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Creating a Maltese Register for Mathematics in Malta

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Abstract: In Malta it is a common practice to use code-switching or mixing for the teaching and learning of mathematics. While this offers pedagogic benefits, some educators have argued in favour of using English throughout. It is less common for educators to argue that mathematics should be taught wholly in Maltese. In this paper, I take up this latter idea and discuss the creation of a standard Maltese mathematics register, which would be necessary for such a hypothetical context. Using Halliday's (1978) definition of register, wherein he considers how grammar is used to express interpersonal, textual and ideational elements, I consider the availability of Maltese mathematical terminology that parallels English expression. I conclude that Maltese lends itself well to expressing mathematics, although some new nouns and verbs may need to be established. On the other hand, while the passive voice in English renders a mathematical text more 'formal', the restricted use of the passive voice in Maltese implies that this grammatical function may not be a key feature of formality. Finally I note the unavailability of some verbs in Maltese that in English are used when mathematics serves as its own context, and wherein mathematics is rendered an autonomous system devoid of real life contexts or human agency.

Keywords: Mathematics register, subject specific terminology, Maltese language, grammatical function of words

Introduction

In Maltese mathematics classrooms, at both primary and secondary level, it is quite a common practice for teachers and students to use code-mixing or switching between Maltese and English. In her study of various secondary school classrooms, Camilleri (1995) found that linking with written texts was the most common reason for code-switching of mixing. Furthermore, the intersecting of the languages occurred when subject specific words were used: for the various subjects she observed, including mathematics, Maltese

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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. Finally, Camilleri (ibid) found that the use of code-switching allowed a flexible and comfortable mode of communication. Thus, she concluded that code-switching served as a useful pedagogical and communicative resource.

While code-mixing or switching tends to be accepted by several educators, students and their parents, there are people who argue in favour of using English throughout. Anecdotal evidence shows the advantages most often cited for the latter is the strengthening of students' skills in the English language. Other perceived advantages are the integrating of non-Maltese students who may speak and understand English, and aiding students who wish to go on to post-secondary academic paths for which English is the language utilised. Finally, using English links more easily the spoken (generally more informal) and written (more formal) texts, the latter being an important link suggested by Pimm (1991). However, I have argued (Farrugia, 2009a) that using English throughout also brings with it issues of inclusion for those students who do not feel comfortable using a second language, of effective class and group collaboration, and of the promotion of students' participation through talk and discussion in general. (For a full discussion of these issues, see Farrugia, 2009a).

Another issue of using English for written and spoken texts is that this would appear to undermine the potential strengthening of the Maltese language by applying it to a specific purpose, in this case a mathematical application. This potential strengthening of Maltese is the focus of this paper. I must state at the outset that I do not consider if and how it would be advantageous for students to learn mathematics completely through Maltese; the aim of this paper is to assume that such a reality is possible and to discuss the implications for the language of mathematics.

Maltese as a medium of instruction is sometimes discussed locally within the educational sector, although it does not appear to be being seriously considered. This is probably due not only to the dominance of English as a global language, and the practical reasons mentioned above, but also a legacy of 165 years of colonial rule that ended in 1964. Indeed, as a result of our recent history, 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 continues to assume importance in international communication, the tourism industry and in local education.

In a seminar on bilingualism held in Malta in 2009 organised by the '**Kunsill Nazzjonali tal-Ilsien Malti'** (National Council for the Maltese Language), the use of Maltese and English in the local educational system was discussed (see

document for discussion, Kunsill Nazzjonali tal-Ilsien Malti, 2009). A number of participants argued in favour of Maltese being developed for specific purposes; a number of participants appeared to assume that words that had already been partially assimilated into the Maltese language through pronunciation, such as **ekwejxin** ['equation'pronounced **ek-way-shin**] or **skwer rut** ['square root' pronounced **skwer root**] may be considered as Maltese, and that what was needed now was an agreed standard orthography for such words.

