Learning Fractions Through Two Languages in an Elementary Classroom: The Interrelation of Maltese and English with the Mathematics Register(s)

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Abstract In many mathematics classrooms in Malta, both English and Maltese are used for verbal interaction during the teaching/learning process. This is because Maltese is generally the students and teachers' home language, whereas English is the assumed academic language for mathematics. Believing that the academic language of a subject should be taught explicitly I carried out a teaching experience to support Maltese children to make periodic shifts from using oral informal Maltese, or a mix of Maltese and English, to expressing mathematical ideas through English. My theoretical assumption was that learning mathematics constitutes the appropriation of a discourse, and my focus was the development of the *spoken* mathematics register. The children were 8 to 9-year olds and the topic was Fractions. In my analysis of the classroom data I drew on Prediger, Clarkson and Bose who distinguish between everyday, school and technical mathematics registers and I explore how Maltese and English interrelated with these registers. I conclude that Maltese and English – used separately or together as an integrated system –fulfilled specific functions in terms in relation to the registers. Hence I offer a particular example of the pedagogic application of translanguaging to the Maltese context.

Keywords Mathematics registers · Translanguaging · Elementary mathematics education

Teaching and learning in Malta is generally conducted through Maltese and English. Maltese, a language with Semitic roots, is the national language and is spoken by more than 90% of the population (Camilleri Grima 2015a). Maltese is a co-official language together with English, the language of Malta's last colonisers. Malta was a British colony from 1800 until independence in 1964. English is recognized as an important global language and is crucial for the local tourism industry (Camilleri Grima, ibid). Camilleri Grima (2013) describes an interesting sociolinguistic

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situation in Malta wherein English and Maltese are used – either separately or together – for the same purposes. She offers illustrations related to civil administration, the media, church services and education, noting that ours is an unusual phenomenon of language contact for an ethnically homogenous group. Camilleri Grima (2013) comments that at times Maltese and English are so intertwined that further linguistic debate is needed on whether such a pattern constitutes a mixed code rather than code-switching. In schooling both languages are often used within the same lesson. In her study of various subject lessons, Camilleri (1995) noted that the main reason for the use of English was the English-language textbooks; furthermore, 'technical' terms were retained in English even if Maltese equivalents existed. Switching between the languages also allowed for a flexible and comfortable mode of communication. While research (Camilleri 1995; Gauci 2011; Sultana 2014) and anecdotal evidence suggest that the vast majority of teachers use both languages, the *degree* to which a teacher uses each language depends on their preferences, confidence and beliefs, and even on their head of school's preference (Camilleri 1995). Camilleri notes that drawing on two languages serves as a pedagogical tool; this supports García and Kleyn's (2016) observation that code switching is commonly practised in post-colonial education contexts, where the medium of instruction is often different from the language spoken by the students, and the students' language is used to aid comprehension. In this paper I explore the use of Maltese and English in a mathematics education context.

1 The Aims of the Study

The language of instruction for mathematics is a subject of debate in Malta. Some teachers and policy-makers argue in favour of using English only. They cite the reasons that textbooks and examinations are in English, that using English helps students develop the language and that, to date, there is no standardised Maltese academic language for school mathematics. (This despite the fact that the EU Commission produces a multitude of papers in technical Maltese for various areas, since Maltese is an official EU language). These arguments are often accompanied by a negative view of code-switching. Favouring English over local languages is a common occurrence in ex-colonies as in the cases of Singapore (Pakir 2004), Hong Kong (Tavares 2015), Tanzania (Kajoro 2016), Kenya (Graham 2010), India and South Africa (Hornberger and Vaish 2008). On the other hand, other Maltese educators argue that students' understanding of mathematics should take priority and therefore both Maltese and English should be used. Meyer (2016) explains that in many countries all over the world there are learners who are learning in a language which is not their first language. Meyer notes that in many of these settings, the first language is used and considered as a resource that can aid access to mathematics. Such settings have been described in South Africa (Setati and Adler 2001), the U.S. (Moschkovich 2007), Wales (Jones 2009), Malaysia (for science) (Then and Ting 2011) and Pakistan (Halai and Muzaffar 2016).

