REGISTERS FOR MATHEMATICS CLASSROOMS IN MALTA: CONSIDERING THE OPTIONS

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Over the years, various writers have focused on mathematical language use in classrooms (*e.g.*, Capps & Pickreign, 1993; Harvey, 1982; Pimm, 1987; Zazkis, 2000). Verbal communication is recognised as an important way for students to participate. More specifically, it has as been argued that knowledge of subject terminology is important since it allows more effective communication about mathematical ideas by both teachers and students. Indeed, Pimm (1987) suggested learning to speak mathematically implies learning to *mean* mathematically. I too am concerned with mathematical language - or, more specifically, with the idea of a mathematics 'register'.

This interest is prompted by the fact that, in Malta, we tend to communicate mathematical ideas through a mix of Maltese, our national language, and English, our second language. Based on data I collected from Maltese primary school classrooms, I reflect on how we use, or could use, language in our mathematics classrooms.

I start by explaining what is meant by a 'register'. This is followed by a brief description of the Maltese socio-linguistic context. I then consider the possibility and implications of exclusively using either English *or* Maltese for spoken and written mathematics. Finally, I reflect on the approach of using code-switching between Maltese and English as the spoken mode alongside English written texts.

Registers

Halliday (1978) used 'register' to refer to a way of talking within, or about, a particular context:

> A register is a set of meanings that is appropriate to a particular function of language, together with the words and structures which express these meanings (p. 195)

A register may be spoken or written. It is dependent on the nature of an ongoing social situation, which is constituted by participants engaged in some activity and using language for a particular purpose. These elements are reflected in the register through grammatical features that indicate the interpersonal relationships between the participants, the role language plays (*e.g.*, to persuade) and the content at hand, that is, what the talk is 'about'. Halliday referred to these components respectively as the interpersonal, textual and ideational functions of the register.

In the context of mathematics education, Morgan (1998) focused her attention on students' written mathematics examination scripts. Regarding interpersonal meanings, Morgan suggested that an expression such as "We shall show that ..." implied the authority of a community, while "For my extension I am going to ..." provided a more personal development (p. 84). The textual function was recognised through the style of writing used, such as narrative, explanation and so on. Morgan considered that the phrase "there is one definite pattern ..." formed part of a descriptive report, while "... so if I multiply ..." formed part of an argumentative style (p. 113). With reference to the ideational aspect, she focused on mathematical vocabulary that referred to processes and suggested that the grammatical ways in which these were expressed indicated what students thought mathematics was about. For example, a student's use of active verbs in statements, such as "If you add ... then multiply ... you get ..." (p. 80), reflected a view of mathematics as coming into existence through human involvement. On the other hand, the use of nominalisation to express processes (*e.g.*, *rotation* and *permutation*) and the use of symbolisation, obscured human presence and hence portrayed mathematics as an autonomous system.

I focus specifically on two main categories of vocabulary: (a) nouns or pronouns, which serve to name what Halliday (1976, p. 160) called 'participating entities' (human or objects), and (b) verbs, which indicate processes. These grammatical features represent experience and therefore have the potential to contribute to ideational meaning, as illustrated in Morgan's examples. For the sake of simplicity, I use the word 'register' throughout.

The use of Maltese and English in Malta

Malta is an island in the centre of the Mediterranean Sea. It has an area of 316 square kilometres and a population of 400,000 but, despite its small size, it has its own language. Maltese originated during a period of Arab domination (870-1249 ce), but over the centuries developed through the addition of Romance elements due to varying European occupying powers. Our last colonisers were the British, from whom Malta gained independence in 1964 after 165 years of colonial rule. During that period, English vocabulary found its way into the local language. Today, Maltese continues to absorb English words owing to the language's status as a global language. As Camilleri (1995) explained, some words have been wholly assimilated into Maltese as in **friġġ** (fridge) and **kompjuter** (computer). Others have

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been partially assimilated - that is, while not yet found in Maltese writing, they are used in speaking, but with a Maltese pronunciation, as in the cases of *rockgarden* (pronounced *rokgardin*) and *graph* (*gruff*).