The idea of expressing mathematics in Maltese can be traced back to over a hundred years in a book by Tommaso Vella (Vella, 1913) a book that served as a preparation for a public exam, possibly the civil service or dockyard, two key forms of employment at the time. This text is written in code-mixing and switching between Maltese using orthography of the time, as illustrated in the example below (the original text is on the right, while my own translation is on the left):

… **Qualunqua** COMPOSITE NUMBER **nistu inkassmuħ 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** …

I am not aware of any other similar attempts since then, except the recent publication of a secondary school textbook written by Caruana and Muscat (2007). The book has two 'front covers' (rather than a front and a back cover), and presents similar material in both English and Maltese, depending at which end of the book you choose to start. The authors use commonly known Maltese vocabulary (e.g. **kwadru** for *square*, **linja** for *line*) or coin their own expressions when words do not exist (e.g. **kosinu** for *cosine*, **rejxjow** for *ratio*). Some terminology used by the authors has been criticised by some educators due to the fact that a word might not have 'sounded right' (Roberts, 1998) to them. Still, I will be using excerpts from this text to help me in the discussion I present herein.

In this paper I build on my previous reflections with regard to language use in Maltese mathematics classrooms. In Farrugia (2009b) I introduced the idea of using Maltese as the language for mathematics and commented on the necessity of appropriate vocabulary; in Farrugia (2013), I extended this discussion by reflecting on the move from 'informal' to 'formal' mathematics language in Maltese. Now in this present paper, I hone in further on the option of using Maltese for mathematics and discuss the creation of a standard register that would allow for this. In particular, in this paper, I focus

on the grammatical function of vocabulary, drawing on the seminal work on registers by Michael Halliday (for example, 1978, 1985) and the work on written mathematical texts by Candia Morgan (1998). I will compare features of English and Maltese registers and draw attention to the detail required when setting up of a standard register, showing how this goes beyond compiling the necessary vocabulary. I wish to emphasise that the use of Maltese as the language of instruction and written texts for mathematics in Malta is a hypothetical idea, but in the event of a move in this direction, we need to be aware of the preparations needed with regard to a standard 'register'.

Defining a Register

Building on the work of the anthropologist Malinowski (1923) and linguist Firth (1935), Halliday (1985) focused on what he called a 'context of situation' (ibid, p.12) in which language played a part. Halliday's view of language was a functional one, whereby he believed that people put language to use according to the situation in which they find themselves.

Halliday's (1978, 1985) definition of a context of situation includes three elements. He referred to these as:

- the field of discourse, or the activity that the participants are engaged in;
- the tenor of discourse or the set of relationships between the participants; and
- the mode of discourse or the role language plays, that is, whether is it spoken or written, spontaneous or rehearsed, whether its purpose is to persuade or to explain and so on.

These three contextual elements then determine what Halliday (1985) referred to as a 'text' which is "any instance of living language that is playing some part in a context of situation" (ibid, p.10).

Within a text, Halliday (1978) identified three functional meanings which are the respective realisations of the context's field, tenor and mode. These are:

- ideational meanings, which express categories of experience;
- interpersonal meanings, which express social and personal relationships; and
- textual meanings which make the language "operationally relevant" (Halliday, 1973, p.42).

As an example to illustrate the idea of context and its resulting text, Halliday (1985) considered a radio talk given by an Archbishop. He identified the field as the maintenance of an institutionalised system of beliefs and the members' attitude towards it. Hence, ideational meanings in the spoken text were carried by words that functioned as names (e.g. 'Christian'), metaphorical expressions ('to defend'), and also processes that were being talked about ('to take seriously', 'to question'). The tenor related to the institutionalised relationship of authority to an unseen and unknown audience, and thus the interpersonal meanings were reflected in expressions such as 'I ask you …', 'let us consider'. Furthermore, Halliday suggested that the use of imperatives ('the Christian should') and declaratives ('three motives have impelled men') also contributed to interpersonal meanings by setting a 'mood' of authority and specialist. Finally, in Halliday's example, the mode was that of a written text to be spoken aloud, carefully prepared as a rational argument. The nature of the language - spoken but not spontaneous - and the rhetorical function, were reflected in the resulting textual meanings characterised in the text by simple grammatical structures and conjunctives such as 'therefore', 'in turn', 'first/next' which created a kind of cohesion in the talk. A 'register' is then:

> "A set of meanings that is appropriate to a particular function of language, together with the words and structures which express these meanings" (Halliday, 1978, p.195).

Hence, one can identify for example, a medical register, a legal register or a mathematics register. Indeed, Halliday (1978) focused on the idea of a mathematics register, mentioning the methods for creating new vocabulary or expressions, although as he had already stressed in Halliday (1975), we should not think of a mathematical register as consisting solely of terminology. Pimm (1987) continued to build on Halliday's work, drawing attention to other features of an English mathematics register, such as subtle changes in meaning from everyday words, as in the case of the word *any*, which in a mathematical context means *every.* Pimm (ibid) also noted that a word's grammatical category may change, as in the case of number names *one*, *two* …etc., which may serve as nouns in a mathematical context while in ordinary English they serve as adjectives (e.g. '*two birds*'). Pimm (ibid) also noted that mathematical language may include differences in the use of prepositions and grammatical connectives, as when referring to '*the area of a triangle*' rather than '*in/inside a triangle*'.

