Generating mathematical talk in the Key Stage 2 classroom

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This action research, based in a mixed ability Year 6 classroom considers why children should talk in mathematics lessons and the conditions for allowing "good" mathematical talk to take place. Within the study a series of PHSE lessons were developed to support the children to arrive at their own understanding of mathematical talk and design their own rules and descriptions of good talk, which are referred to in subsequent lessons. This study ends with a lesson that shows examples of exploratory talk.

Keywords*:* Mathematics; Talk; PHSE; Exploratory talk;

Setting the context

This research took place in a Junior School, in which the majority of the teaching is 'didactic'. The children often lacked the ability to explain their mathematical thinking and lacked confidence in using technical vocabulary when working in groups. They were not used to working independently and did not really seem to think for themselves, particularly when solving problems. This was true for all subjects, and was an issue the school management team had identified as an area for improvement across the school. Previous research in the school made me aware of the lack of precise mathematical language that was used by the children in my school, and also how teacher-led the lessons were.

I realised that my idea of an effective mathematics lesson (detailed in Wickham 2008) would not be met just by the children knowing longer or more precise words. My hypothesis was that giving the children more opportunities to talk about mathematics would make them more likely to increase their understanding of mathematics, and precise vocabulary could then be introduced to them during the lessons so that they could then use in their discussions.

> …Children being able to perform aspects of mathematics satisfactorily … but being unable to give an estimate or to explain how or why the algorithm works. This is the difference between learning the vocabulary of a language and being able to use that vocabulary to communicate and understand" (Thompson 2003, 56).

I realised that the choice of task was key to getting the children to start talking. The area that most interested me involved changing the nature of classroom tasks to enable purposeful mathematical discussion. I wanted to find tasks that challenge groups of children to solve them by talking together, and tasks that create cognitive conflict, so the children have to discuss mathematics with each other.

Research on why children should talk in the mathematics classroom

As Hiebert, Carpenter et al (2007) state "Students who reflect on what they do and communicate with others about it are in the best position to build useful connections in mathematics." (Hiebert et al 1997, 6). This resonates with my beliefs about mathematics and how children learn best. "They must be given the opportunity to engage in the processes of *coming to know* – through problem solving, exploration, observation and practice – with direction and assistance from their teacher." (Reid, Forrestal and Cook 1989, 9). Although it is important that children have support from their teachers I do not completely agree with Reid et al. Children could talk amongst themselves, use reasoning to solve or attempt problems and still make useful connections to support their learning. "Ideas are constructed through interaction with others. Discussion helps children to master the language of mathematics and to clarify their conceptions of the subject." (Coles and Copeland 2002, p8).

> You need discussion in mathematics in order to learn:
> - What words and symbols mean;
> - How ideas link across topics;
> - Why particular methods work;
> - Why something is wrong;
> - How you can solve problems more effectively (Swan 2005, 31).

On a very simple level talking about mathematics would explain the meaning of symbols etc but it is the discussion with others or being able to verbalise (even internally) that would help them realise why something is wrong.

Types of talk

This section discusses the types of talk that might be present in a mathematics lesson and offers some possible progressions for talk. The categories, directly below, are referred to in many articles and books. Some appear to be commonly used, others are rarer. I have collated a list from a variety of sources (referenced throughout).

Transmissional talk – The talk used by teachers in transmissional lessons is where the children are 'lectured' and the curriculum is 'delivered' to them. This is how I have chosen to describe the practise I feel is currently happening in my school. It puts "heavy demands on both listening and reading skills, and students who were not successful were seen as unmotivated, feckless, inattentive or less able" (Cooke 2003, 1). This teacher led talk does not give children opportunities to practise and develop their own language. In response to this transmissional talk, pupils use formal/presentational talk.

Formal/presentational talk is "used by students to express their understanding either in spoken or written form. Formal speech can be used for a range of purposes, such as giving answers to closed questions, presenting findings to the groups or the teacher..." (SCAA 1997, 38). It "offers a 'final draft' for display and evaluation: it is often more focussed on the expectations of an audience than on the speaker's ideas." (Norman 1992, 126). This is what the children often use in didactic lessons where the teacher gives little thinking or discussion time when asking questions. It occurs when there is transmissional talk by the teacher, and when the children are presenting their final work.

It is also possible for children and adults to use less formal talk in lessons.

