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A functional linguistics analysis of a mathematics register expressed through two languages

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In Malta, Maltese and English are used for learning mathematics. In this paper, I present a starting point for investigating features of a spoken mixed Maltese/English mathematics register. Using data from an elementary classroom (two lessons), I draw on functional linguistics to describe how Maltese and English were combined to constitute the register in terms of interpersonal, textual and ideational meanings as defined by Halliday. I conclude that the translanguaging formed an integrated system due to the intricate role each language played in realizing the three elements of the mathematics register. Furthermore, diagrams and symbols were 'read' in English, illustrating the role of English in linking various semiotic systems. Finally, while nouns/noun phrases were embedded easily into Maltese sentence structure, I noted that some words that serve as adjectives or verbs in English were rendered nouns in Maltese. Further investigation will now require a larger scale study.

Keywords: Mathematics register, elementary mathematics education, functional grammar.

Introduction

As Lin (2017, p. 10) points out, much has already been written internationally “to uncover the good sense of rationality” of existing practices of translanguaging in various contexts. Within the area of mathematics education, two examples of research-based discussions are Halai (2009) and Norén and Andersson (2016), who focus on situations in Pakistan and Sweden respectively. However, Lin (2017) recommends that research might now take new directions. One suggestion she offers is to view the whole lesson as a curriculum genre and investigate therein the role of participants' home language (referred to as L1). In this paper, I take up this suggestion, however focusing on both L1 *and* the participants' second language (L2) as they are used in an elementary classroom in Malta. The languages in question are Maltese (L1) and English (L2). English plays a key role in Maltese education, as a result of 164 years of British colonization (1800-1964). Most notably, it continues to be the written language (textbooks, assessments, etc.) for various school subjects, including mathematics and science. This situation prompts extensive mixing of Maltese and English, especially in terms of 'technical' vocabulary, which tends to be stated in English. Of course, I cannot suppose that all Maltese teachers and students use language in the same way, but Camilleri Grima (2013) does note similarities in patterns of language use across Grade-levels and subjects. In her early seminal work on code-switching in Malta (Camilleri, 1995), she also comments specifically on similarities in the use of English during mathematics lessons.

Assuming the pedagogic benefit of using two languages, I wished to focus my attention on the mathematics register, as brought into existence through the practice of the bilingual participants. Halliday (1978, p. 195) defines a register as “a set of meanings that is appropriate to a particular function of language, together with the words and structures which express these meanings”. My research questions were: *How do Maltese and English contribute to the school mathematics register? What are some features of a spoken mixed Maltese/English mathematics register?* Here, I adopt the expression 'Mixed Maltese English' that was first used by Borg (1980). There were

two reasons for these questions. The first relates to the local debate regarding the medium of instruction for mathematics. While some practitioners and policy-makers accept the benefits of using two languages, others argue in favour of an English-only approach, generally because of the use of English for written texts and/or because they hold a deficit view of language mixing. I wished to contribute to this debate in a theoretical manner. Second, in my role as a mathematics educator involved in teacher training, I promote the explicit teaching of mathematical language. Such attention to language involves focusing on shifts from informal to more formal language. I believe that it would be beneficial for me to be aware of (possibly prevalent) ‘ways of saying’ pertaining to the informal, spoken elements of our mathematics classrooms. A full study will require observation of a large number of classrooms, and hence, the small case study presented here serves as but a starting point to indicate how a larger study might unfold in terms of research method and analysis. All this may be of relevance to other post-colonial countries with comparable educational contexts.

The mathematics register(s)

Halliday and Hasan (1985) hold a functional view of language that is based on the premise that people put language to use according to the situation in which they find themselves. A context of situation includes: the *field* of discourse (what the language is ‘about’), the *tenor* of discourse (the set of relationships between the participants) and the *mode* of discourse (the role or purpose of the language). These elements determine a ‘text’ within which they are realised through respective functional meanings: *ideational* meanings, which express categories of experience; *interpersonal* meanings, which express social and personal relationships; and *textual* meanings that help to structure the flow. Meanings are constituted through grammatical choices, and it is the particular configuration of meanings that creates a register. Hence, for Halliday and Hasan, a register is a semantic concept. I will elaborate on the three elements of the register in the course of the paper, presenting them together with the data. Schleppegrell (2004) applies the functional linguistics perspective to the language of schooling, noting that each discipline can be characterized in terms of linguistic choices that are typical and pervasive. I chose to use this perspective since I anticipated that it would help me describe the specific roles played by Maltese and English as used by the participants; furthermore, I recognised the particular relevance of the ‘ideational’ element to a discussion on mathematical terminology.

