Exploring Synergies between the teaching of mathematics and modern foreign languages

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This study considers whether the pedagogical strategies and techniques conventionally used in modern foreign language (MFL) lessons may be of value in developing mathematical understanding. It aims to explore some of the potential synergies between mathematics and MFL teaching and reports on an intervention with a group of students following a mathematics specialism unit, as part of their BA in primary education. The aim of the taught session described with the student group, was to focus on learning mathematical concepts, related to measurement and scaling, using Spanish as the language for teaching, in order to answer the question: To what extent does the use of a different language medium support the development of understanding of mathematical concepts?

Keywords: talk; language

Introduction

In its broadest sense, mathematics provides a means of organizing, communicating and manipulating information, Cockcroft (1982, p. 3).Yet, for many children, mathematics is a 'foreign language'; the symbols and expressions provide a formidable barrier to understanding of mathematical concepts *(Council of Australian Governments, 2008).* Mathematics can be considered a language in its own right in that has its own lexis, syntax, grammar and semantics. This may make it difficult for learners. Kotsopoulos (2007), reporting on a study that analysed transcripts from a Year 9 classroom, demonstrated how the mathematical register can sound like a foreign language to students. He notes that this 'mathematical register' is unique to mathematics and that it is highly formalized, abstract and compressed, largely reliant on symbols.

Moreover, the actual vocabulary used in mathematics lessons presents two separate challenges for teachers. Firstly, mathematics 'borrows' some everyday general words but uses these in specific ways; for example, difference, face, net… Halliday (1978) points out that, whilst counting and measuring draw on everyday language, school mathematics requires learners to use language in new ways, to serve new functions. Secondly, the subject also uses some subject specific terms such as tetrahedron. Learners need to become familiar with using these subject specific words in order to be part of a mathematical community. Gough (2007, p. 8) notes that

> Mathematics is like a language, although technically it is not a natural or informal human language, but a formal, that is, artificially constructed language. Importantly, we use our natural everyday language to teach the formal language of mathematics. Sometimes we encounter problems when the technical words we use, as formal parts of mathematics, conflict with an everyday understanding or use of the same word, or related words.

Cobb (1988, p.92) refers to the tendency for communication to break down in the mathematics classroom, because "…pupils and teachers construct their own

meanings for words and events in the context of ongoing interaction". Tout (1991) also notes that, in mathematics, there are often several words or phrases meaning the same thing, for example, words such as decrease, reduce, take away, minus, difference between, each one implying subtle differences but all concerned with subtraction.

Barwell (no date) identifies a social dimension in the talk in mathematics classrooms: there are particular ways that students and teachers talk in mathematics classes that are not specifically mathematical, but that are associated with mathematics. Instructions, for example, might include expressions like 'simplify' or 'complete the following'. Teachers often use 'we' to refer to 'people who do mathematics' (e.g. we use x to represent an unknown).Yet, if learners are to see themselves as mathematicians and become part of a community of mathematicians, as with any other community, they do need to be able to understand and speak the language, Lave and Wenger (1991). Moreover, Schleppegrell (2007) notes that there are particular grammatical patterns in mathematics, involving the use of noun phrases and conjunctions with technical meaning, all of which imply but do not make explicit the logical relationship. Jamison (2000) suggests that making the syntactical and rhetorical structure of mathematical language clear and explicit to students can increase their understanding of fundamental mathematical concepts.

This emphasis on making the language structure clear may have particular resonance in the mathematics classroom where there is a continued emphasis on the place of talk in developing reasoning and forging understanding, as advocated by Mercer, Wegerif and Dawes (1999). Such a process may be associated with a socio-constructivist paradigm. Vygotsky (1981, p.62) records that "…children develop higher mental functions through social interaction that takes place predominantly, but not exclusively, in verbal language". This shared forging of understanding is somewhat different to the notions of Hirsch (1998) which involve a paradigm of enculturation whereby learners are initiated into a group by simply learning its facts, its rules and conduct.

Given these issues in mathematics and the potential synergies with modern foreign language learning, where learners are also confronted with an unknown lexis, syntax and grammar, it was felt that it may be useful to explore the pedagogical strategies in each subject. Both are concerned with enabling learners to understand and express ideas so that they can communicate with others.