Although Maltese is the national language, both Maltese and English are recognised as official languages. Maltese is widely spoken as a means of daily communication and is the language of parliament and the courts, while English is essential for international communication, the tourism industry and in local education (Camilleri-Grima, 2003). Popular perceptions persist in associating English with higher levels of education and social standing. As Camilleri (1995) pointed out, it is not possible to talk about language compartamentalisation, since Maltese and English frequently overlap. Consequently, code-switching is a common language pattern. (If the switch is for one or a few words only, this can be referred to as 'code-mixing'; I do not distinguish between the two here.) The extent to which code-switching occurs depends on the speaker and the context, but it is certainly a feature of many classrooms.

UK textbooks tend to be used in our schools for various subjects. Written Maltese is used only for social studies, Maltese history, religion and, of course, Maltese itself. All other subjects (mathematics, science, economics, *etc.*) continue to use English language publications and all written work for these subjects is done in English, including whiteboard work, copybook notes and examinations. In her study of various Maltese secondary school classrooms, Camilleri (1995) found that linking with written texts was the most common reason for teachers to code-switch from Maltese to English.

Another instance of code-switching noted by Camilleri was the use of subject specific words. For the various subjects she observed, including mathematics, Maltese equivalents of some technical words did not exist, and when they did, they were more commonly used in 'everyday' life, rather than as part of the 'academic' classroom register. **Frixa**/*pancreas* in biology is one example Camilleri cited. Similarly, in a mathematical context, a teacher might offer an explanation such as:

> "**L-i***square* **għandu erba' ***sides*; **kollha indaqs** .... **u** *four angles* **ta' ***ninety degrees*".
> "**The** *square* **has four** *sides*; **all equal** .... **and** *four angles* **of** *ninety degrees*".

Recently, some schools or individual teachers have taken to teaching mathematics through English, following the recommendation in the National Minimum Curriculum (Ministry of Education, 1999). The document encourages the use of English as a medium of instruction for mathematics and the sciences mainly as part of a drive to improve students' competency in English. However, I am also aware that some of the writers frown upon code-switching since they believe that neither Maltese nor English is being used or developed correctly.

In the sections that follow, I consider *three* language options for mathematics. The first is to use English for both the written and spoken modes; the second is to use Maltese, and the third is to use code-switching for spoken interaction while retaining English written texts. Each appears to offer benefits, but also prompts issues that require reflection.

First option for registers: English for both spoken and written modes

The first possibility is to use English as the medium of instruction, thus developing an *English* mathematics register. A benefit of this method is that it supports children's learning of English through increased exposure. It may also be beneficial to students who pursue higher-level academic paths since here the dominant language of knowledge production is English.

Another apparent benefit is that when the spoken language is the same as the written one, the two registers are 'close', although the written text is likely to be more formal. Pimm (1991) suggested that the transition from the informal spoken mode to the more formal written text can be eased through an intermediate stage of either more formal spoken language or informal written language. Thus one intermediate stage suffices to link the two. (Pimm was writing with respect to first language learners, which strictly speaking is not the case for Maltese students.)

Using English may have disadvantages as well. I observed two classrooms, Grade 3 (7- to 8-year-olds) and Grade 6 (10- to 11-year olds), in which this option was implemented with Maltese-speaking girls. [1] The first issue I noted with regard to the English-use was the discomfort of some pupils. While the girls who had been described by their teachers as 'high achievers' stated that they had no problem with the use of English for mathematics, there was a tendency for the 'average' or 'weak' pupils to express reservations related to potential understanding and participation. Some of the girls reported that they held back from asking questions because they were afraid that they would make mistakes or because they were not sure how to ask the question in English.

Interestingly, it appeared relatively easier for the younger girls to respond to their teacher's questions in English, since they were only required to offer short responses. The style of interaction preferred by the Grade 3 teacher was that known as 'Initiation-Response-Feedback' (Sinclair & Coulthard, 1975). The students gave very short, often numerical, answers. For example, during a unit-conversion exercise, the teacher might ask *'Jessica, what is your answer to question number 3?'* to which Jessica would answer *'fourteen centimetres'*. On the other hand, the Grade 6 teacher often asked 'open' questions with the expectation of more detailed response. Girls tended to struggle to use English for longer contributions, although some less than others. They sometimes resorted to Maltese, but more often used gestures; the teacher would sometimes finish off their sentences. I concluded that using English inhibited verbal participation and hence discouraged the use of a spoken mathematics register.