The word ‘register’ has been used in a different sense by Duval (2006), who applies the term to semiotic systems - such as graphs, geometric figures and symbolization - that are governed by rules and that allow transformations. Duval defines two types of transformations: *treatments*, which are transformations within the same system, and *conversions*, which are transformations from one system to another (e.g. algebraic notation to graphical representation). The word register in this sense has also been utilized by Prediger and Wessel (2011) in their work on ‘relating registers’. They suggest that a verbal register may be related to other registers of increasing abstractedness, namely, concrete representational, graphical, symbolic-numerical and symbolic-algebraic registers. With reference to the verbal register, Prediger and Wessel point out that this can be expressed through a student’s L1 or L2. In this paper, I will retain the term *register* in the sense used by Halliday due to its constituting elements, but will make reference to links between the spoken register and other semiotic systems.

Research context and method

The data for this study consists of two lessons of approximately 40 minutes each, carried out in a class of sixteen 8 to 9-year olds. The choice of class was opportunistic since I was in the school carrying out another research project. I asked the teacher to allow me to record two of her lessons, since hers was a class wherein a ‘typical’ mix of language was used, as a result of all participants

being Maltese speakers. She suggested two up-coming lessons: “Greater/less than” and “Carroll diagrams”. The lessons included long stretches of whole-class discussion, followed by individual written worksheet or textbook exercise; this lesson development is also rather typical of Maltese classrooms. The lessons were recorded using two camcorders and later transcribed in order to enable a detailed analysis in terms of the register components, and to look out for any notable features. The data consists of the whole-class interaction. Some verbatim excerpts are presented in this paper as illustrations of how Maltese and English were used to contribute to the elements of the register. Where appropriate, both Maltese and the English translation are presented; however, for the sake of conciseness, some excerpts are presented only in their translated version.

Analysis of data

Most of the spoken language observed was Maltese, with English words embedded within it, as illustrated in the excerpt below (T for teacher, P for pupils and Glen for one of the pupils). At this point of the lesson, a projected image showed some pirates and a 4-celled Carroll diagram marked with the English classifications “*has 1 leg / has 2 legs*” and “*has a sword/does not have a sword*”; the use of spoken English in relation to written text is evident in the illustration. In the transcript, Maltese speech is shown in a **bold** font (left-hand column), and a translation is presented alongside it (right-hand column).

T:	Mela, hawnhekk (touches Carroll diagram) qed jistaqsini “has one leg” jew “has two legs”. Ahna, kemm għandna saqajn?	So, here (touches Carroll diagram) he’s asking us “has one leg” or “has two legs”. How many legs do WE have?
P:	Tnejn!	Two!
T:	Tnejn. Imma hemm pirates minnhom, minflok sieq, x’jkollhom?	Two. But there are pirates who, instead of a leg, what do they have?
P:	Injama!	A stick!
T:	Injama, stick. Bicca injama. Allura, mela dak jigi ‘one leg’. Issa, ma’ din in-naha (touches right side of diagram), għandi ‘has a sword’, ‘does NOT have a sword’. Kollha għandhom xabla?	A stick, stick. A piece of stick. So that is ‘one leg’. Now, on this side (touches right side of diagram), I’ve got ‘has a sword’, ‘does NOT have a sword’. Do they all have a sword?
P:	Le. (...)	No. (...)
Glen:	Miss, hemm wiehed zero leg [sic] għandu!	Miss, there’s one [who has] zero leg [sic]!
T:	Agħti ċans! Jista’ jkollu zero legs?!	Wait a bit! Can he have zero legs?!

Now I consider the elements of the register in turn: interpersonal (relationships), textual (purpose and structure) and ideational (expressing ideas) elements.

