Using a second language to develop mathematical understanding

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Mathematical reasoning and conceptual understanding are central to the national curriculum. We argue that a Content and Language Integrated Learning (CLIL) approach can support both aims, providing a meaningful context for subject content and language learning. Our research examines the role of communication within a second language, to develop and consolidate conceptual understanding. We describe a small-scale intervention project in which a group of teachers attended workshops, exploring the potential of CLIL pedagogy within primary mathematics, using the medium of French. Data collected consisted of tutor observation notes, supported by video recordings and semi-structured interviews. Data was analysed using a cognitive discourse framework. Articulating their own ideas and understanding in a second language enabled the teachers to focus on the key elements of their explanations to others. They developed a deeper understanding of the relationship between conceptual understanding and communication and saw that communicating ideas can contribute to conceptual development.

Keywords: CLIL, language, communication, conceptual understanding

Background

It is the intention of this small-scale study to argue that locating the teaching of mathematics through a second language (French) provides both a linguistically rich and cognitively challenging content and context. (Sylvén & Sundqvist, 2012).

CLIL is a term used to describe a pedagogical approach that is popular across mainland Europe that places the emphasis on a content led approach to the teaching and learning of a second language. Marsh (2002, p.15) defines CLIL as "any dual-focused educational context in which an additional language, thus not usually the first language of the learners involved, is used as a medium in the teaching and learning of non-language content."

In CLIL research circles, much has been made of its potential and capacity to facilitate richer, more naturalistic and meaningful language learning contexts, which researchers suggest, (Lyster, 2007; Krashen, 1985; Lightbown & Spada, 2006), leads to greater language proficiency and motivation. What researchers have also suggested is that CLIL also provides opportunities for the regeneration of content teaching by fostering greater cognitive development and flexibility in the way learners approach, access and process this content (Lyster, 2007; Coyle, Hood & Marsh, 2010; Dalton-Puffer, 2008), in turn recognising the central role language plays in this learning process.

Much has been made by the exponents of CLIL of the general cognitive advantages of bilingualism (Baetens Beardmore; 2008; Coyle, Hood & Marsh, 2010) and its links to greater communicative ability, metalinguistic capabilities and capacity for creativity and creative thinking (Meehisto, 2008; Baker, 2006). Marsh (2002) suggests that CLIL provides different 'thinking horizons' as a result of learners

engaging with content in another language. The ability to think about concepts in another language has the potential to promote a greater understanding of these concepts and extend learners' conceptual mapping resources. Blackmore & Frith, (2005) suggest that not only is CLIL a powerful and effective way to engage with and learn a second language but also has significant implications in terms of the way in which we learn generally and that as a result, the brain is fundamentally altered. We suggest that when implemented effectively, CLIL challenges learners to transform information, think creatively and solve problems, thereby developing flexibility in their thinking with the potential for developing learners' critical thinking. Allain, Gao, Mondt & Van de Craen, (2007) suggest that learners, in the case of this study, teachers, are encouraged to engage more actively with the content in CLIL contexts.

What it is hoped can be argued here is that CLIL provides a learning environment where learners (the teachers) had the opportunity to develop and use their cognitive skills to generate their own knowledge through engagement with the mathematical content in the second language (L2). The term 'cognitive development' can cover every mental process involved in the process of knowing/acquisition of knowledge. However, Jappinen (2005) suggests that 'cognitional development' refers/relates to the ability of CLIL learners to understand, use and apply conceptual knowledge and understanding that has been acquired in and through a second language. This is potentially a useful and valid stance to adopt when exploring the potential for deeper conceptual understanding when learners (the teachers) engage with and access the mathematical concepts and knowledge in a second language and the role that L2 plays in this process.

The purpose of these teacher workshops was not to promote a bilingual or immersion approach to the teaching of mathematics but through locating some of the learners' mathematical learning in another language, it is contested that their ability to problem solve and engage in higher order thinking skills as a result, is significantly enhanced (Baetens Beardsmore, 2008).

Placing the emphasis on content rather than language also has the potential to be mutually beneficial for both the content subject and the language, a view supported by Marsh (2002). The dual purpose and focus of CLIL pedagogy (Marsh, 2002) provided a more cognitively challenging and more authentic platform for language acquisition and use by the teachers, whilst providing meaningful and new contexts for them to revisit and re-examine key mathematical concepts from a different perspective through a second language. They were able to experience first-hand the potential rich learning opportunities for their learners and to create opportunities for them to deepen their conceptual understanding as a result. Another significant point explored within this study were the opportunities afforded the teachers and potentially their learners. Locating the teaching of mathematics in French enables both teachers and learners to encounter new learning opportunities, to re-examine key mathematical concepts from a different perspective whilst not reducing the cognitive demands associated with the activity, which in turn can offer greater cognitive challenge and lead to learners demonstrating deeper conceptual understanding. It is this context that can be argued provides the linguistically rich and cognitively challenging setting for effective CLIL teaching and learning, designed to nurture learners' thinking skills (cognition) (Mearns, 2012).