Another issue concerned mathematical terminology. Some expressions included *'ten division by two'*, *'do plus'*, *'do multiply'*, *'three multiply by four'* and *'the multiply'* - expressions that depart from 'standard' English mathematical language. While such examples may be steps in students' learning to use a new language, and therefore perhaps no source for concern, I noted that the teachers themselves occasionally used the expressions.

These variations may be of interest from both linguistic and epistemological points of view. The use of the verb *do*

supports the research on negative transfer carried out by Camilleri (2004) who studied 16-year-olds' English essays, noting that one of the most common mistakes was inappropriate uses of the verbs *do/make*. The Maltese verb **għamel** translates into both *to do* and *to make*, but is often used in Maltese where *do/make* would not be used in English. I return to this point later.

If I consider the word *multiply* as used in Grade 3 lessons and interviews – that is: *'three multiply by four'*, *'do multiply'* and *'the multiply'* – it seems that one word multiply is sufficing for three expressions, namely *multiplied by, multiply* and *multiplication*. Although related, the variations offer potentially different mathematical meanings. In 'three *is multiplied by* four', the verb is in a passive form and implies that one number is acted on by another; human agency is obscured (Anghileri, 1995). On the other hand, *[I] multiply* is an active verb that implies a human involvement. Admittedly, variation in the meanings for *multiply* was offered by participants through the use of [*you*] *do* and *the*, denoting an active verb or a noun respectively. However, if we are to promote English as the medium of instruction for mathematics, we must keep in mind that within the English register there are established ways of saying things. Hence, if we choose to promote an English mathematics register, this should be accompanied by the awareness of the variation offered by related, but different, words.

Second option: Maltese for both spoken and written registers

A second option is the use of Maltese for both spoken and written registers, which could encourage pupil participation in verbal interaction and increase their engagement with written texts. Further, using the same language for spoken and written texts would once again simplify the link between spoken and written registers (Pimm, 1991) – this time, however, through Maltese. A 'standard' Maltese mathematics terminology does not exist.

The task of creating and encouraging the use of 'ways of saying' in Maltese is not straightforward. There are several mathematical words for which Maltese equivalents are used as common parlance. Examples are **tul** (*height*) and **munita** (*coin*). For other words, such as *graph, equation* and *square root,* there are no standard translations. A first step would thus be to decide on translations.

Choices may not always be straightforward. For example, in a recent discussion with trainee teachers, we could not decide on a translation for *quadrilateral*. My inclination was for the word **kwodrileteril**. This spelling reflects our pronunciation of the English word and I conjecture that, since it is already used orally, the word may come to be accepted by teachers and students. Another option was **kwadrilitteru**, the translation given in a reputable dictionary (Aquilina, 1999), although in my experience not used in classrooms.

More recently, I came across another possibility, **kwadriliterali**, in a publication intended for secondary school students (Caruana & Muscat, 2007). The book has two 'front covers', reading in English from one and in Maltese from the other. Where common Maltese translations were unavailable, the authors created them by (a) assimilating an English word (*e.g.*, **ekwejxin**, pronounced *ek-way-shin*, for *equation*), (b) creating a new word (*e.g.*, **sinu**, pronounced *see-noo*, for *sine*), or (c) using a Maltese word close in meaning (*e.g.*, **ċaqliqa** [*movement*] for *translation*). Currently, our examinations are in English so, strictly speaking, the Maltese version is not immediately applicable for examination purposes. Furthermore, while I felt comfortable with several of Caruana and Muscat's translations, there were others that gave me pause for grammatical reasons or mathematical reasons, or because of everyday associations. The possibility of varying opinions on terminology highlights Robert's (1998) suggestion that, ultimately, a community must decide what 'sounds right'. For a new register to become fully functional it needs to be developed collectively.