The study was developed with reference to the Content and Language Integrated Learning (CLIL) approach, a term first used by Marsh (1994). CLIL refers to situations where subjects, or parts of subjects, are taught through a foreign language with dual-focussed aims, namely the learning of content, and the simultaneous learning of a foreign language. Dalton-Puffer (2007) records the value of the experience of total language immersion for learners. Furthermore, using the foreign language to teach about another subject can increase the cognitive demands of the language element, which may be of benefit to learners. Cajkler and Addelman (2000) record that, in some circumstances, pupils may experience the same topics taught in different languages or may cover the same material in different years and advocate the use of cross-curricular approaches, avoiding such repetition.

There is a need to consider how effective such language immersion might be for understanding and learning about the concepts associated with the other subject area (mathematics in this case). The use of a different language medium can enable the repetition and reinforcement of these key ideas, albeit in a different context. There may also be the issue that, in the modern foreign language classroom, all learners are

coming from the same starting point. Therefore, those learners who have had negative experiences of mathematics and may consider themselves as not able mathematically, may feel more positive, more engaged and more willing to try out new ideas. The importance of a context for mathematical learning may help to overcome some of these fears although the introduction of such a context may mask some of the important concepts as learners may focus on the superficial elements

Moreover, Dalton-Puffer (2007) notes that there are fears that the learning experiences in the subject being taught may be minimised, children getting a watered down and less challenging version of the ideas. Mathematics is frequently perceived as a difficult subject to understand in its own right and there is the possibility that adding in teaching in a modern foreign language might make the subject even less accessible. Pimm (1987) cautions that whilst the idea that mathematics is a language is a useful metaphor, it should not be allowed to obscure the complex role of language in mathematics.

Research Study

The stimulus for the research stemmed from a six-month visit to our mathematics department by an associate professor from Cordoba who was preparing to teach mathematics in English to her own initial teacher training students, all of whom were native Spanish speakers. During the course of her visit, meetings were held with our modern foreign languages department. As a result of these, a mathematics and modern foreign language event was organised, for our university staff and students and our partnership schools. This event consisted of a series of practical workshops, each based around a mathematical concept where the language medium was either Spanish or French. Following on from these, it was decided to incorporate this approach into a more formal lesson setting, in order to assess the potential value of this approach, in terms of teaching both mathematics and modern foreign languages.

The researched lesson involved a group of final year mathematics specialist students on the BA Primary Education course. The focus was travelling between Manchester and Cordoba and involved areas of mathematics including measurement, scaling and investigation. The first part of the lesson was taught in Spanish. In order to do this, the tutor followed a pre-prepared script and supplemented what was said by the use of artefacts, images and gesture, as deemed appropriate. The students were invited to respond to the tutor and to engage with activities, using Spanish if they could. They were also provided with prompt sheets and resources. The tutor, using a fixed video camera, recorded this lesson.

The measurement element involved establishing the distance between their home city, Manchester and a selected destination in Spain, Cordoba. This task was introduced by measuring the difference between markers already placed on the classroom floor. The students then had to use the scale on the map provided to calculate the actual distance. The initial measurement activity was accomplished relatively quickly, and the students did engage in counting the clicks on the trundle wheel in Spanish. The scaling up of the distance measured required further support, in terms of ensuring that the resources provided were utilised. In hindsight, it may have been useful to make a comparison with doing this in English, to see if this would still have been an issue.

The students had already worked with the tutor on many occasions and, perhaps because they had already built up a good relationship, they seemed willing to try to engage with this session. None of the group had any degree of proficiency in

Spanish. They appeared to listen intently, though, from reviewing the film, most of the verbal responses, in the first element, came from the same two students. These two students were the ones who had also volunteered to be involved in the practical activities. It was apparent that they communicated in English, unless prompted, and, when they spoke in Spanish, they needed the support of the cue cards provided. The tutor found that repetition of phrases was required, after which some students were prepared to make an attempt at translation. At other times, the tutor needed to draw their attention to the resources provided within the classroom, using gestures. Sime (2006) notes that gestures used by the teacher can serve three functions within the MFL classroom: cognitive, emotional and organisational. In this instance, the gestures were used to enhance learning by modelling what was required and, thus, fulfilled a cognitive function.