A register may be spoken or written, and Morgan (1998) considered the three types of meanings defined by Halliday in the context of secondary level mathematical examination scripts. Morgan (ibid) also mentioned certain grammatical structures that appear to render language more mathematical most notably the use of the imperative ('*draw a diagram'*) and nominalization. The latter is the process of changing a process into a noun, for example,

transforming the verb *to rotate* into the noun *rotation*, thus creating a mathematical 'object'. Morgan also mentions the use of the passive structure ('*a line is drawn*') or the use of the more formal '*we*' rather than the personal '*I*' ('*we draw a line*' rather than '*I draw a line*'). Styles of writing may also indicate deductive reasoning by including words like 'hence', 'therefore', 'by Theorem 1' and so on. Furthermore, Morgan listed characteristics of a written register to include the presence of symbols, specialist vocabulary and conciseness, diagrams, tables, labels, and even neatness, as contributing to an impression of a written text being 'more mathematical'.

Morgan (1998) admitted that it is difficult to define a mathematics register precisely, and indeed there exist more than one mathematics register. For example, the language used in a primary classroom is different to that used in an A-level class; the text found in an infants' workbook is far removed from an academic research paper. And yet, all four examples could classify as making use of a mathematics register. While being fully aware of these differences, in this paper I discuss the idea of register in a general sense.

One point I would like to highlight before embarking on this discussion is that both the English and Maltese registers may be considered to be 'western' ones, in the sense that the words included in the register denote western mathematical ideas. I state this explicitly since it should not be taken for granted. For example, Barton (2008) mentions the fact that in Māori, as it was spoken before European contact, numbers were verbal in their grammatical role. Barton (2008) explains that although we are not familiar with numbers as verbs, since we do not think of numbers as actions, he draws attention to the fact that in English, there are in fact verbal forms for the numbers 1 to 4: "I can single someone out, I can double my bet, I can triple my earnings … a new school may even quadruple its enrolment over a few years" (ibid, p.4).

In fact, Barton et al. (1998) explain that when a Māori register was developed to accommodate Western mathematics, the language experienced changes in its grammatical features, which were then imported into everyday discourses. Barton et al. (ibid) considered this to be one of a number of corruptions to the language that resulted from the exercise stated in the mid 1980s of the "community-led impetus … to increase contact with the Māori language" (p.4). Differences in concepts or views of the world were also noted for the following peoples by various researchers: Aborigines (Australia) by Meaney (2005), Navajo (U.S.) by Mellin-Olsen (1987) and the Yoruba (Nigeria) by Morris (1974, cited in Orton, 1992). However, with regard to the Maltese situation, I can safely assume that we share 'the same' western concepts implied in the mathematics words expressed in English, and thus the creation of a new register would not bring with it such issues.

Developing a Maltese standard mathematics register – similarities to English register

When considering each of the elements of a register as defined by Halliday and further developed by Morgan, I note that a 'parallel' may be described between English and Maltese registers, in the sense of how Maltese grammatical features may serve a similar role to those constituting an English standard register, albeit that at times it may be necessary to add to the vocabulary presently available. I will consider the three elements in turn.

Interpersonal element

The voice of the verb in an English register contributes to the interpersonal aspect of the register by establishing a 'relationship' between the speaker and the listener (or writer / reader). For example, by using the expression "Let us consider…" the speaker/writer appears to be inviting the other person to inhabit a common world (Morgan, 1998, drawing on Rotman, 1988). On the other hand, the extensive use of imperatives in mathematics, especially in written texts, creates a different 'relationship' between the two participants where, say, the student is being ordered by some authority to perform some action (Morgan, 1998). Two examples of such instances are '*Draw a line*' and '*Construct a triangle ABC ...*'.

Similar expressions may be uttered /written in Maltese, for example: "**Ejja nikkonsidraw** …" (let us consider); "**Pinġi linja …"** (draw a line) and **"ħażżeż** (or **ikkonstraktja) trijangolu**" (construct a triangle). Both these formats may be found in the Maltese section of the textbook written by Caruana and Muscat (2007). Hence, since the active voice of the indicative and the imperative mood are commonly used in Maltese, I conjecture that in this respect, a parallel to the English mathematics register may be noted.