Morgan (2007) believes that students should be provided with access to higher status forms of language and various researchers offer advice on how to teach mathematical language explicitly (Gibbons 2015; Murray 2004; Sammons 2011; Setati et al. 2010). Bresser et al. (2009) argue that second-language learners have the dual task of learning the second language and content simultaneously. Indeed, some writers offer recommendations on how to focus on mathematical expression with second language learners (Coggins et al. 2007; Gibbons 2015; Melanese et al. 2011). As a teacher-educator/researcher with an interest in mathematics education, I wished to explore the inter-relationship between the use of Maltese and/or English and mathematical language. The study described in this paper had two aims. As a teacher-educator I wished to experience first-hand the process of engaging children in the use of mathematical language; I wished to encourage the students to use topic-related terminology, so as to support them in expressing concepts and ideas encompassed by the terminology (Lee 2006). As a researcher I wished to investigate the relationship between the medium of instruction and mathematical expression. Thus I posed the research question: "*How do Maltese and English interrelate with the mathematical register in an elementary classroom?*" I conducted a series of lessons wherein I supported Maltese-speaking children to move from the more informal Maltese and/or switching between Maltese and English, to expressing mathematical ideas through English, the academic language of the discipline. I viewed the use of both languages positively; following García and Li Wei (2014), I considered 'translanguaging' as a speaker's construction and use of original and complex language practices or, as defined by García and Kleyn (2016), the "deployment of a speaker's full linguistic repertoire" (2016: 14). García and Kleyn actually reject what they consider to be socially and politically defined boundaries of named languages (e.g. English/Maltese). In this article, I use the term 'translanguaging' but my stance is what García and Kleyn call a 'weak version' of translanguaging, i.e. supporting named language boundaries but calling for a softening of these boundaries.

2 Theoretical Framework and Research Design

I now outline my guiding theoretical framework, together with the research design adopted (context and approach).

2.1 Theoretical Framework

Learning mathematics can be viewed as a participation in a practice or 'apprenticeship' (Lave and Wenger 1991). As a student progresses in their learning, they move from what Lave and Wenger call "peripheral" to "full" participation (p. 37), which involves learning the tools of the activity. In a similar vein, Rogoff

(1995) writes about *guided participation* and *participatory appropriation*. The former refers to the mutual involvement of individuals, including communication, in a collective valued activity, whereas the latter refers to the process by which individuals transform their understanding of, and responsibility for, activities through their participation in the 'discourse' at hand. In the context of the mathematics classroom, learning may thus be taken to be the appropriation of, and participation in, the practice of the discourse of mathematics. This is turn implies engaging in mathematical thinking (Gutiérrez et al. 2010). My focus in this study was on *spoken* discourse, which was used in relation to other elements such as diagrams, written text and objects. For the purpose of analysing the classroom interaction, I drew on literature on registers. Halliday and Hasan (1985) define a register as a configuration of meanings appropriate to a particular function of language. This view assumes that language is strongly contextualised (Halliday and Matthiessen 2004). Hence, the language brought into play in contexts where mathematics is the topic at hand can be considered as a 'mathematics register'. The mathematics register includes not only vocabulary, but also modes of argument and styles of meaning (Halliday 1978). As explained by Morgan (1998), there is not just one mathematics register; for example, the language used in a primary classroom is different to that used in a University lecture; the text found in an infants' workbook is far removed from an academic paper. Yet, all these texts could classify as making use of a mathematics register. Focusing on written mathematics, Morgan (1998) lists characteristics of the register as the presence of symbols, diagrams, specialist vocabulary and conciseness; she also notes grammatical structures such as the use of the imperative and nominalization. These characteristics render a text more 'formal' or more 'mathematical' and a number of them would also be present in a *spoken* register.