Informal talk is talk between students or students and adults that helps students gain confidence, explore ideas, refine understanding, and to rehearse and extend their repertoire of mathematical language (Adapted from SCAA, 1997, p38). Informal talk can include the following:

Disputational talk - "Which is characterised by disagreement and individualised decision-making. There are few attempts to pool resources, or to offer constructive criticism of suggestions… short assertions and challenges or counter-assertions" (Mercer 1995, 104) "the relationship [between partners] is competitive; information is flaunted rather than shared, differences in opinion are stressed rather than resolved, and the general orientation is defensive" (Mercer 1995, 105). The partners reason and work individually, despite working on a shared task.
Cumulative talk - "in which speakers build positively but uncritically on what the other has said. Partners use talk to construct a 'common knowledge' by accumulation. Cumulative discourse is characterised by repetitions, confirmations and elaborations" (Mercer 1995, 104). The partners have "implicit concerns with solidarity and trust, and the ground rules seem to require constant repetition and confirmation of partners' ideas and opinions" (Mercer 1995, 105) The partners/group try to agree and come to a joint conclusion.
Exploratory talk –

> In which partners engage critically but constructively with each other's ideas. Statements and suggestions are offered for joint consideration. These may be challenged and counter challenged, but challenges are justified and alternative hypothesis are offered. Compared with the other two types, in exploratory talk *knowledge is made more publicly accountable* and *reasoning is more visible in the talk.* Progress then emerges from the eventual joint agreement reached. (Mercer 1995, 104).

The students in the group use each other's ideas to come to conclusions. "More than the other two types, it is the kind of talk which has been found to be most effective for solving problems through collaborative activity" (Mercer 1995, 105).

In conclusion "Both presentational and exploratory talk are important in learning. Teachers need to be sensitive to the differences between them and to ensure a balance of opportunities" (Norman 1992, 126). In my research I was hoping to see exploratory talk taking place during the group work. This kind of talk allows pupils to develop their talk and to increase their understanding through sharing ideas and unpicking them together. The children would then be able to present their findings using formal talk.

Methodology

I used action research. The data includes observation notes, video recordings, lesson transcripts and work samples. I decided it was important to share the purpose of the research with the class, because, if my approach was to be successful, the children needed to be aware that I was changing the way they learnt in mathematics lessons and to have an idea about how this would look. I planned introducing the exploratory talk to the class and how to establish some ground rules to make this more purposeful type of talk possible. I wrote a series of six lesson plans to introduce the children to mathematical talk which included possible rules to share with my class.

Talking about talk

The children became very interested in the subject and motivated to prove that talking in lessons worked so that they could then work in groups in mathematics and not in silence. I do not think the subsequent lessons would have been as effective if the children had not been involved in the decision process. "The children are expected to follow them [the rules] when engaged in any joint discussion activities in class. It is therefore important that they feel some ‘ownership’ and responsibility for adherence to them” (Mercer, Wegerif and Dawes 1999, 100). It was also useful for me to hear their ideas and find out what was important to them. Their ideas were displayed in class. I made sure that the children were aware of how important it was for children to explain their reasons, especially in a mathematical context, but otherwise I agreed with the children’s ideas and did not need to influence their ideas.

As part of the series of PHSE lessons that I wrote and used with my class. I asked my children what they thought a good mathematical explanation included. I think it was important to involve the children in this process as they needed to be aware of the types of talk that would most help them in their learning so that they took ownership of their successes. It was also valuable to have this discussion as the children had not previously related their understanding of talk and good talkers and good listeners to a mathematical context as much as I had hoped. The children were able to give lots of general suggestions (e.g. “explain how you know”), but found it difficult to give specific vocabulary that would be included in a good mathematical explanation. I made their suggestions into a poster to add to the class display on talk.

I shared some of the transcripts from the lessons with my class. Some groups recognised good talk as agreeing on an answer, explaining what they are doing, talking to each other, reading the question, correcting each other, helping each other, explaining the question to each other. Many children were able to recognise ‘bad talk’ as jumping to conclusions without trying it out, and not using mathematical vocabulary. Unfortunately it was not possible to video this lesson, but their suggestions were recorded during the lesson. When asked why the later example was better the class replied that the group were:

- Talking about the work.
- Giving reasons why it’s the answer, not saying “it’s that one”.
- Working well as a group.
- Using better mathematical vocabulary.

We also talked about how we could improve the talk they suggested to use more mathematical words, and to take turns/talk one at a time, not all at once. We discussed which bits of the video showed exploratory talk, the class suggested:

- The group asked questions “is it..?” and “why is it…?”
- They checked it over 3 or 4 times, then “let’s go on to the next one”.

Putting their talk into practice

To give the children opportunity to use the talk they had been learning about and practicing I chose to use “Lesson N9 Evaluating directed number statements” (Swan 2005). The lesson is from the Standards units for improving learning in mathematics. Although this is a further education resource for sixteen year olds, it was an appropriate challenge for my year 6 top set, who we were hoping would all achieve a National Curriculum level 5. The lesson involved sorting statements involving negatives into ‘always true’, ‘sometimes true’, and ‘never true’. I decided to split the lesson into two parts, the first lesson was to sort the addition and subtraction statements and the second lesson was the multiplication and division statements. I felt the lessons met all my criteria for choosing a task to enable mathematical talk. Both lessons were very successful. The following piece of transcript is from the first lesson (Each bullet point is a new speaker in this group of 3 children)

- If you added that would it go to 0?