What may be necessary for the Maltese register is the occasional creation or standardisation of vocabulary. In the example above, I offered two choices for the English verb *to construct*. The first - **ħażżeż** - is a Maltese word of Semitic origin whose meaning is given in a Maltese dictionary as '*to draw/mark/scribble lines*' (Aquilina, 1987, p.526). The second option **ikkonstraktja** is a loan-shift from the English word *to construct*, where the meaning is imported but morphemic substitution is complete. It may be the case that both words are accepted as appropriate, thus offering a speaker/writer an element of choice, or it may be decided that one or the other would be encouraged; such encouragement might be achieved by using the chosen words in written texts to be used by schools.

Textual aspect of the register

The vocabulary needed for this aspect of a register includes vocabulary necessary to convey the intention of the text, such as persuasion, explanation, definition, justification and so on. For example, as explained by Morgan (1998) deductive reasoning is expressed through words like *hence*, *therefore*, *by Theorem*. A predominance of temporal themes (e.g. *first, next, then*) would construct a report or if accompanied by imperative, would construct an algorithm; conjunctions (*because, so*), prepositions (*by, because of*), together with nouns (*the reason is*) and verbs (*X causes Y*) all contribute to the development of mathematical reasoning (Morgan, ibid, drawing on Martin, 1989).

Maltese words that parallel those mentioned above exist, and Maltese can be put to similar uses of argument, explanation and so on, and hence similar lines of thought are possible in a Maltese register. Two examples found in Caruana and Muscat (2007) are the following:

Example 1: Setting up a sense of direction for the reader through temporal words and the future tense:

Fit-taqsimiet li ġejjin se naraw … 'Il quddiem f'kapitli oħra ... (Caruana and Muscat, 2007, p.64, Maltese version of text)	**In the forthcoming sections we will see ... later on, in other chapters ..**

Example 2: Presenting an explanation through the words '*because*' and '*similarly*':

Issa, fl-ewwel eżempju, l-għerq kwadru ta' 4 sibna li huwa 2, għax meta nimmultiplikaw it-2 bih innifsu (2x2) jagħtina 4. Bl-istess mod fit-tieni eżempju … (Caruana and Muscat, 2007, p.64, Maltese version of text)	**Now, in the first example, we found the square root of 4 to be 2, because when we multiply 2 by itself (2x2), this gives us 4. Similarly [in the same way], in the second example …**

Ideational aspect

The field of a register is expressed through the ideational function of grammar. Simply put, this aspect of the register expresses what the text 'is about'. This is achieved through what Halliday (1976) called 'transitivity', a term which he uses in a wide sense to mean "the representation in language of processes, participants therein, and the circumstantial features associated with them" (p.159). By the terms participants or participating entities, Halliday was referring to humans or objects represented by nouns (or

pronouns). By processes, Halliday meant anything to which a specification of time can be attached, and therefore he referred to all verbs, these being an event, state or relation. For example, in the statement "*He pelted the dog with stones*", *he*, [the] *dog*, and *stones'* are three participants, while the physical event is represented by the verb *pelt (*Halliday, ibid, p. 159). On the other hand, the sentence "*The sun is shining*" (p.161) involves only one participant, while "*It's raining*" involves no participant at all (p.159). Some statements utilise a verb to express a state, rather than an action, as in the case of "*Jupiter is the largest planet of all*" (p.159).

Halliday considers this aspect of the register to be the experiential function. In mathematics, nouns (or pronouns) and verbs come together to express experience in various ways, for example:

- "I draw a circle with radius 10cm".
- "We can find the perimeter of a rectangle by adding twice its length to twice its length"
- "A square has four right angles"
- "Four multiplied by three equals twelve"

For a Maltese register, similar nouns, or pronouns and verbs are necessary to express similar ideas. I will consider each in turn.

<u>*Nouns*</u>

Many mathematical nouns already exist in Maltese such as **kwadru** [**square**], **multiplikazzjoni** [**multiplication**] and **erja** [**area**] among others. Looking through Aquilina's Maltese-English (1990) dictionary, one can find some mathematical nouns which although included in this respected dictionary, they are not commonly used in classrooms. Such words include **kwadrilitteru** [**quadrilateral**] and **assi** [**axis**]; my personal experience suggests that the English versions are the preferred ones in local classrooms. Some nouns have been partially assimilated by using the English word but with a Maltese pronunciation; such examples are *graph*, (prounounced "gruff") and *equation* (pronounced ek-way-shin). Caruana and Muscat (2007) utilise such words in their textbook, fully assimilating them as **graff** and **ekwejxin**. This is done in line with the recommendation found in Azzopardi (2003), who stated that words that are derived from foreign languages but integrated into Maltese, should – to the extent possible - be spelt in a way so as to indicate the original pronunciation.