Clarkson (2009) addresses the issue of formality by offering a three-tiered model that includes three types of language. Informal language tends to include idioms specific to the age group and locality and 'shorthand' language. In the more mathematical structured language, there is an increase in the use of full sentences and in written texts, informal jottings decrease and writing becomes more structured. Finally, academic mathematical language consists of specialised language that allows the expression of precise mathematical thinking. Clarkson points out that each of these three varieties of language can be conducted through a first or other language. Bose and Clarkson (2016) refine the afore-mentioned model to read 'everyday register', 'school register' and 'technical register', stressing the dynamic between the three and the possibility of each being conducted in different languages. Prediger et al. (2016) link the registers with other representations. The everyday register is context embedded and can include concrete representations, informal graphics but rarely symbolic representations. The school register – which is the language of textbooks and teachers' speech – has less personal references and uses numeric, graphical and symbolic representations, but generally not algebraic representations. Finally, the technical register is similar to the school register but has an even higher economy and unambiguousness; it includes structural and quantifiable

relations and is further de-contextualised. Prediger et al. (ibid, 212) stress that the boundaries between the registers "are not hard and rigid, but permeable and at times quite fluid". This is due to the overlap between the contexts in which they are used, in particular the school and technical registers.

Another consideration of registers that I found helpful for my analysis was that offered by Chapman (2003). Chapman highlights that informal and formal mathematics registers are not mutually exclusive, but that 'mathematical language' is *a matter of degree* depending on two aspects. The first (drawing on Walkerdine 1988) relates to a continuum between metaphoric and metonymic elements. By 'metaphor' is meant the use of a non-mathematical context and discourse as a starting point to lead the learner to mathematical discourse. For example, a teacher might encourage children to put sets of coloured blocks together to model addition. The blocks constitute a representation which is a metaphoric context for addition. On the other hand, the symbolisation "4 + 3 = 7" or the expression "four add three equals seven" are metonymic structures that represent a mathematical generalisation. Chapman (2003) explains that the less metaphoric, and the more metonymic, elements present in a statement the more 'mathematical' that statement is. So, for example, "Thirty cents is what fraction of a dollar?" which contains a metaphoric context of money is less mathematical than "Find the value of two to the power of five" (Chapman 2003, p. 113). The second (drawing on Hodge and Kress 1988) is a question of modality or certainty. Chapman suggests that the higher the modality, the more 'mathematical' a statement sounds. So, for example, "Eighteen divided by three is six" (ibid, p. 143) has higher modality than "Does it make sense to say three is a multiple of one?" (p. 160).

2.2 Research Design

I chose to carry out a case study, since this type of study allows the researcher to address a 'how?' question, asked about a contemporary event (Yin 2014). Furthermore, as stated by Stake (1995), a case study allows the complexity and detail of a situation to be brought to the fore. An education official, who was an acquaintance of mine, suggested a school where I was likely to be welcomed and I approached the Head of school. Hence, the choice of school was opportunistic (Wellington 2000). The Head of school then identified a teacher who was willing to accept me into her Grade 4 class (8–9 year-olds). I was open to teach any topic and the teacher, whom I call Ms. Louise, wished the topic Fractions – which had been covered earlier in the year -to be revised. Ms. Louise felt that whereas the children had mastered fractions of regions (for example, shading one eighth of a circle divided into eight equal parts), she felt that the children had not fully mastered fractions of quantities (for example, identifying one third of a set of 12 books). The five lessons I delivered were video-recorded with the consent of the children themselves

and their parents. If consent was withheld by either, then the child was placed out of camera view although they still participated fully in the lessons.

The home language of all 16 children was Maltese. They had daily lessons of both Maltese and English, as is normal practice in local schools. One-to-one discussions with six children prior to the lessons revealed a positive attitude towards English. Furthermore, I noted no resistance to English on the other students' part during the lessons I delivered, nor during three lessons delivered by Ms. Louise which I observed to familiarise myself with the classroom context. It is beyond the scope of this paper to describe the interactions during her lessons, but suffice it to say that the main language used by Ms. Louise to teach mathematics was Maltese, with English interspersions. The transcript below gives an illustration. The topic at hand here is 'smaller than/greater than' and the respective symbols < and >. Ms. Louise is referring to written English text projected on the whiteboard and to a 'crocodile' metaphor as a memory aide. (Maltese or mixed speech is shown in the left-hand-side column, Maltese in **bold** font; the translated speech is shown in the right-hand-side column; pseudonyms are used).