- No that's not right, it said...
- -5 + -6
- Sometimes, because if you add the same number that would take it to 0
- No, that would be –11,
- -11
- Yes it would, because the two minuses, I think it's always true
- Because you are plussing minuses together, it's the same as adding plusses together...
- Explain more?
- Well like 5 and 6 would be 11, -5 and –6 would be –11. Add the minuses together…
- It's pretty much exactly the same as that... (Draws a number line) –9..-10..-11 add minus 6 it goes…
- That's always true!

I felt this transcript showed exploratory talk. The group listened to each other's ideas and considered them, but then challenged them and improved their ideas until they came to a joint understanding. They worked together collaboratively to solve the problem.

The second lesson was observed by my Head Teacher. The class explored the meaning of the word "generalisation" in this lesson. They also were able to extend their investigation by writing the statements using their own notation e.g. writing one of the statements on the cards as P÷P=N (Where P = Positive number and N = Negative number). One of the groups became interested with decimals and explored the statements using decimals, which was very interesting as for a while they added D = Decimal number into their notation, and did not think about whether that decimal was positive or negative. On my feedback form my Head Teacher commented that "the learners were obviously used to working in this way, being confident to discuss ideas and not afraid for their theories to be disproved," and "The learners were skilled in being able to use 'talk' as a tool to discuss ideas and test out theories on each other." This implies that she heard exploratory talk where the children challenged each other's ideas before coming to conclusions as a group. My Head Teacher also commented, "Most (learners) were very articulate and could use concrete examples to prove or disprove an abstract theory". I found it very constructive to have this feedback because, where I have worked with the children all of the time I had not realised how much better they have become at using talk in mathematics, and it was interesting to see how an outsider viewed the value of their talk in the lesson.

Conclusions

Children are able to learn from each other through discussion. Talking in mathematics helps the children to reflect on their thinking, instead of just saying 'because it is' and helps them to explore and form new understanding. "If you would like students to understand, then be sure they are reflecting on what they are doing and communicating it to others." (Hiebert et al 1997, 18)

It is important to use rich mathematical tasks and have a culture that encourages talk and learning. "Tasks are the key. They provide the context in which students can reflect on and communicate about mathematics" (Hiebert et al 1997, 18). Children need to be given tasks that interest them and that are accessible and challenging. The choice of activity is important to get the children to talk mathematically. It needs to be relevant and it needs to be a rich mathematical task. It is not just the choice of task that generates mathematical talk, but the culture of the classroom.

I believe that the PHSE lessons were very important. It was vital for the children to be involved in the research process, so they were clear about the definitions and rules. It also helped transform the culture of the classroom.

I found that allowing the children involvement through their 'pupil voice' encouraged the pupils to become partners in their learning. I felt this was important, as it was their learning that I was changing, so they had a right to an opinion. The children in my class felt it was important that they were involved in the research. When asked they said it made it more exciting for them, and they learnt more than if I had just told them to start talking more in mathematics. Part of the "Every Child Matters" agenda (QCA 2007) is that children need to learn how to work effectively with others. In my research, the children worked together to investigate and explicitly decide how they could work together. The children got to make genuine decisions that affected how they worked and learnt together in lessons.

The study improved the children's ability to explain their mathematics. The leadership team at school studied the children's practice SATs papers and commented on how well my class had done on the questions that asked the children to write an explanation. I believe this is because they are more experienced than previous year groups in orally explaining their thinking. Although this is based purely on their opinion it was reassuring that I was not the only person that felt the children were now good at explaining their understanding.

In the future I would like to develop a set of criteria to apply to a task to help me to ensure that the task will enable purposeful mathematical talk in the lesson. I would like to develop my PHSE lessons further, particularly to include lessons that develop the children's ability to ask questions in mathematics.

References

Cooke, S. 2003. Learning through dialogue, NALDIC website: http://www.naldic.org.uk/ITTSEAL2/teaching/SpokenLanguage.cfm (Accessed 12 January 2008)

Flanders, N. 1970. *Analysing teaching behaviour*. Reading: Addison-Weasley Publishing Company

Hiebert, J, T.Carpenter, E. Fennema, K. Fuson, D. Wearne, H. Murray, A. Olivier and P. Human. 1997. *Making sense. Teaching and learning mathematics with understanding,* London: Heinemann

Mercer, N. 1995. *The guided construction of knowledge: Talk amongst teachers and learners.* Clevedon: Cromwell Press

Mercer, N., R.Wegerif and L. Dawes. 1999. Children's talk and the development of reasoning in the classroom. *British Research Journal,* 25(1), (Feb., 1999), pp. 95-111

Norman, K. 1992. *Thinking voices – The work of the national oracy project,* London: Hodder and Stoughton

QCA 2007. Every child matters http://www.qca.org.uk/qca_15299.aspx Accessed 5 May 2008

Reid, J., P. Forrestal, and J. Cook. 1989. *Small group learning in the classroom,* Scarborough: Chalk face Press

Swan, M. 2005. *Standards units: Improving learning in mathematics,* Sheffield: DfES

Wickham, L. 2008. Strategies for generating mathematical talk in a key stage 2 classroom, July 2008, Unpublished MA (Mathematics Education) dissertation