The interpersonal element: Relationships

Speakers and writers demonstrate their understanding of the role relationships inherent in a context through grammatical choices related to the interpersonal component of the register. One grammatical feature is ‘mood’, which can be, for example, declarative, interrogative or imperative (Schleppergrell, 2004). In these lessons, the declarative mood was often utilized, for example, when the teacher stated (in Maltese) “**Instead of writing a sentence ... you know that in maths we write only number and signs**” or when a pupil said “**Miss, I noticed that the ‘G’ for Gracie [the alligator] is the big one**”. *Written* declarations were in English, as in the slide text: “*You can remember when to use < or > by thinking of a crocodile.*” With respect to the interrogative, Erikson (1996) notes that questioning is very commonly used in spoken whole-class interaction in the form of ‘know information questions’ (p.42). These are a type of request for information that the teacher generally already knows. The use of questioning in the class appeared to create a

relationship of the adult as the knowledgeable and guiding person; the students were placed in a role of answering questions in order to progressively achieve the lesson objectives which had been displayed at the start of each lesson. The imperative mood was evident in the spoken interaction in terms of instructional/procedural strategies stated in Maltese: “**Daniela, come out**”. In relation to mathematics, the imperative was noticeable mainly in *written* English texts. Commands imply an authority which the students are expected to follow. For example, an online game on Carroll diagrams gave the instruction “*Click and drag the objects to the correct square*”. Indeed, Morgan (1998) notes that the imperative (‘Draw a diagram’) is a grammatical structure very typical of a written mathematics text.

Morgan (1998) explains that the interpersonal function concerns not only the relationship between the participants, but also the ways in which they are constructed as individuals. These relationships were expressed in Maltese. Following Morgan, I noted that the frequent use by the teacher of the third person plural (“we”) suggested that the teacher was not speaking ‘alone’ but as part of a community. At times, this community appeared to be the classroom itself: “**Now, look at it [the diagram] before we do [click] ‘submit’**”. This sense of community was sometimes echoed by the pupils themselves, as when Daniela asked with respect to how to proceed in a set task: “**Do we keep matching them?**” Morgan also mentions the use of the pronoun “we” as used in a general sense, whereby an extraneous authoritative community appears to be called into existence, as in the written example “We saw in section 2.2 that ...” (p.85). I did not observe this use of the third person, but an extraneous authority was still called upon through the third person singular on a number of occasions. For example, with reference to some questions written on a worksheet beneath a diagram, the teacher said “**Beneath, he’s given us four questions**”. It was interesting to note that the extraneous authority was rendered male.

I concluded that except for occasional English words, the interpersonal element of the *spoken* register was constituted by the use of Maltese. *Written* aspects were in English.

The textual element: Purpose and structure of language

The textual element of the register relates to the purpose and structure of language. The language was *spoken*, and set up in a way that the teacher did a lot of the talking as she strove to introduce new ideas and to confirm that her pupils were ‘following’ the lesson. Pupils tended to give short answers, contributing to the structure of the interaction. Various language elements contributed to the structuring of the intended line of thought. At the start of each lesson, the teacher referred to previous work through (Maltese) adverbials of time “**Yesterday we did...**” and “**Last week ...**”, thus creating a sense of continuity. Throughout the lessons, cohesive devices contributed to the textual element of the register, in particular the conjunctions **so/or/and/because**. Such ‘explicit conjunctions’ are common in school spoken interaction (Schleppergrell, 2004, p.65). For example, the word **mela [so]** was used extensively by the teacher at the beginning of sentences, marking a logical progression from one point to another. Another cohesive device is reference (Schleppergrell, 2004). The teacher often used the words **this, that, here, there** in order to take the children through a point. For example, linking a worksheet with a image projected on the whiteboard, she said: “**So [now], look here. Your worksheet is like this.**”

Schleppergrell (2004) also mentions other elements that enable a controlled flow of information. These include repetition, emphasis and the introduction of details and asides. The following two stretches of interaction are examples of detail and repetition respectively. The context is a story of two alligators as an introduction to the symbols > and <.

T:	<p>Gracie [female alligator], jekk ha tiekol in-naha tal-left, lil fejn ha tifthu halqha?</p>	<p>If Gracie [female alligator], eats from the left, in which direction will she open her mouth?</p>
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Rachel:	Lil hemm (<i>indicates left direction; other children do the same</i>).	That way (<i>indicates left direction; other children do the same</i>).
T:	Lejn in-naħa tal-left.	Towards the left.

