How can questioning to create thoughtful reflection and learning in mathematics?

Stone, P.

In Sangster, M. (ed) Developing Teacher Expertise: Exploring Key Issues in Primary Practice. London and NY: Bloomsbury

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Paula Stone

The way we as teachers engage with children in the classroom is deeply embedded in our culture (Alexander, 2001) however, it is important to bear in mind the learning and teaching interaction between teachers and pupils is very complex. One would assume that questioning generates higher level thinking and discussion and maximises the potential of a learning opportunity in the classroom, and it is the teachers' ability to ask questions and more importantly respond to them that engages pupils, and promotes learning. However the findings of several studies reveal that although teachers ask lots of questions they are rarely used to encourage elaborated ideas (Smith et al., 2004). Furthermore, Dillon (1981) found that too many questions can evoke anxiety and can actually make pupils dependent on their teacher and become passive learners.

How can teachers and student teachers get it right?

There is a wide range of research dating back over 100 years that has examined the number and purposes of questions teachers ask (Stevens, 1912; Haynes, 1935; Gall, 1970, all cited in Wragg and Brown, 2001). More recently, Wragg and Brown (2001) have suggested that a teacher asks on average 300 questions a day and of these 57% are managerial type questions, 35% are used to gather information or recall data and 8% are higher order questions which encourage children to reason and reflect on their learning. If this was the distribution in your own lesson, what changes would you make and why? Why not count the number and type of questions in one mathematics lesson and reflect on the impact on children's learning.

Focussing on those questions that are related to learning – recall questions are generally closed questions that have just one correct answer and open questions which usually offer opportunity for possible alternative responses. There is general agreement based on a wide range of academic research (Bloom, 1956; Wragg and Brown, 2001; Alexander, 2004; Hodgen and Wiliam, 2006) that open questions are more likely to encourage higher order thinking and lead to greater understanding.

Can you think of reasons why? Here are few suggestions, open questions: enable children to enter the activity at their own starting point based on their own ability; engage in mathematical dialogue and observe other people being mathematical; extend their conceptual knowledge or apply knowledge in new contexts and encourage children pose as well as solve problems.

Consider the difference between;

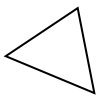
What are four threes? and Tell me two numbers with a product of 12.

45 + ☐ = 60 and Here's the answer, what could the question be?

Think of some examples you have used with children.

Of course each type of question has their use and purpose and we as teachers need to consider when it is appropriate to use open or closed questions. However, research by Smith et al. (2004) found that in numeracy lessons teachers spent the majority of their time asking questions that were of a low cognitive level designed to channel pupils' responses towards a required answer. They found that only 10% of the questions were open and only rarely were teachers' questions used to ask pupils for more complete or elaborated ideas.

So what constitutes a good question in a mathematics lesson? Discuss with a peer which of these questions is more likely to require recall or promote higher order thinking and why? When would it be best to use each type of question?

What is this shape called? 

Give me a definition of a triangle

Draw me a triangle…….. Now draw another different one, and another. What is the same and different about each one?

Askew and Wiliam (1995) advocate the blend of higher order and lower order questions that match the needs of the learning outcome and the children in the class.

This is supported by Wragg and Brown (2001) who suggest that teachers have to choose what kinds of learning they want to promote and then choose the appropriate questions. For example if it is a lesson in which you are mainly focusing on facts, rules and procedure, for example learning the times tables, you may be more likely to ask closed questions which relate to knowledge. Or, if it is a lesson in which you are focusing mainly on understanding of mathematical concepts like examining the properties of shape or responding to a statement like 'An even number that is divisible by 3 is also divisible by 6', you will be more likely to use open questions which relate to analysis, synthesis and evaluation.

If we, as teachers, want to encourage thought and thoughtful responses from the children we need to plan appropriate questions based on the learning outcome - it is not good enough merely to rely on our ability to ask questions as issues arise spontaneously in the lesson. Planning what type of question you will use is just one aspect of effective questioning techniques. Do you ever plan how you are going to distribute your questions; how you are going to pitch the questions so that they match the needs of the pupils; and how you are going to respond when the child gives an answer? These are all crucial elements to effective questioning.

Wragg and Brown (2001) claim that it is easy for teachers to deceive themselves about how many children, and who, have answered the questions in their lessons. They suggest that questions should be directed so that more pupils are involved more of the time. Can you discuss some strategies that you have observed and what made them more or less effective?