In some cases, decisions will need to be taken as to whether to use a dictionary translation as in the case of **multiplikazzjoni,** or the more commonly used English word *multiplication*, partially assimilated into Maltese

through the pronunciation **maltiplikejxin**. Possibly, both versions might be considered acceptable.

Morgan (1998) makes an interesting observation about how nouns formed through nominalisation create an impersonal effect, thus obscuring a human relationship. Since nominalisation is the representation of a process as a noun, this creates what Morgan referred to as a 'process-object' whereby it is these process-objects that are the active participants in the mathematics rather than human mathematicians (Morgan, ibid). The following illustration is taken from Morgan (2001, p.170); the first statement includes the active verb *to measure,* while the second includes the nominalisation *measurement:*

> Statement 1: If you measure the lengths of the diagonals of a rectangle, you will find that they are the same.
> Statement 2: The measurements of the lengths of the diagonals of a rectangle are always equal.

Nominalisations are also used in Maltese and indeed, **in-nom verbali,** as it is known in Maltese, is a key feature of Maltese grammar. Grech (2004) gives twelve forms of creating such nouns, depending on the type of verb from which the noun is derived. Hence, one is likely to find nominalisations to express ideas in a similar way to that expressed in English, and if not, Maltese grammar will lend itself easily to the creation of such words. An example found in the Caruana and Muscat textbook is: **it-tkabbir tal-forom** (**the enlargement of shapes**) where the noun **tkabbir** is derived from the verb **kabbar**, to enlarge. While this noun is a commonly used one, the authors also coined their own versions of nominalisations for mathematical ideas when needed, as in the case of **ix-xaqliba.** This word translates literally into English as the slope or incline, but in the mathematical context, the authors use it to mean the *gradient*, or *slope* of a graph; the noun is derived from the verb **xaqleb**, *to move /incline in a direction* (Aquilina, 1990).

A number of nouns in Maltese may still need to be determined. Generally speaking, the higher the level of mathematics, and hence the more 'technical' and specific to the subject the terminology becomes, the more likely it is that a Maltese version does not presently exist and will need to be coined. For the purpose of their textbook, Caruana and Muscat (2007) created all the terms necessary, either through assimilating English ones or drawing on comparable Maltese vocabulary, however, ideally any creation of new terminology will need to be done through collective discussion if it is to become fully functional.

As explained by Azzopardi (2003), the process of assimilation of new expressions into a language consists of four phases. Assuming a standard form of a word as a first phase, Azzopardi describes how a 'deviant' form

enters the language (second phase), this new form becomes accepted and commonly used (third phase) and finally the new form takes the place of the original one. This process is a slow one and may take several years. Applying this idea to a Maltese mathematics register, there may be cases where there is no 'original' version in Maltese and therefore the new entries into the language start at the second phase. In the case of a new Maltese mathematics register, the four-phase process may need to be sped up if the register is to be used in the near future. As stated by Pimm (1991), requirements for expressing mathematical meanings can place strains on a language and it is this strain that prompts the creative aspect of language. One important tool in the creation of expressions is the application of metaphor to provide old names for new things (Pimm, ibid). One such example used in Caruana and Muscat (2007) is the use of the Maltese word **ċaqliqa** (*movement*) for the mathematical notion of spatial translation. Another example is the use of the word **sieq** (*leg*) to refer to the point of a compass used for circle construction.

Pronouns

Pronouns may also be readily used in Maltese texts, although in line with Maltese grammar these are often implied rather than stated explicitly. For example, one might state "**Pinġejt ċirku**" [**I drew a circle**] omitting the pronoun **Jiena** [**I**]. The first person is indicated through the conjugation of the verb **pinġa** [**to draw**].