When creating expressions, grammatical aspects may also need to be taken into consideration, since different structures imply different meanings. During the interviews, two Grade 6 girls needed to use an expression equivalent to their teacher's use of 'drop a perpendicular'. Translated from Maltese, one said 'You go down', while the other said 'the vertical line falls'. The grammatical differences between the three expressions offer different meaning potential. In Halliday's (1976) terms, 'drop a perpendicular' involves two participating entities, namely, a *person* acting on a *mathematical object;* on the other hand, the use of the intransitive verb '[you] go down' implies a person acting on their own accord. Similarly, the word [the line] 'falls' renders as subject the *mathematical entity*. The expressions are epistemologically different.

The English expression 'drop a perpendicular' also includes the imperative structure, which Morgan (1998) identified as one that renders a text 'more mathematical'. The girls did not use this structure, probably because they were not familiar with it for mathematics in Maltese. The imperative is a commonly used structure in Maltese, and it would be interesting to consider if its use for mathematics would have the same 'effect' for a Maltese register as for English.

Extending my reflection to the use of active and *passive* verbs, while active verbs bestow agency on either a mathematical object or a human, passive verbs obscure it (*e.g.*, 'a triangle was constructed'). Thus, the structures offer different views of how mathematics comes into being. In English a choice is available, with the passive structure perhaps being considered 'more mathematical' due to its formal tone. The passive voice in Maltese is reserved for very specific functions, and generally it is the active voice that is preferred. Therefore I conjecture that a Maltese mathematics register, both spoken and written, would utilise verbs in an active form. This difference in the languages highlights that producing equivalent verbs in Maltese is a complex task if one is to consider fully the epistemological implications of the grammar at hand.

Having established a standard Maltese register, one would must then consider implications and issues arising in its implementation. First, textbooks would be needed, requiring a major financial commitment. Second, it can only be hoped that teachers will take on the Maltese expressions. This project can be eased if the written register is established attentive to oral patterns already in use. For example, my sense from informal conversations with teachers is that **sajn** (pronounced *sine*) may be more readily accepted than

a newly coined **sinu** (pronounced *see-noo*). Third, we would need to address the issue of whether all schools are to use Maltese, or whether an option would be offered, as is done in Wales (Jones & Martin-Jones, 2004). Differentiated curricula raise logistic and social issues. Assessment may also be problematic. As noted by Jones (1997) for Welsh dual-language examination papers, it is no easy task to produce equivalent versions of a test in two different languages.

The option of using Maltese for mathematics is not considered seriously amongst most local educators - which may seem strange in an ex-colony, proud of its independence. However, the view may be explained by the complexities outlined above, coupled to the importance generally afforded English. Furthermore, since English is perceived as the established language for the sciences, we may feel that it is not 'worth the trouble' of developing scientific registers in Maltese.

Third option: code-switching speech and written English

A third option is retaining code-switching for spoken interaction alongside English written texts, which has the advantage of being familiar to the majority of teachers in Malta. Indeed, Camilleri (1995) noted in her study that code-switching allowed a flexible and comfortable mode of communication between teacher and pupils.

Explicit focusing on mathematical expressions is considered by many to be an important aspect of mathematics education. Some researchers have reflected on how this may be done with second language learners (*e.g.*, Campbell, 1986; Moschovich, 1999). Hence, a second advantage of inserting English mathematical words into Maltese speech is that mathematical words may be 'highlighted' by virtue of the fact that they are in English, unlike the rest of the words in the sentence.

Furthermore, Camilleri (1995) noted that code-switching served as a useful pedagogical tool. Indeed, from my experience, this is one of the most commonly perceived benefits. This view concurs with that of Setati and Adler's (2000). In the South African mathematics classrooms they observed, code-switching appeared to enable learners to harness their main language as a learning resource. For some topics taught in school, children may already be familiar with some concepts and Maltese vocabulary from their lives outside schools, as in cases of money and measurement. A teacher can thus draw on the pupils' everyday knowledge and terminology. In these cases, the introduction of the English academic terminology *(length, width, coin, value, change etc.)* might then be seen as a 'renaming' of already familiar concepts.

I observed a primary school teacher use this approach for money-related ideas. She formulated the same questions and statements in both languages prior to any written (English) work; she explicitly pointed out translations for the common Maltese words, while progressively using the English versions more as the topic developed. She also encouraged her pupils to express mathematical ideas in simple English. Of course, this method is appropriate only when the terminology is already available in Maltese, which may not be the case for more advanced topics. The point here is that, even if we use code-switching, it remains important to focus explicitly on English mathematical expressions orally, since these will be met in written texts.