Ms. Louise:	**Hawnhekk għandkom** explanation **qasira ta' dak li għadna kemm għamilna**. **Xi jfissru s**-signs **u kif nużawhom. Qegħdin tarawhom pereżempju dawn in-numri?** *(Touches two numbers shown on the whiteboard)*. Three hundred eighty five and four hundred fifty eight. **Issa, Karl, minn dawk iż-żewġ numri, liem hu l-kbir?**	**Here we've got a short** explanation **about what we've just done**. **What the** signs **mean and how to use them. Can you see these numbers, for example?** *(Touches two numbers shown on the whiteboard)*. Three hundred eighty five and four hundred fifty eight. **Now Karl, which of these two numbers is the bigger?**
Karl:	Four five eight.	Four five eight.
Ms Louise:	**U qiegħed fuq in-naħa tal-**left **jew tar-**right?	**And is it on the** left **or on the** right?
Karl:	Right.	Right.
Ms Louise:	**Mela, l-ħalq tal-kukkudrill jrid jiftaħ lejn in-naħa …?**	**So, the crocodile's mouth is going to open toward the …?**
Karl:	**Tar-**right.	**The** right.

I acknowledge that in this study I served the double role of teacher and researcher and that thus I was instrumental in creating the data. For the lessons, I planned language and mathematics objectives alongside each other, as recommended by Gibbons (2015). At times I interwove the two languages while at other points I emphasised English mathematics language. The general whole-class approach I used was typical of that with which the children were familiar. The main difference was that I used more English than Ms. Louise did, since this was a necessary feature of my teaching and research objectives. Of course, I also had my own particular teaching style in terms of resources, questioning techniques and so on. Following the lessons, I viewed the videos in order to analyse the classroom interaction, now applying the notions of everyday, school and technical registers and reflecting on how I, and the children, used Maltese and English to express these.

3 Data and Analysis: The Use of the Registers

The 'coming-and-going' across registers – and these in one language or another – has been noted by Bose and Clarkson (2016), Prediger and Wessel (2011) and Prediger et al. (2016). The relevance of this idea in a Maltese context is the focus of the forthcoming discussion.

3.1 The Everyday Register

In order to establish an informal relationship with the children I used Maltese for social talk (e.g. during the lunch break). Furthermore, as we settled down to a lesson, I interacted informally with the students in Maltese. For example, in the following excerpt, the children were entering the classroom after an Art lesson.

Child 1 (unseen)	*(Child 1 moves from one desk to another and is one of the children who does not wish to show up on the video).*	
Child 1	**Miss, minn hawnhekk ma nidhirx [fil-vidjow].**	**Miss, I don't show up [in the video] from here.**
Author:	(*Claps hands*). **Ħa nibdew**.	(*Claps hands*). **We're going to begin**.
Child 2 (unseen)	**Miss, ħa mmur naħsel idejja**.	**Miss, I'd like to go to wash my hands.**
Author:	(*Addressing child 2*). **OK**.	(*Addressing child 2*). **OK**.
Author:	(*Addressing Glen who has sat at a different desk to usual*). **Glen, tista' toqgħod hemm, jekk trid… jew inkella ejj' hawn** (*indicating his usual seat*).	(*Addressing Glen who has sat at a different seat to usual*). **Glen, you may sit there if you like, or else come here** (*indicating his usual seat*).

However, this classroom talk is not what is meant by Prediger et al. (2016) when they refer to the everyday register. Rather, Prediger et al. had in mind talking informally about mathematics. As an illustration they give the following oral text (ibid, p. 206): "*Yesterday I was at a sale, in my favourite shop. The sale meant that I received a 10€ discount … Since I paid in cash, the sales clerk gave me another discount …*" In my study it was difficult for this register to be observed, since once the lesson started, the school register was called into play immediately. Frobisher et al. (1999) note that fractions are little used outside the classroom, apart from halves and quarters. Rather, the school topic 'Fractions' marks the beginning of a journey toward rational number understanding and proportional reasoning (Lamon 2006). In fact, any reference we made to 'everyday life' was somewhat contrived: for example, we spoke about a pizza divided into four equal parts with exactly five mushroom slices placed neatly on each part, or a flowerbed partitioned into sections, with exactly six flowers in each section. Admittedly, I might have planned more specifically to tap into the everyday register, but given the data available, I can only conjecture that talking about fractions in an everyday register is likely to be done in

Maltese, and include the everyday words **nofs**(*half*) and **kwart***(quarter)*. Other curricular topics may lend themselves better to exploring the everyday register.