An example taken from Caruana and Muscat (2007) is the following (I have underlined the verb to draw attention to it):

> "We can change ratios into fractions quite easily" (p.36, English version)
> "**Ir-rejxjows insarrfuhom fi frekxins kif ġej**:" [**We] change ratios into fractions as follows**:"] (p.36, Maltese version)

Verbs

While many Maltese verbs are already available, some new verbs may need to be determined, or decisions about full assimilation from English will need to be taken. As in the case of some nouns, decisions may need to be taken as to whether two versions of a verb will be acceptable, especially in written texts. One example is the verb *to divide/share.* The traditional Maltese word is **qasam**, while common practice is classrooms is to use the verb **ixxerja** (pronounced *ish-sher-ya*, derived from the English to *share*).

Maltese verbs are conjugated. Conjugations of such assimilations can be achieved through calquing that is, integrating a word through morphemic substitution. While Halliday (1978) states that this is rare in modern English,

he also states that it is a feature of many other languages. Indeed, in his study of Maltese loan verbs, Mifsud (1995) states that this method is the only really productive channel for the integration of verbs into modern Maltese. Cachia (1994) explains that English verbs may be integrated through a conjugation that is not totally Semitic and I note that this is the case for a number of verbs used in mathematics such *to label*, *to plot* and *to construct (***illejbilja, ipplottja, ikkonstraktja**. For example, the verb *to plot* is conjugated in Maltese in the present tense as follows, preceded by the respective pronouns: **jiena nipplottja, inti tipplottja, huwa jipplottja, hija tipplottja, aħna nipplottjaw, intom tipplottjaw, huma jipplottjaw**.

Further reflections on Maltese register – potential dissimilarities to English

While as argued above, a Maltese mathematics register may easily be created if the language is to be put to this specific purpose, I would now like to draw attention to two notable *differences* when comparing the English and Maltese registers. The first relates to the utilisation of the passive voice while the second relates to an epistemological issue, namely, how mathematics is expressed as 'coming into being'.

Formality and the restricted use of the passive voice in Maltese

As far back as 1968, Kane noted that written mathematical English varies from ordinary written English. Kane (1968) stated that letter, word and syntactical redundancies are different and the grammar and syntax of mathematical English are less flexible than 'everyday' English. Adding to this, and as already outlined earlier in this paper, Morgan (1998) highlighted that varying grammatical roles of words as also contributing to the formality or otherwise of a mathematical text. Other features of written texts are non-redundancy, use of symbolisation, timelessness and context-independence (Morgan, 2001). While Morgan (ibid) herself questions the privileging of these features by drawing attention to these being part of a social convention, still we can consider that there does in fact exist an English mathematics register that 'sounds' to the listener or reader to be more 'formal' or 'more mathematical' and indeed, Morgan (2007) poses the challenge of how teachers can coordinate the everyday and specialised language in order to facilitate learning.

Yet another important feature that renders mathematical English more formal or mathematical is the use of the passive voice. For example, "*A line 10cm long is drawn*" sounds more mathematical than "*I draw a line 10cm long*". However, in Maltese the passive voice is used for very particular purposes, and it would be uncharacteristic to use the passive extensively in a mathematics register. In fact, when considering the textbook by Caruana and Muscat (2007), I note that the authors 'got around this' by using the active voice in the

Maltese version, even when the English version of the same section uses the passive. The following are two examples (here I reproduce the respective English and Maltese versions of the 'same' text, translations mine):

> Example 1 (p.55)
>
> "The symbol √ is used to denote the 'square root'"
> "**Bis-simbolu √ nirreferu għall-għerq kwadru ta' numru**"
> ["**By the symbol √ we refer to the square root of a number**"]
>
> Example 2 (p.73)
>
> "The equation of a straight line can be written as follows: $y = mx + c$, m is the gradient. The gradient can be defined as the steepness of the line. This can be found by dividing the difference…."
> **L-ekwejxin ta' linja dritta hija: $y = mx + c$, m hija x-xaqliba (il-grejdjint). Fi kliem ieħor, kemm hija mxaqilba l-linja. Ix-xaqliba nsibuha billi niddividu d-differenza** …."
> ["**The equation of a straight line is: $y = mx + c$, m is the slope (the gradient). In other words, how steep the line is. We find the slope/gradient by dividing the difference** …."]

Admittedly, in textbooks for children and secondary school students, it may not be so common to use the passive voice as in the past. For example, in random checks of two textbooks published almost twenty years apart, I noted that in the older book (Harwood Clarke, 1984) it was easier to find examples of the use of the passive voice than in the more recent textbook by Berry, Bland, Goldie, Heard, Turner and Wilshaw (2002). This may indicate that authors are using a less formal style as mathematics textbooks utilise a less traditional pedagogic approach to the subject.

