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Exploratory talk in mathematics: what are the benefits?

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Using a range of qualitative and quantitative data collection techniques, this small-scale research study investigated whether encouraging the use of more exploratory talk in mathematics lessons could help improve understanding of mathematical concepts for a mixed ability Year 4 class. It was found that although most children derived some benefit, those of middle ability levels developed their understanding the most.

Keywords: mathematics; exploratory talk; primary school; dialogue; ability

Introduction

Following the publication of the *Cockcroft Report* (Cockcroft 1982), it is now widely accepted (e.g. Barwell et al. 2005; Mercer and Sams 2006) that discussion is essential to the teaching and learning of mathematics and research stresses that it is through the informal use of mathematical language that more insightful mathematical thinking can begin to develop (Leung 2005). Policy documents concur with this view, for example the *National Numeracy Strategy* stated that ‘a structured approach to the teaching and learning of vocabulary is essential’ [emphasis added] (DfEE 1999, 2) and the *Primary Framework for Literacy and Mathematics* (DfES, 2006, 65) emphasised that in ‘good mathematics teaching’ children ‘support one another in group work and are happy to share their ideas and to explain their reasoning and methods’. Yet, OFSTED observed that most mathematics lessons did not emphasise talk enough (Ofsted 2008) and Williams (2008) stressed a need for more discussion in mathematics lessons stating that ‘only by constructive dialogue in the medium of the English language in the classroom can logic and reasoning be fully developed’ (4). High quality dialogue is recognised as an essential component in achieving mathematical understanding, but there is ambiguity as to how this can best be facilitated in the classroom, particularly the balance between engaging in free-flowing dialogue in mathematics lessons and using precise mathematical vocabulary.

The purpose of this research was to investigate whether facilitating, and encouraging, the use of more ‘exploratory talk’ (Barnes and Todd 1977), in the form of peer group interactions in mathematics lessons, could help improve understanding of mathematical concepts for a mixed ability Year 4 class. It was of particular

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interest to see whether the impact of classroom dialogue using this approach varied according to the ability levels of children.

Literature review

Over 70 years ago, Vygotsky (1978) suggested that a learner's actual achievement is a combination of their own ability and the effectiveness of the *communication* between teacher and learner. Mercer (2000) reconceptualised Vygotsky's theory and suggested that in order to learn individuals must create a shared communicative space of common knowledge in which they negotiate their way through an activity. He termed this the Intermental Development Zone (IDZ) and argued that if the IDZ can be maintained, and learners are able to operate just above their ability levels, effective learning can take place through collaborative dialogue. Mercer and Sams (2006) suggested that introducing children to a type of talk where they engage critically, but constructively, with *each others'* ideas could help improve their learning and understanding. This type of dialogue, where 'knowledge is made publicly accountable and reasoning is visible in the talk' (Monaghan 2006, 13), is known as 'exploratory talk' (Barnes and Todd 1977). There is a place for instructional teaching (for example to explain new concepts, methods and theories) but there is also the need to promote purposeful dialogue, both between teacher and pupil and between pupils, if learning is to be as effective as possible (Alexander 2008).

Mercer and Sams (2006) found that talk which takes place in primary schools when children work together can often be 'un-cooperative, off-task, inequitable and ultimately unproductive' (510). So, despite the overwhelming evidence that dialogue has an important role to play in the primary classroom, it has been suggested that this is not always a successful learning strategy (Kutnick and Manson 2000; Williams 2008). This may particularly be the case if the nature of the task assigned does not invite children to engage in meaningful dialogue. Galton and Williamson (1992) found that, in primary schools, children were placed in seating groups for nearly 60 per cent of their working time but that they actually worked together on given tasks for only 5 per cent of their time.

Another factor regarding facilitating purposeful talk in the classroom is that although teachers use a range of groupings within the classroom environment they have often received little, or no, training on how to encourage group dialogue (Blatchford et al. 1998). Likewise, children cannot be expected to engage in meaningful conversation, or manage joint activities, without guidance. The 'Thinking Together' approach (Monaghan 2006) showed that by laying down explicit ground rules for talk and then guiding the development of childrens' skills in using language as a tool for reasoning, teachers can facilitate the development of effective exploratory talk. So, if a teacher can scaffold the development of childrens' use of language, the traditional 'initiation – response – feedback' (IRF) technique can also be effective in the context of pupil-pupil dialogue.

Fawcett and Garton (2005) found that the most significant benefits of collaborative learning were gained by lower ability children working with higher ability peers. However, Light et al. (1994) found that all children can benefit from group dialogue opportunities provided they work in same ability (or 'symmetrical') partnerships since such groups ensure that the status of power is more even and give more opportunity for children to scaffold each others' learning. It is perhaps in

consideration of this theory that the government has recommended ‘setting’ children (DfEE 1997), a practice which has become quite usual in primary schools today (Hallam et al. 2003).