3.2 The School Register

Having settled down to a lesson, I began to use both languages. The excerpt below gives an illustration.

Author:	**Mela, aħna l-ġimgħa l-oħra tkellimna fuq, pereżempju** circles, rectangles **… u xxejdjajna l-biċċiet, sewwa? Illum ġibt dawn il-pizez miegħi** (*touches IWB on which are projected three circular pizzas cut into pieces, with mushroom slices on each*). **Dawn huma pizez tondi. Qegħdin maqsumin fil-biċċiet, li huma** equal parts. (*Touches first pizza*). **Mela din** into two … two HALVES. (*Touches second pizza*). This pizza is divided into four, so we call them q …	**So, last week we spoke about, for example,** circles, rectangles **… and we shaded the pieces, right? Today I brought along these pizzas** (*touches IWB on which are projected three circular pizzas cut into pieces, with mushroom slices on each*). **These are round pizzas. They are divided into pieces that are** equal parts. (*Touches first pizza*). **So this** into two … two HALVES. (*Touches second pizza*). This pizza is divided into four, so we call them q …
Children:	Quarters.	Quarters.

The style of interaction, wherein children 'fill in the blanks' with a short response is a common whole-class teaching approach. However, at other parts of the lessons, I encouraged the children to give longer and more open-ended responses, in an attempt to engage them in more discourse and hence thought. For example, during one lesson I introduced the Cuisenaire rods. These are wooden (or plastic or virtual) rods of different standard colours that are utilised to focus on numerical relationships. For example, the white rod is a 1 cm cube and may be taken to be a unit, or '1'. The red rod is double the length of the white rod, and can therefore be considered as '2'. The light green rod is three times the length of the white one and is therefore '3' and so on, up to the orange rod, which is '10'. We were using software that was projected on the interactive whiteboard and the children were offering their ideas.

Zak:	**Miss, dak taqbad il-**white … **u … mhux id-**double **tiegħu, it-**three **pereżempju**.	**Miss, you pick the** white **one** … **and … not its** double, **[but] the** three **for example.**
Carlton:	(*Refering to a comparison between a white rod and a purple rod).* **Jekk tagħmel tliet' oħra, tiġi bħall-oħra.**	(*Refering to a comparison between a white rod and a purple rod).* **If you put three more, it'll be like the other one.**
Maxim:	The yellow is half of orange.	The yellow is half of orange.

The described interaction contains elements that prompted me to consider the discourse as a school register. That is, there was evidence of the language progressing along the continuum of formality. First, there was a mix of personal and impersonal elements ("Miss, you pick the white one"/"the yellow is half of orange"); second, sometimes everyday phrasing was used, while at other times topic-specific vocabulary was used ("if you put three more, it'll be like the other one"/"one fourth"); third, there was a metaphoric element to the discussion (dragging virtual coloured rods on the whiteboard); finally, modality of the statements varied (for example "the yellow is half the orange" had high modality, whereas "not the double, the three, for example" less so).

Maltese and English contributed to the same function, namely the school mathematics register. Alternation was usually unmarked, and the participants interwove the languages to the point of creating a fully integrated system (Canagarajah 2011). On the other hand, there were times in the lesson when I purposely prompted the conversation *as a whole* to be carried out in English. The children followed my lead in using English and this resulted in them using English in relation to different mathematical processes and hence 'ways of saying' that form part of the school register. Examples are illustrated below.

Justification	Because the pizza is divided [into] four groups, four slices.
Description	The circle is cut into three equal parts.
Expression of relationships	The yellow [rod] is half of orange [rod]
Argumentation	Miss, that's what I was talling [telling] you! Because it's in the Table of 2!
If/then reasoning	If you draw, you shade them all, [then] they will become a whole.
Reflection/self-correction	Two, four, six. And it is in three groups. Ah! It's half … it becomes three because it's a half.