On the other hand, with this option, we introduce more steps in shifting from informal spoken to formal written registers. In a situation where children are learning through a second language, Setati and Adler (2000) offered a variety of multi-step routes. One route is: informal spoken mathematics in first language (in our case, code-switching), followed by informal spoken mathematics in English, informal written English, then formal written English. The above-mentioned teacher included the second, although not the third, step in this chain.

Another route suggested by Setati and Adler (2000) involves informal spoken in first language (in our case code-switching), informal written in first language (code-switching), informal written in English, formal written in English. In practice, the step 'informal written' may seem rather alien to Maltese teachers, since writing in a 'code-switching' mode is not a standard method of writing and may not be seriously considered. Yet, it is interesting to note that such a style has been used. The following excerpt is taken from a 1913 book apparently designed as preparation for some public mathematics examination in English (translation mine):

> . **Qualunqua** COMPOSITE NUMBER **nistu inkassmuh fil** factors **collha tighu, li allura icunu collha** PRIMES ... **Esempiu:- Chif issib il** prime factors **ta 999** .. (Vella, 1913, p. 38)

> . **We can break down any** COMPOSITE NUMBER **into all its** factors, **that will therefore all be** PRIMES . **Example: How to find the** prime factors **of 999** ..

Vella used code-switching (or mixing, as in the above example) extensively, perhaps mirroring what may have already been a common verbal mode of communicating mathematical ideas. He did not seem to be restricted by standard writing conventions. Like other Maltese texts of the period, he used an old form of spelling; standard Maltese orthography (which varies from the above) was established twenty-one years after his book was published. Similar oral language patterns are still prevalent today, almost 100 years later, although conventions would restrict us from *writing* as Vella did.

Another possible issue arising in a code-switching setting is a linguistic point, relating to verbs that I became aware of as I interviewed pupils. As they discussed mathematical ideas through code-switching, I noted that English mathematical words that were nouns or adjectives fitted well into the Maltese speech. For example:

> Square **hija** regular shape **għax għandha** all sides equal.
> ([A] Square is a regular shape because it's got all sides equal.)
>
> (*The pupil refers to a diagram of a shape.*)
> Irregular **dik.**
> **That one [is]** irregular.

On the other hand, English verbs were not inserted 'intact'. The girls used the Maltese equivalents for the verbs if they

knew them, as in the case of **hija** [*is*] as above, **kejjel** (*to measure*) or **ipplottja** (*to plot,* derived from the English word *plot* and pronounced *ip-plot-ya*). The latter type of verb is known as a 'loanshift'. These words have been fully assimilated into the language, by adapting an English word to Maltese grammar. Another example of this type of verb is **illejbilja** (*to label,* pronounced *il-label-ya*) and they are created through what Halliday (1978) referred to as calquing, that is, creating new words for a register in imitation of another language.

The Grade 3 girls did not seem to have Maltese verbs available to them for *multiply* and *divide,* which do exist and are commonly used. Possibly, this was because it was the first year they were learning these concepts, and lessons were conducted in English. Therefore, in order to express the notion in 'Maltese', the pupils coined the mixed expressions **għamel** multiply (*to do* multiply) and **għamel** dividing (*to do* dividing), conjugating the verb **għamel** (*to do*).

According to Li Wei (2007), code-switching involves skilled manipulation of overlapping sections of two grammars. Irrespective of the bilingual ability of a speaker, there is virtually no instance of ungrammatical combination of the two languages. While the details of theories on how languages overlap may differ, it is typically one language that sets the grammatical framework, with the other providing items to fit into the framework. According to the theory proposed by Myers-Scotton (1993), it is the matrix language (in our case Maltese) rather than the embedded language (English) that provides the grammatical frame for code-switching. So, with reference to the afore-mentioned examples, "Irregular **that [one]**" is in line with Maltese sentence structure, while verbs are conjugated in line with Maltese patterns. If an English verb were inserted as it is used in English, as in the example '**Jiena** plot **il**-graph' ('**I** plot **the** graph'), the unconjugated verb would violate the grammatical structure of the matrix language.