Heidi:	(<i>Heidi is reading English text from a projection</i>).	(<i>Heidi is reading English text from a projection</i>).
T:	(<i>Repeating written text</i>) “They forgot to pick up the left-overs”. X’jigifieri?	(<i>Repeating written text</i>) “They forgot to pick up the left-overs”. What does this mean?
Heidi:	Insew jigbru l-fdal.	They forgot to pick up the left-overs.
T:	Il-fdal, prosit. U hallewhom hemm.	The left-overs, well done. And they left them there.

Textual elements of the register were expressed almost exclusively through Maltese. Hence, the role of Maltese was crucial to the structuring and logical progression of the spoken interaction.

The ideational element: Expressing mathematical ideas

The field of a context is realized through ideational meanings that express circumstances, participating entities and processes (Halliday, 1976); it consists of mainly nouns, verbs (processes) and what Schleppegrell (2010) calls ‘content words’ that contribute to text in particular subject areas. It was for this element of the spoken register that English played the greatest role. Circumstantial information (e.g. time, place) relevant to mathematics was expressed through both languages with English being used for words commonly forming part of local school discourse, e.g., “**In today’s lesson, we’re going to learn**” ‘Participants’ in mathematics include the objects being talked /written about which are expressed grammatically through nouns or noun phrases. In the observed lessons, English was used extensively for these. For example (NOTE: excerpts are not consecutive):

T:	Hiedi, kemm hemm tally marks ghax-xagħar ta’ January?	Heidi, how many tally marks are there for the month of January?
T:	Kylie, aqralna t-two numbers.	Kylie, read the two numbers for us.
T:	Aqbad is-sign it-tajjeb.	Pick the correct sign.
Dulcie:	Ikun hemm zeroes, u jkun hemm lines ohrajn hdejhom.	There’d be zeroes, and there’d be other lines next to them.
P:	Hundreds, tens u units.	Hundreds, tens and units.

In the observed lessons, English nouns were always preceded by the Maltese definite article (of which there are 9, depending of the first letter of the noun). The following are various examples used by the teachers and/or children: in-number, is-sign, il-five, il-maths, iz-zero, l-objects [the number, the sign, etc.]. This is line with a linguistic feature of the Maltese language, which makes extensive use of the definite article the.

Halliday (1976) lists three types of processes: mental, action and relation. Mental processes involve consciousness, as in I liked ... (p. 165); action processes indicate that something is being done, e.g. he is throwing stones (p. 161); relational processes may include attributes expressed as adjectives e.g., Mary looks happy or may involve two nouns e.g., John is the leader (p. 167). Processes are realized through verbs. Examples of the three types of processes expressed in Maltese are respectively:

T:	Taqblu magħha?	Do you agree with her?
Sandra:	Għax iċċekkja jnihom kollha.	Because we checked them all out.
T:	Mhux kollha ndaqs.	They’re not all equal.

Mental and action verbs tended to be expressed through Maltese, with the vast majority of action verbs being everyday words such as to do, draw, check, write, choose, look at and so on. In these

two lessons, the use of ‘mathematical’ verbs was not observed, except in one case where the point at hand was multiplying by two. However, the idea was expressed as “tagħmel times two” [you do times two] by a pupil, followed by the teacher’s feedback “Brava, tagħmel id-double” [“Well done, you do the double”]. Hence, the idea was expressed through the verb ‘to do’ followed by an expression that appeared to function as a noun. This feature of expression prompted me to recall a similar phenomenon I had noted in a different study (Farrugia, 2007) wherein different 8-year-old children uttered the phrases: “tagħmel adding / plus / il-plus / multiply / division / dividing” [You do adding / plus / the plus / multiply / division / dividing]. This might be a particular feature of the local mixed register; further investigation will shed more light on this.