There has also been some discussion in the literature of the role of language and social interaction specific to the field of mathematical understanding. For some there is a disparity between the two elements of classroom dialogue in the mathematical context: that is the acquisition of the mathematical register and the acquisition of the skills necessary to engage in dialogue to ensure the development of a sound understanding of mathematical concepts (Barwell 2005). In the mathematics strand of the National Curriculum, emphasis is placed on children developing the necessary skills to ‘use the precise mathematical language and vocabulary for handling data’. It has been argued that the notion of ambiguity in mathematics is counterintuitive, ‘how can mathematics be discussed when... it is all sorted out and written down at the school level’ (Pimm 1987, 47). However, as Morgan (2005) has pointed out, the ‘one-to-one word-to-meaning’ relationship apparent in the National Numeracy Strategy (DfEE 1999) does not actually reflect the way mathematical meanings are related in practice. When the focus is less on the correctness of mathematical speech and more on exploring concepts and ideas ambiguity can actually be a ‘productive way to build students’ understanding of mathematical principles and certainties as opposed to assuming they simply have to be taught given truths’ (Street 2005, 140). Instructional teaching has a role to play in mathematics teaching – both to inject vocabulary and because it is obviously untenable that children could reach many mathematical conclusions solely through discussion – but exploratory talk also can also have significant value.

The review of the literature seems to affirm the premise of this research study that exploratory talk has an important role to play in improving mathematical understanding. ‘Language is about more than words; mathematics is about more than numbers’ (Barwell et al. 2005, 146) and, just like learning a language, developing mathematical understanding is a socially constructed activity. However, complexity still surrounds the issues of how dialogue can best be encouraged and facilitated in the mathematics classroom.

Methodology

Since the aim of the study was primarily ‘to improve personal practice rather than to produce knowledge’ (Elliott, 1991) action research was selected as the preferred methodology. Following similar techniques to those adopted by Baines et al. (2009) a sequence of mathematics lessons were structured so as to provide opportunities for a class of 33 Year 4 children in a village primary school, organised in 9 mixed ability groups, to engage in exploratory talk. The ground rules for exploratory talk were discussed with the children at the beginning of the study; referred to frequently in subsequent lessons; and were on display throughout.

Quantitative data were provided through the benchmark activity of maths assessment tests pre- and post-intervention, with a parallel Year 4 group acting as a control. Semi-structured observations recorded the pupil–pupil interactions that took place amongst all 39 Year 4 children (33 in one class and 6 children in the control group) as observations are ‘unrivalled in enabling the researcher to immerse themselves in the research environment’ (Burton et al. 2008, 97). To give three

different perspectives to the data, classroom observations were recorded by the researcher, the class teacher and the teaching assistant. Semi-structured, face-to-face group interviews with six children were also conducted at the end of the study since interviews have the advantage of adaptability (Bell 2005, 157) with group interviews providing additional insights. Due to time constraints, it was not possible to interview, or record interactions between, all the children so a purposive sampling method was adopted (Denscombe 2003) although it is acknowledged that random samples can be considered to give less biased results (Cohen et al. 2007).

Further data were collated in the form of questionnaires completed by the pupils in their groups at the start of the study. These contained both closed (multiple choice and rank order) and open questions, as recommended by Cohen et al. (2007) as the best way to achieve meaningful results within small-scale research.

Analysis

When asked how they preferred to work, the majority of the children (over 50%) originally saw more advantages to working independently than in engaging in group dialogue, because 'you can work in peace' and 'you get it done quicker'. However, at the end of the study 83% of the children said they now preferred to work in groups. So, perhaps through the use of more structured opportunities to engage in dialogue and with the implementation of basic ground rules, the children were able to derive more benefits from classroom discussion, as suggested by Monaghan (2006).

Interestingly, 78% of the children stated at the start of the study that mathematics was the subject most likely to offer the chance to engage in pupil-pupil dialogue. In informal discussion teachers at the school thought that literacy and the humanities were most likely to incorporate dialogue which was similar to the researcher's observations and national findings (see Ofsted 2008, 15). This discrepancy could perhaps be explained by the fact that the children were often engaged in individual work in mathematics lessons, during which they were *allowed* to talk, as opposed to the teacher *specifically* asking the children to discuss mathematical concepts in together in order to help them find solutions to problems.

In the initial stages of the study, when the concept of using exploratory talk was still being embedded, disputes were much more common and led to arguments, conflict (as also found by Azmitia, 1998) and, in the most extreme case, fragmentation of the group. This type of discussion was a threat to the self-esteem and self-confidence of pupils and this was a primary concern with the use of exploratory talk at the beginning of the project (as supported by Chang and Lee, 2001). Some of the groups, therefore, needed additional support and guidance from the teacher to help them develop the social skills necessary to follow the ground rules of exploratory talk, supporting the findings of Monaghan (2006).

The following example of dialogue implied that many of the children were able to scaffold each others' learning, using the initiation-response-feedback technique, in a way that benefitted them all. Use of some of the words commonly associated with exploratory talk, as identified by Wegerif and Mercer (1997), are shown in bold.

Middle: It's a divide question.

High: Why?