All the above statements canbe expressed in Maltese with English insertions, as in "**Naħseb li din** two thirds. **Għandi raġun**?" [**I think that this is** two thirds. **Am I right?**]. However, by encouraging the use of English, a new function for the language was established, namely, using English to express the school register. Thus two possibilities for the school register became available during the whole-class discussions: a mix of Maltese and English, and English alone. I found that supporting the children's use of English was easiest to sustain during whole-class discussions, since I found it to be unrealistic to expect them to continue to use English during paired work. In the latter situation, they quickly slipped back into mixing the languages, which of course, I accepted.

3.3 The Technical Register

At certain parts of the lessons, I encouraged the use of the technical register in order to prompt more precise or more generalised statements. This was done through English since this is the assumed academic language for mathematics. One method

of encouraging the children to use the English register was to provide sentence frames (Bresser et al. 2009). For example, the sentence frame "The [COLOUR] rod is [FRACTION] of the [COLOUR] rod" prompted children to give statements such as "The red rod is half the purple rod". Guided participation includes observation and listening (Rogoff 1995) on the children's part, and my modelling served to make the terminology explicit and to show the children what language and knowledge I wished them to draw on. At times I prompted them to use English simply by using it myself. Since the children were already familiar with English – in general and with its use for mathematics lessons – they followed my lead. One such activity dealt with diagrams of divided pizzas which were projected on the whiteboard. Each circular pizza was divided into equal parts (halves, thirds, etc.) and on each part there were an equal number of mushroom slices. For a pizza divided into quarters, with four mushrooms on each part, I asked the children 'What is a quarter of sixteen?' By looking at the projection, the children could immediately answer 'four', since this was perceptually evident. I then asked for reasons for their answer.

Rachel:	…because four times four is sixteen.
Carlton:	…because the … four plus four plus four plus four is sixteen.
Sandra:	…because sixteen divided by four equals four.

For a pizza divided into two with three mushrooms on each part, examples of reasons were:

Daniela:	…because six is even.
Rachel:	…because double three is six.

This activity was carried out to help the students to link fractions of regions (equal parts of a circle) with fractions of sets (mushroom slices), by articulating the multiplicative relationship embedded in the context. Hence the language I encouraged was intended to help them focus on this relationship. The above-cited statements qualify as examples of the technical register since a high proportion of the words consisted of mathematical vocabulary (*times*, *equals* etc.), the statements were concise, were of high modality and indicated a move away from the metaphoric base of pizzas to state a mathematical generality or abstraction (metonymy). The statements were said in English thanks to my prompting in this direction. All the above statements can be uttered in a mix of Maltese and English, for example "**ghax** six **huwa** even" [**because** six **is** even], but I wished to encourage the children to practice the technical register in the 'standard' register available to us. To date no *standard* academic Maltese mathematics register has been established, nor is a mixed code considered to be standard. Once again, it was the whole-class discussion that proved to be the most suitable for the encouragement of the technical register, since I could channel the discussion accordingly through what Lewis, Jones and Baker (Lewis et al. 2012, p. 665) refer to as "teacher-led translanguaging".

I generally overlooked the children's occasional errors of grammar, structure or pronunciation so as not to overemphasise form over function. However, when technical expressions were used, I did rephrase or correct where necessary. For example:

Naomi:	Twelve divided four is three.
Author:	Yes, twelve divided BY four is three. That's a good reason.

Maxim:	Two divided by six equals three.
Author:	Ok, just be careful because we don't say 'Two divided by six' but it's the other way: 'SIX divided by two is three'.

The correction was done so as to expose the children to more standard ways of saying as part of learning the discourse of mathematics, and because in the case of the technical register, language itself is key to encompass the mathematical idea at hand.

3.4 Register Use During Pair-Work

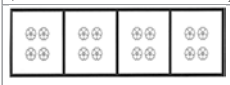
During whole-class discussion I had an element of control over the interaction, but during paired activities, children communicated as they wished. In these contexts, the students used a mix of both languages. For example, in the illustration below, Sandra and Sammy are working on a worksheet that consisted of statements to be completed like '*The white rod is _____ the yellow rod*'.