Still, the potential use of the passive voice remains a feature of formality for English. If we were to try to follow the English style of expression, then we would need to encourage the passive voice in the Maltese register. However, this would seem to be an artificial use of Maltese, possibly creating problems for the register to be fully accepted and therefore used. It would appear to be more natural to the language to accept that different languages encode formality differently. Hence, rather than mimicking the English register artificially, it may be more appropriate to acknowledge that establishing 'formality' or 'how mathematical' a text appears, or sounds, may need to be judged with slightly different criteria, due to the limited use of the passive voice in Maltese in general.

Epistemological issues arising from possible restrictions in availability of vocabulary

Up to now in this paper, I have used the expressions 'mathematical register' and 'formality' as though it were possible to draw a line between such language and 'everyday' or informal language. However, it should be pointed out that in reality, the divide is not so clear cut. Chapman (2003) offers a way of considering the idea of language being 'more' mathematical, by considering two overlapping continua. According to Chapman (ibid), the first continuum to be considered is that relating to modality. Drawing on Hodge and Kress' (1988) notion of modality or degree of certainty, Chapman (2003) suggested that the higher the modality, the more mathematical a statement sounds. For example, she considered the following utterance to have high modality: "What angle does the minute hand of the clock pass through?" (ibid, p.122). In this question there is implied that the angle exists, the hand passes through it, it always happens, it is a fact. Similarly, "So eighteen divided by three is six" (ibid, p.143) implies certainty. A statement of low modality is "Does it make sense to say three is a multiple of one?" (p.160) since it indicates uncertainty.

The second and overlapping continuum is drawn from Walkerdine's (1988) seminal work on shifts from metaphor to metonymy. Walkerdine had shown how mathematical meanings are developed through a series of shifts from focusing on particular everyday objects to more general relationships. Chapman (2003) suggested that the less metaphoric and the more metonymic elements present in a statement, the more mathematical that statement is. For example, the question "Thirty cents is what fraction of a dollar?" (p.113) contains the metaphoric element of money which provides a context for the fractional relation, while "Find the value of two to the power of five" (p.113) operates in a purely metonymic way. Chapman (ibid) overlapped the two continua as shown in Figure 1.

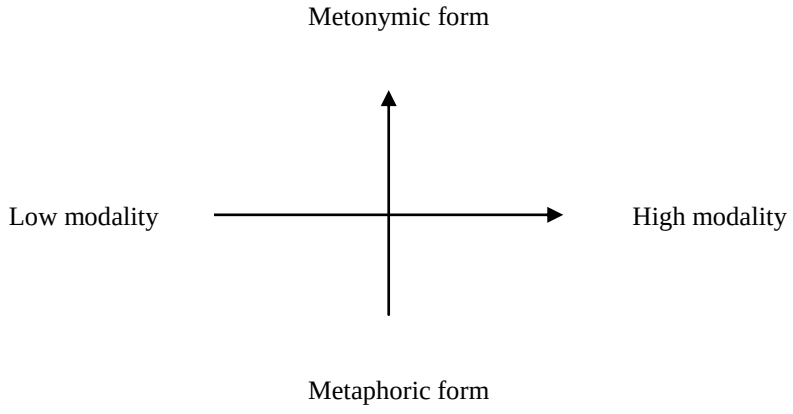

Figure 1. Language shifts in mathematics (Chapman, 2003, p.128).
The diagram is reproduced with the kind permission of the author and the publisher, The Edwin Mellin Press.

According to Chapman (ibid), considering mathematical language involves considering shifts along these related continua. Steinbring (2005) expresses a similar idea by stating that while for the benefit of young children, the context used is often a real life context or a picture, this empirical character of knowledge can be increasingly replaced by diagrams or symbolic notation in order that mathematical relational connections are set up. In a sense, we can consider this as mathematics itself being 'its own context'.

We can use the metaphor/metonymy continuum to reflect on epistemological aspects of the subject. In a 'real life' (metaphoric) context one might use language that implies an human action, thus implying that mathematics comes into existence through human involvement, while at the other end of the continuum, human agency would be obscured, portraying mathematics as an autonomous system. For example, consider a typical school 'problem' wherein an employer shares out €15 tips between three employees. The student working out the solution to this situation is taking the place of the employer, who brings into existence the mathematics €15 ÷ 3 = €5. The language used in this sitaution may be '*fifteen euro divided amongst three employees results in five euro each*' or '*If I (the employer) divide the money into three, I get five euro*' or '*I give each employee five euro*' or similar. On the other hand, when presented with the symbolic notation 15 ÷ 3 = 5, apparently devoid of any context except mathematics itself, the language attached to such notation may be '*fifteen divided by three equals five*', apparently expressing a universal truth.