Next, the students were introduced to the main focused task. The tutor explained the task, using models and images alongside key Spanish phrases displayed in writing and spoken. This involved researching different possibilities available to travel to the given destination. They were asked to identify which method of travel might be preferable for three different sets of travellers, offering a rationale for this. This required them to take into account a number of basic factors including calculating costs and journey times as well as considering the wider implications, for example, of travelling with young children. Thus, there was an attempt to introduce real life relevance and elements of problem solving and reasoning were incorporated. The students engaged readily with this task but utilised English and the translation sheets provided, rather than attempting the Spanish and all their contributions to discussions were in English. Thus, if this were to be considered as supporting their use of another language, the session was of limited value, as it was only a teacher modelling this, hence a somewhat transmissive model. One of the key aims of the 2013 National Curriculum for modern foreign languages is to ensure that students both listen and speak in the target language; here the students were only doing the former.

Following the session there was a discussion, in English, with the students about the strategies used, the place of resources and gesture in supporting talk, and the value of combining subjects in this way. The students were also asked to evaluate the session via questionnaires.

During the initial discussion, the students noted that they had had to listen intently, in order to focus on what was going on. They also commented on the fact that the repetition had helped and that some words were easier than others were, as they linked with known words. Jappinen (2005) notes that one of the benefits of the CLILI approach is that learners actively seek such commonalities between their first and the second language. This strategy of searching for connections appears to be carried over to the other subject area. The students also noted the value of having all the resources to hand, but did not appear to recognise the place of gesture in mediating their understanding.

Analysis and Conclusions

Analysis of the questionnaires showed that the students had enjoyed the session and the majority preferred learning the language in this way, via another subject, to the more traditional way and half said that they would like to see greater links between the two subject areas. There was a less definite response to the question around learning mathematics in a more conventional way. The majority of positive comments

related to the affective domain, noting that the session had both engaged and challenged them, making them concentrate and listen harder. Negative comments related to the students' own uncertainty about the language, in terms of what they were asked to do. However, they did note that this was of value in thinking about their own teaching. Some noted that one needed to have some background in either mathematics or the target language in order to be able to access the lesson. Two noted that the activities did not really involve anything new mathematically and that this was more about translating than mathematics. This may have been because no explicit links were made between this and developing reasoning and problem solving.

The tutor field notes record the fact that she was speaking far more slowly than her normal pace within this lesson, which did raise questions for her, about whether this normal pace was actually too fast. It also brought to the fore questions about how much teachers may normally say within their lessons. Does the sheer volume of teacher talk obliterate the key messages and meaning? Though the intention is often to create a context and to make links with experiences, it does increase the often high percentage of teacher talk. One might ask how learners can ever fully make sense of the amount of teacher talk. Associated with this, is the realisation that teachers do tend to say a great deal in lessons, when arguably, far more of the talk in the classroom should involve the learners, Alexander (2006). Classroom discourse can be considered as separate from ordinary conversation, in that it is usually intended that such discourse leads to an endpoint, determined by the teacher. There may be a tension between these two elements, particularly in mathematics where the teaching is intended to lead to an appreciation of key ideas and concepts, as opposed to modern foreign language teaching where the purpose is to engage in dialogue, per se, similar to the apprenticeship approach, discussed by Wenger (1998). However, one could also suggest that there is a similarity in modern foreign language classrooms where language immersion is recommended and all learners are expected to engage at a peripheral level initially. Learners then gradually become full participant members of the community, as they acquire the language. In the same way mathematics learners who 'speak the language' may also become more confident and able to talk about their mathematics and see themselves as mathematicians.

If we do consider mathematics to be a language that learners need to understand and use themselves, then there are some key messages that seem to be emerging, in terms of repetition and slowing down the normal speech patterns, possibly removing some of the extraneous detail that may clutter explanations. Moreover, the use of gestures, resources and pictures seemed to be beneficial for this group of learners and parallels may be made with working in a classroom.

However, in terms of the actual combining of these subjects, there were reservations expressed by the students that, though this approach may have value in terms of developing the modern foreign language, this may not support the understanding of mathematical concepts. A further area of study may relate, more specifically, to how we might teach mathematics as a language, in itself, borrowing some of the strategies from modern foreign language teaching, rather than developing a CLIL approach.

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