These examples prompt me to conjecture that students unfamiliar with a Maltese mathematical verb may very well coin an expression in order to maintain a correct grammar. The implication for the development of a register is that, even within a code-switching situation, it may be best to provide students with appropriate Maltese mathematical verbs to express themselves. If the verb does not exist, loanshifts may need to come into use for this specific purpose. Verbs of the type '**ghamel** multiply' ('**do** multiply') are not ideal since they replace a Maltese verb that may actually already exist (*e.g.*, **immultiplika**, *to multiply*). Further, the word *multiply* is apparently rendered a noun, when in English it is a verb. While this grammatical change across the languages may not be problematic *per se,* the expression may then be translated literally into English, resulting in the expression *do multiply*.

Conclusion

The medium of instruction for mathematics in Malta is often debated amongst local educators. The options generally discussed are the use of English for both spoken and written texts, and oral code-switching alongside English written texts. Maltese for both is rarely considered seriously.

I have considered the three options, reflecting on the apparent benefits and possible issues arising. While I hope that one day it would be possible to teach and learn mathematics through Maltese, I recognise that this option is unlikely to materialise in the foreseeable future. Given the implications of the remaining options, my preference is to retain code-switching. However, favouring the retention of code-switching practices should not imply accepting a 'status quo', since even this option needs further reflection. In particular, I believe that it would be beneficial if more detailed and structured discussion were carried out on practical strategies to link the meanings of words used in the mixed spoken register with the meanings of words forming part of English written texts. We might also explore ways of encouraging students to use the academic English register orally as an intermediate step towards the more written mode.

While the arguments for the options were varied, a recurrent issue was one concerning verbs that, in Halliday's (1976) terms, denote processes. When using an English spoken register, it seems that we must be aware of the possibility of negative transfer due to the overuse of *to do* which may result in the elimination of mathematical verbs (*e.g., do plus* instead of *add*). If we choose to develop a 'standard' Maltese register, then we must consider the epistemological implications of verbs in their different forms (*e.g.*, active/passive). In code-switching situations, verbs cannot be among the words retained in English, since they must be conjugated as dictated by Maltese grammar. Hence, either the Maltese verbs must be known to students or loanshifts must be created to fulfill the function.

The points raised in this article illustrate the complexity of our choices. I believe that this aspect of our education is one that begs discussion between mathematics educators and linguists, in the interest of serious reflection on language use in our mathematics classrooms.

Acknowledgement

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Note

[1] See Farrugia, M. T. (2007) *Medium and message: the use and development of an English mathematics register in two Maltese primary classrooms* unpublished Ph.D. thesis, University of Birmingham, Birmingham, UK.

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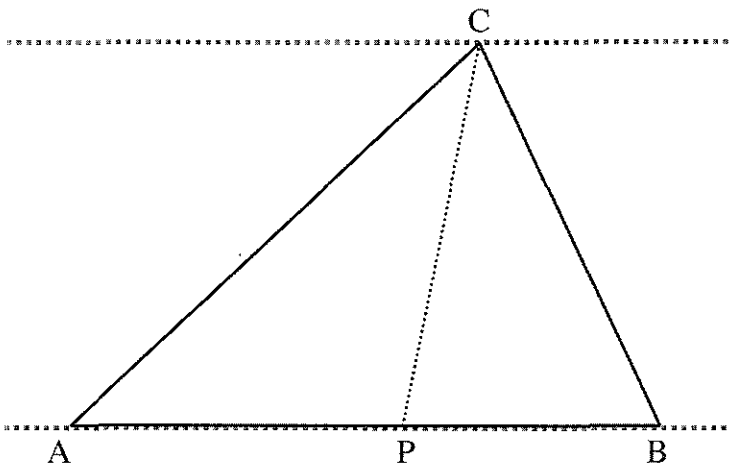
An Unsettled C

ABC is a triangle. The line that bisects ÐACB intersects AB at P. Consider the line parallel to AB that passes through C.

When C is translated along this line, what is the behavior of P? Is it going to the left or to the right? What sort of trace does P leave on AB? (Is there a relation between this trace and the height of the triangle?) What is the locus of P in relation to C? How do the answers to these questions change if the height of the triangle changes?



(posed by Michel Warisse; selected by Jérôme Proulx)