If we consider division in Maltese, three words immediately come to mind: the Semitic words **qasam** (split, cut, divide (property)) or **qassam** (share out) and the Romance derived word **iddivida** (to divide) (Aquilina, 1990, 1987, respectively). In the 'story' situation of sharing tips, one could use any of these words (verbs underlined):

> "**<u>Naqsam</u> il-flus bejn tlieta**" [**<u>I split</u> the money between three**]
> "**<u>Nqassam</u> il-flus bejniethom**" [**<u>I share out</u> the money between them**]
>
> The word iddividi can be used instead of either:
> "**<u>Niddividi</u> l-flus bejn tlieta**"
> "**<u>Niddividi</u> l-flus bejniethom**"

On the other hand, I need to think carefully about how to express the metonymic expression "fifteen divided by three equals five". My difficulty is that in this statement, the words 'divided' and 'equals' are verbs that express a state. Halliday (1976) explains that in English, verbs can be used to express states and he consider these too as 'processes', since a specification of time may be attached to them. On the other hand, in Maltese, I only have available

to me **ndaqs** (**equal**) as an adjective; furthermore, the difficulty with **maqsum** (**divided**) is that the word carries with it the metaphor of cutting up or splitting.

I can make a similar argument for subtraction, a metaphoric representation of this could be a real life situation where a child has a number of stickers, and gives some away. The language used could be:

> "John has twenty-five stickers. He gives his sister five stickers. How many has he left?"

In order to work out the operation 25 – 5 = 20, one might use the language (English): "*twenty-five take away five leaves twenty*", which expresses a human action (*take away*) with its result (*leaves*). On the other hand, the metonymic interpretation of the symbols 25 – 5 = 20 prompts the language "twenty-five subtract five equals twenty". In the latter case, there is no context apart from the mathematics itself and hence the language utilised is different.

In Maltese, Aquilina's (1999) dictionary gives the word **naqqas** to express ideas relating to 'taking away', reducing and in general, subtraction. Hence, a similar argument may be made for subtraction as for division with regard to availability of vocabulary to move us along the metaphor / metonymy continuum that increases formality in the sense of representing mathematics as an autonomous system.

While these are just two examples, consideration of other mathematical topics may bring to light similar situations with regard to this point. Hence, this is another aspect of the Maltese mathematics register that would need careful consideration.

Conclusion

In this paper, I have considered a mathematics register in term of Halliday's definition that considers ideational, textual and interpersonal aspects of a register. I highlighted the similarities and differences in registers between the English and potential Maltese registers based on similarities and differences in grammatical characteristics of the two languages. I note that the Maltese language can easily adapt to the function of a standard mathematics register, since much vocabulary already exists and is in usage, and through collective discussion, further vocabulary may easily be created. This applies mainly to 'mathematical entities' (nouns) or processes (verbs). Textual and interpersonal elements may generally be created in a similar manner to English.

On the other hand, I have noted two instances where development of the Maltese register may vary from English. The first is due to the use of the passive voice in English to render the text 'more mathematical'; the passive voice is less commonly used in Maltese, and hence a potential register in Maltese may lack this element of language as part of its definition of what constitutes more formal language.

The second point relates to how language is used to express mathematics along the continuum

metaphor → metonymy

It may be the case that consideration needs to be given to this aspect of register development which also touches on an epistemological issue of how mathematics comes into being. As mathematical ideas advance over the schooling years, the subject is likely to make use of metonymy more as it leaves behind the metaphorical context so extensively used in the earlier years. Careful consideration needs to be given to whether suitable vocabulary exists to express these ideas, since some verbs that may not be readily available in Maltese may be needed for rendering mathematics is its own context.

However, one must also consider that languages function in different ways, and it may not be possible, or even desirable, to try to mimic English simply because its register is a standard and widely accepted one today. The development of a register will inevitably bring with it grammatical considerations, but through reflection and discussion, language issues can be resolved.

I end with a quotation by Halliday (1978) who stated:

> "No language is inherently 'more mathematical' than another. All languages have the potential of developing mathematical registers; but since languages differ in their meanings, and in their structure and vocabulary, they may also differ in their paths towards mathematics, and in the ways that mathematical concepts can most effectively be taught" (p.204).

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