*Middle: **Because** it's really about sharing. Sharing the children. So 64 shared between 6 is . . . what?*

*Low: **I think** we just count up with our 6s when it's sharing.*

*Middle: **Let's** try. Well 10 lots of 6 is 60. So . . .*

*Low: **But** that doesn't fit.*

*High: It's OK. It does. There's just 4 left over. That's OK. You can have that. **I think** that's the answer.*

Middle: Oh yeh. 6 teams and 4 left. That's it.

Observations showed that groups in which the children were friends were the most consistent in the class at keeping discussion on task. This supported the findings of Light and Littleton (1998) who have suggested that the quality of the pre-existing relationship between members of a group can help promote high quality talk in collaborative learning.

Further observations showed that, in pupil–pupil dialogue, the children were much less concerned with using explicit mathematical language than they were when involved in teacher–pupil dialogue. This is apparent in the example above where the children use terms such as ‘lots of’, ‘sharing’ and ‘left over’. This meant that the discussion was able to flow more freely which seemed to contribute to the development of mathematical understanding, supporting the findings of Street (2005).

In contrast, the following typical example of more confrontational dialogue was heard between members of one of the control groups, who had been given no instruction on the use of exploratory talk. The higher ability child was over-confident and able to impose an incorrect answer on both the other children (a problem identified by Puncochar and Fox 2004) and the process of collaborative discussion was actually detrimental to the childrens' learning.

Middle: So what shape has 6 sides?

High: Octagon is 6

Low: I think it's hexagon

High: It's not. I remember that octagon window. That definitely had 6 sides. I'll draw it [draws a hexagon].

Low: That's not it. That's not an octagon.

Middle: It is. Two of us agree. You're wrong.

Low: But . . .

High: We're not supposed to argue.

Low: OK.

Analysis of the quantitative data gathered seemed to suggest that children of middle ability derived the most benefit from the study. In the final assessment, of the three children who achieved marks noticeably higher than the levels previously assessed by the school two were of middle ability. Perhaps this was because they had the opportunity to work collaboratively so as to scaffold their

learning at two levels and because many of the tasks set were ‘mid range’ and often just above their own level of competency (supporting Vygotsky, 1979). Qualitative data seemed to support this view. Both middle ability children who were interviewed thought that the tasks set in mathematics lessons were ‘really fun’ and said that they were able to focus more when working in mixed ability groups rather than on similar ability tables. The use of more exploratory talk in the classroom also seemed beneficial to their self-confidence as both children stated that they felt more confident talking in class after the study – ‘I don’t mind putting my hand up now if I think I know it’.

Five of the six children interviewed said that they preferred sitting in mixed ability groups as it gave them somebody to ask for support:

It takes too long to get the teacher. Before, often, nobody on my table got it so I ended up trying on my own and getting it wrong...now I can just ask the others for help

However, one of the most common causes of disagreement in the study were that ‘he doesn’t share’ or ‘he just takes over’ with reference to a higher ability child and this could suggest that rather than constructing knowledge collaboratively the higher ability children were assuming the role of teacher/helper. As one higher ability child explained:

*Now, in maths I help the others no but no-one helps me... Before, if I got stuck I got help as the others were at the same level... I like helping people but I don’t like doing it all the time. It’s not like I’m wasting my time but if I’m in the middle of something... it holds **me** back*

This seemed to accord with much of the current research that suggests that higher ability children gain the least benefits from exploratory talk if working collaboratively with 2, or 3, lower ability children (e.g. Schmitz and Winskell, 2008). However, one higher ability child notably did seem to benefit from constructing knowledge with others. As he stated:

I like being the teacher. I like helping and explaining what you should do... it’s really fun... and I get it more sometimes when I’m explaining... [X] is actually good for a ‘should’ and she taught me some stuff too when we were talking.

Implications for practice

The study had its limitations. It was a small-scale study and generalisations should not be made without further research being conducted into the impact on teaching practice of introducing more exploratory talk over a sustained period of time and the long-term benefits to children of different ability levels. However, some conclusions can be drawn.

- (1) The high level of on-task and productive dialogue that was recorded for most of the groups suggested that children were able to use exploratory talk to help scaffold their learning effectively and develop their mathematical understanding. However, it was necessary for the teacher to provide clear guidelines on the use of exploratory talk (Monaghan 2006); to set tasks that helped to promote dialogue between the children; and to effectively

- facilitate the use of exploratory talk as a way to develop ideas and concepts.
- (2) Children of medium ability in mathematics seemed to derive the most benefits from the introduction of exploratory talk. This differed slightly to the research of Light and Littleton (1998) which stressed the benefits of ‘symmetrical partnerships’. In accordance with much other research (e.g. Schmitz and Winskell 2008) the higher ability children derived the least benefit. The research also suggested that when children worked in friendship groups this provided the best opportunity to facilitate talk for learning (as supported by Light and Littleton 1998).

The main implication for practice found as a result of the study is that children should be encouraged to engage in more exploratory talk in mathematics lessons working in both same and mixed ability groups dependent on the task set. This would provide a range of opportunities to learn through dialogue and optimise the benefits of this learning tool for all children.

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