Sandra:	(*Reading the worksheet*). 'The white rod is … the yellow …' (*Places a yellow rod and two white rods*) 	
Sammy:	*(Looking at the arrangement)*. **Trid ohra hux? U ohra u ohra**.	*(Looking at the arrangement).* **You need another one, right? And another and another.**
Sandra:	**Ehe.**	**Yes.**
Sammy:	(*Passes on three more white rods and watches Sandra place them*).	
Sammy:	**X'tiġi?**	**What is it? [What's the answer?]**
Sandra:	One fifth.	One fifth.

In terms of registers, I would consider the above to be the school register due to the mix of informal and occasional mathematical words. I cannot consider the conversation to be expressed in an everyday register, because the context is a mathematical model, not an everyday situation; on the other hand there are not enough formal elements to consider the stretch to be technical. Here distinct functions of the two languages can be noted: English was reserved for reading the written text and for stating fractions, while other communication was carried out in Maltese. From my

observations of Ms. Louise's lessons, this was typical use of the languages and evidently, this mix served as the 'language of comfort' (Bose and Choudury 2010) for the children's conversations.

Another example is the excerpt below illustrating Carlton and Daniela carrying out a worksheet task. They had to figure out the fraction shown by one part of a flowerbed, glue a matching paper strip next to it (e.g. a strip showing *¼ of 16*), write the answer (*4*) and colour the part.

Daniela	*(Looks at the third example on the sheet)*	
		
	Mela… Four, eight, twelve, sixteen. **Ara,** one fourth of sixteen.	**So...**Four, eight, twelve, sixteen. **Look,** one fourth of sixteen.
Carlton:	**X'tiġi?**	**What is it?**
Daniela:	One fourth of sixteen. **Mela, l**-answer **tal-**one fourth of sixteen equals … four. **Isa, waħħal!**	One fourth of sixteen. **So, the** answer **of** one fourth of sixteen equals … four. **Come on, stick it!**
Carlton:	**Aħjar inpinġuhom, ta**.	**We'd better colour them**.
Daniela:	**Hux inpinġuhom! F'aħħar**.	**Oh, don't bother! [We'll do that] at the end**.

Similarly to Sandra and Sammy, Carlton and Daniela used Maltese for general communication and English for the mathematical terms and fractional expressions, although here more mathematical terms were used. It is interesting to note that while Sandra had read *written* text in English, Daniela read the *diagram* in English, illustrating the close link between a visual model and the development of the technical register (Prediger and Wessel 2011).

4 Conclusions Drawn from the Data

The lessons conducted allowed me to draw theoretical and practical conclusions with regard to the Maltese bilingual experience of learning mathematics.

4.1 Teasing Out the Registers

Prediger et al. (2016) stress that the boundaries between the registers are not hard and rigid and through the analysis of my data it became clear that drawing clear lines between the two registers was challenging. I present and discuss a transcript to illustrate this point; at this point in the lesson the children and I were talking about a projected image of a rectangle of which two fifths were shaded.

1	Ian:	Two fifths.
2	Author:	Give me a sentence. The FRACTION … shaded …is …
3	Ian:	The fraction shaded is two fifths.
4	Dulcie:	Shaded, it will be five fifths.
5	Maria:	ALL the parts are equal.
6	Zak:	The not-shaded are three fifths.
7	Carlton:	If you draw, you shade them all, they will become a whole.
8	Ella:	That, em, that you can cut, cut it in different ways (*undecipherable speech*).
9	Author:	Can you give me a sentence with the word 'numerator' and 'denominator'?
10	Kylie:	(*Referring to the words attached to the board*). The first one is the numerator and the second one is the denominator.
11	Yolande:	(*Indicating the fraction 2/5 written on the board*). The denominator is on the bottom…five.
12	Dulcie:	(*Pointing to a paper strip that was detaching from the board. On this strip was written the word 'numerator'*). Miss, the numerator is going to fall.
13	Author:	OK. (*Secures the paper strip on the board*).