However, it is neither the act of asking questions itself, nor the type of question teachers ask, which limits pupil response in mathematics lessons, but the feedback given in reaction to pupil responses that has the greatest impact (Smith et al., 2004). According to Alexander (2003), the English primary education system is

'dominated by closed questions inviting recall, limited 'wait' time for pupil thinking, brief answers which deliver information rather than access speculation and problem-solving, feedback which praises and supports but does not diagnose and inform, many questions from teachers but few from pupils, and little systematic building upon answers in order to construct coherent lines of reasoning and enquiry.' (p.6)

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Teachers sometimes fail to see the implications of their responses to children's answers to their questions. Some of the most common teachers' responses I have observed in mathematics lessons are when children's answers are ignored and the teacher moves on, or the teacher acknowledges but terminates the response with evaluative feedback (e.g. yes, no, well done). Both of these responses are usually demonstrated because the answer was correct; or the answer was incorrect or inappropriate; or indeed if there is a deficit in the teacher's subject knowledge.

Teachers need to go beyond the use of initiation-response-feedback type interaction in mathematics lessons by asking open-ended questions and follow-up questions, including asking pupils to justify or explain their answer through the use of further prompting and probing questions. Prompts contain hints that can help children if they are stuck or having difficulty explaining their reasoning. This can be done by rephrasing the question using more simple language or linking the learning to children's experience; asking a sequence of questions or by providing new information:

> Can you describe the problem in your own words?
> Can you talk me through what you have done so far?
> What did you do last time?
> Is there something that you already know that might help?
> Could you try it with simpler numbers… fewer numbers… using a number line…?
> What could you try next?
> Is it a reasonable answer/result?

Probing questions are an effective strategy to encourage children to think more deeply about their responses and give more precise or detailed responses. Some examples include:

> How do you know……?
> Why do you think that……..?
> Do you have a reason……..?
> Can you give me an example…….?
> Is this always so…….?
> Is there another way/reason/idea……..?

What if…….? What if…….does not…..?

Where is there another example of this…..?

What do you think happens next?

It is at this point that one might want to consider the use of wait time (Askew and Wiliam, 1995) or talk partners so that the individual child feels less pressured or you want to engage all the children in their learning.

To promote a classroom culture in mathematics where children are offered more opportunities to think and talk about their mathematics, you will need to consider your questioning style. Plan your questions based on the learning outcomes; think about whether you can use open questions instead of closed questions; anticipate how children may respond; and most importantly think about how you will respond appropriately to what pupils say. In this way you can promote higher level thinking that maximises the potential of a learning opportunity.

References and further reading

Alexander, R. (2001) *Culture and Pedagogy: International Comparisons in Primary Education,* Oxford: Blackwell

Alexander, R. (2003) *Talk for Learning: the first year,* Northallerton: North Yorkshire County Council.

Alexander, R.(2004) *Towards Dialogic Teaching: Rethinking Classroom Talk*, Cambridge:Dialogos.

Askew, M. and Wiliam, D. (1995) *Recent Research in Mathematics Education*, London: HMSO

Bloom, B., Engelhart, M., Furst, E., Hill, W. and Krathwohl, D. (1956). 'Taxonomy of educational objectives: the classification of educational goals' in Handbook *I: Cognitive Domain*, New York: Longmans

Dillon, J. (1981) 'To question or not to question in discussion' in *Journal of Teacher Education*, Vol 32, (pp51-55)

Hodgen, J. and Wiliam, D. (2006) *Mathematics inside the black box: Assessment for learning in the mathematics classroom,* London: NFER Nelson

Kyriacou, C. and Issitt, J. (2008) *What characterises effective teacher-initiated teacher-pupil dialogue to promote conceptual understanding in mathematics lessons in England in Key Stages 2 and 3?* London: EPPI Centre, Institute of Education

Myhill, D., Jones, S. and Hopper, R. (2006) *Talking, listening learning: effective talk in the primary classroom.* Maidenhead: Open University Press,

Mercer, N. and Sams, C. (2006) 'Teaching children how to use language to solve maths problems' in *Language and Education,* Vol 20:6, (pp. 507-528) 6AA

Mercer, N. and Littleton, K. (2007). *Dialogue and the Development of Children's Thinking: A Sociocultural Approach*, London: Routledge.

Smith, F., Hardman, F., Wall, K. and Mroz, M. (2004) 'Interactive whole class teaching in the national literacy and numeracy strategies' in *British Educational Research Journal*, Vol 30:3, (pp395–411)

Wragg, E. and Brown, G. (2001) *Questioning in the Primary School*, London: Routledge

Wragg, E. (1993) 'Teaching Teaching' in *Classroom Teaching Skills*, London: Routledge