This study framed its research within a pluriliteracies and cognitive discourse function framework. The pluriliteracies approach to CLIL relates to how language is perceived in relation to its function and importance in the processes involved in the acquisition of knowledge that is altered significantly through CLIL. Coyle, Halbach,

Meyer, Schuck & Ting (2015) identify the development of a pluriliteracies model in relation to CLIL. They emphasise the interrelated nature of language and content and how language is needed for progress in the construction of subject knowledge and meaning making. If we accept this view of the centrality of language to subject knowledge acquisition and learners' ability to internalize and articulate this knowledge, CLIL teachers need a heightened awareness, understanding and focus on the role of language in the learning process. They contest that progression along a 'knowledge pathway' is key to learners developing deeper conceptual understanding, requires them to develop and negotiate their way through and acquire mastery of subject specific literacies. Learners' progression along this knowledge continuum can be measured by how effectively they can articulate their understanding of the subject content and the underlying concepts. Through putting literacy at the heart of learning, deeper and more sustained learning is acquired. (Coyle et al., 2015).

Given that mathematics is a language itself, with its own lexis and grammar (Gough, 2007), we were keen to explore the synergies between the two disciplines of mathematics and modern foreign language teaching. Both pedagogies commonly use practical activities and visual images to support learners and, in each, learners need to become confident in using the vocabulary independently. Modern foreign languages became a compulsory subject for key stage two children in 2014. Many primary teachers lack experience and/or training in this area of the curriculum. Hence, as with mathematics (Williams, 2008), teachers can lack confidence or feel anxious about teaching the subject.

The intervention

Our intervention was based around a series of four professional development workshops designed to explore the potential of CLIL pedagogy within primary mathematics, using the medium of French. The workshops were led by the authors and attended by a self-selected group of primary practitioners. Within the group, there were newly qualified teachers and experienced teachers, one of whom was a school subject leader for mathematics, and another led modern foreign languages. Each session explored an area of mathematics and involved the teachers in trying out some practical activities for themselves and discussion. Subsequent to each session, they were asked to try out these activities in their own classrooms and to report back at the following session. Feedback from the teachers, at the interim point, indicated that they were keen to experience CLIL as learners. As such, we planned and delivered a session in which the mathematical content was taken from the secondary curriculum in an area outside their own area of expertise, outside their comfort zone.

Research Study

The data collected was qualitative and consisted of tutor observation notes and video recording from each session, plus teacher feedback about the activities they had trialled. We also carried out semi-structured interviews with the participants following the final workshop. Data was analysed using a cognitive discourse function framework (CDFs). Dalton-Puffer (2013) perceives CDFs to be outward, physical representations of thought. Unlike cognition, CDFs are therefore arguably, a tangible measurement of understanding that are visible and able to be documented through the observation of classroom discourse and interactions (Kramer-Dahl, Teo & Chia 2007). By locating this small-scale study within a CDF, the teachers were able to experience language from the learner's perspective, as a way of not only making

sense of the world around them but, also, to share their learning experiences with others. The aim was to encourage the teachers to think and communicate as mathematicians through a second language.

Analysis and Conclusions

The session in which the teachers encountered previously unfamiliar mathematical content proved to be pivotal in their learning. Providing this opportunity for them, within an L2 context, led to them articulating their own ideas and understanding to others. As a result, they were able to recognise and develop a deeper understanding of the relationship between conceptual understanding and communication. They began to understand how focusing on using subject specific language to communicate ideas can play an active role in developing a deeper understanding of mathematical content and concepts. This is key in the pluraliteracies approach to learning.

Discussion

Modern foreign languages are often taught by subject specialists, whilst mathematics is frequently taught by generalist teachers within the primary school. However, we believe that using a CLIL approach can be beneficial for teachers and learners. In terms of delivering a full curriculum, the connecting of two discrete areas can be efficient in terms of teacher time and beneficial in enabling pupils to make meaningful connections between subject areas. The use of subject content provides a meaningful context for language learning. Providing a new context for mathematical learning can also enable both reinforcement of existing knowledge and, more importantly, new and deeper conceptual understanding to be forged as learners seek to articulate their understanding with great precision using the vocabulary available to them. Our future research will involve us in looking at children's use of language to explain their ideas in mathematics that they have learnt through an L2. We intend to look further at this deeper conceptual understanding, a notion that is currently the focus of discussion around 'mastery' in mathematics.

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