If I consider conciseness and impersonality as features of technicality, then such a register can be noted in interaction lines 1, 3, 4, 5 and 6. Other interactions are 'less' technical as follows: line 11 gives a concise statement about the denominator, although expressed rather informally ("on the bottom"); human agency is evident in lines 2, 7 and 9, although these interactions still contain mathematical vocabulary; line 8 contains no topic-specific vocabulary; lines 10 and 12 contain statements about the denominator and numerator, but do not deal with their mathematical significance. The conversation contains a certain metaphoric element, since it is tied to the context of a shaded rectangle; modality is high in a statement like "The fraction shaded is two fifths" (line 2), but lower in the line 9, "Can you give me a sentence …?" Carlton's statement (line 7) is note-worth because it includes the 'if … then' reasoning. This type of reasoning was noted by Morgan (1998) to be a particular feature of mathematical text.

Whereas in the classroom it is not necessary for a teacher or students to be constantly aware of the mathematical degree of their talk, in theory it is useful to confirm other researchers' views on the continuity and fluidity of mathematical language.

4.2 The Use of English and Maltese

Since the children participating in this case study were familiar – and comfortable – with the interweaving of English with Maltese, it was possible for me to setup a 'translanguaging space' wherein the children's language practices were brought together (García and Wei 2014). The most 'natural' code for expressing the school register was a mix of Maltese and English, but with some prompting, the children also expressed themselves in English, thus participating in a new style of discourse. More technical articulations were done through English.

LANGUAGE	REGISTERS		
	Everyday	School	Technical
Maltese (L1)			
Mixed code			
English (L2)			

Fig. 1 Inter-relating of languages with registers

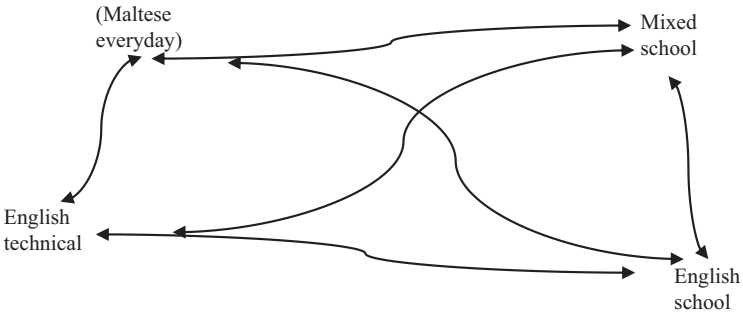


Fig. 2 Movement through registers – 'shifting sands'

Prediger and Wessel (2011) offer a model presenting the everyday, school and technical registers being used in either L1 or L2. My study allows me to add to this. Figure 1 shows the interconnectedness of languages and registers (shown shaded) based on my data. The cell linking Maltese with the everyday register is conjectural for the topic fractions, but I might assume its use for other curricular topics.

My data brought to mind the metaphor of 'shifting sands' as the children and I moved between the options. Figure 2 gives a diagrammatic representation of the shifts.

Hence, translanguaging in local mathematics classrooms is a fluid process as students build their communicative repertoires.

5 Significance and Implications of the Study

My study supports international research that highlights the beneficial uses of translanguaging. It offers a scenario of English being targeted together with a discipline, a dual emphasis that finds a parallel in Content and Language Integrated Learning (CLIL) contexts (Baker 2011). However, as I discuss further in Farrugia (2017), my approach was a 'variety' of CLIL, in that I gave dual attention during only *parts* of the lessons, while other parts maintained the common practice of integrating both languages. This approach allowed me to put into practice research

recommendations for learning mathematical discourse in general, and in bi/multilingual classrooms in particular.

My study shows that with explicit attention to both mathematics and language objectives, it is possible to use both Maltese and English in pedagogically helpful ways. While internationally this is not a new idea, it has important implications for the local scene, namely that the local debate with regard to medium of instruction need not be restricted to an either/or option (code-switching or English). Rather, educators might embrace the perspective of translanguaging and recognise that different language practices might be used and/or developed as part of the process of teaching-learning mathematical discourse. Of course, attention to English (general and mathematical) would need to be tailored according to the students' age and confidence with the language.

Through my role as a teacher-educator, I have frequent contact with pre-service and in-service teachers and, through discussion, I hope to be able to share my reflections on language use in our mathematics classrooms. Ultimately, my study shows that the languages – separate or together – can serve very specific functions in terms of mathematics registers. Consequently, I recommend that the everyday, school and technical registers as expressed through Maltese and English be recognised, valued and investigated further.

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