to engage with mathematics in a richer way.

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