For relational processes regarding mathematical ideas, integrated Maltese/English was also used. For example, “Carlton, how did you realise that they [the number of chicks] are not equal?” It was on only one occasion that the expression ‘greater than’ was used in Maltese: “Seven huwa ikbar mill-five” [Seven is bigger/greater than five]. What was striking was that at times, words that in English are attributes - and hence adjectives - were rendered nouns in the integrated language. For example: “We’ve got the odd and the even as we had in the game”. Admittedly, here the word numbers was implied, as it might be in English, however other examples of adjectives rendered nouns were: “She chose the long” and “Last week we did the greater than and the less than”.

Variation in grammatical category of words is a feature of the English mathematics register noted by Pimm (1987). To illustrate this point, Pimm mentions the number names (one, two, three, etc.) which tend to function as adjectives in everyday English, while in mathematics they often serve as nouns. For example, in the phrase “Seven birds”, the word seven is grammatically an adjective, describing the noun birds. On the other hand, in the statement “Seven is prime”, it is the word seven that functions as a noun, described by the adjective prime. Pimm notes variation from ‘ordinary’ to ‘mathematical’ English, while in my case the variation went across languages. I suggest two reasons for this grammatical shift. One reason is that the mathematical words were sometimes used as labels: ‘long’ and ‘short’ were the titles of cells in the Carroll diagram. Thus, as a child contemplated where to place an item, the teacher asked: “With the long, or with the short?” Similarly, ‘Greater/less than’ were sometimes taken as the names of the new symbols $>$ and $<$: “I’m going to show you a story so that you’ll remember whether to use the greater than or the less than”; at one time the teacher asked “What’s the name of that sign, Daniela?” to which Daniela answered: “Il-le... il-greater”. [The le.. the greater]. The teacher also referred to the $=$ symbol as “l-equal” [the equal]. Another reason for the rendering of an adjective into a noun may have been the influence of a feature of the Maltese language, whereby an adjective can be rendered a noun phrase by attaching the definite article to it. Hence, “Għażlet il-long” [She chose the long] (‘one’ implied) may not sound so alien to a Maltese speaker, as an English translation might sound to an English speaker.

Conclusion

In this paper I have assumed the positive benefits of using two languages in education and, as suggested by Lin (2017), investigated the role of L1 – and L2 – in the curriculum genre that is the typical whole-class teacher-directed lesson. In the observed elementary classroom in which the teacher and children were Maltese speakers, while the academic language of mathematics was English, the translanguaging formed a truly ‘integrated system’ (Canagarajah, 2011). This was due to the role each language played in realizing the three elements of the mathematics register as defined by Halliday (1978). In particular, Maltese served a clear role in the expression of interpersonal and textual meanings (although any written form of these elements was given in English). As part of the spoken register, the greatest role played by English was as part of the expression of ideational meanings.

Another observation regarded the use of English in relation to diagrams and symbols. When the Carroll diagrams were read, this was done in English. At times the utterance may have involved a single English word, as in the teacher's question "Issa property wahda għandna?" [Now do we have one property?] or in a rarer full sentence in English by a child, "It's an even number". Symbols were also read in English, resulting in number relations being expressed in English. For example, as children manipulated numbers into their correct places on a Carroll diagram with classifications <10 and >10 , the teacher asked them to double check where they had placed the number: "Read for us what the sentence would say", to which a child would answer, "Eighteen is greater than ten" or "Four is less than ten". Thus conversions (Duval, 2006) from the graphic and symbolic semiotic systems to spoken language were realized through English or a mixed code, highlighting the role English played in relating registers in the sense of Prediger and Wessel (2011). Given the fact that, locally, educators debate the language of instruction for mathematics, the study highlights the over-simplicity of any recommendation that mathematics in Malta should be taught exclusively through English and the potential challenge of any aspirations of using Maltese alone. Rather, the study illustrates how the languages come together in a very intricate way to express mathematical meaning.

Using a functional grammar perspective allowed me to note that nouns and noun phrases were embedded easily into Maltese sentence structure; however, nouns were sometimes used where in English one might use an adjective or verb. In an English mathematics register, adjectives tend to be used for properties, and verbs for processes. I wonder whether their replacement with a noun is a widespread practice, and if so, what one might conclude about the local mixed mathematics register. An important question to address when more data is available, is the possible implications of the grammatical features for the mathematics being learnt. Halliday (1978) states that since languages differ in their structure and vocabulary, they may also differ in their paths towards mathematics. Further analysis of the local register/s can help to identify this path.

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