Good questioning techniques have long being regarded as a fundamental tool of effective teachers. Unfortunately, research shows that 93% of teacher questions are "lower order" knowledge based questions focusing on recall of facts (Daines, 1986). Clearly this is not the right type of questioning to stimulate the mathematical thinking that can arise from engagement in open problems and investigations. Many Primary teachers have already developed considerable skill in good questioning in curriculum areas such as Literacy and History and social studies, but do not transfer these skills to Mathematics. Teachers' instincts often tell them that they should use investigational mathematics more often in their teaching, but are sometimes disappointed with the outcomes when they try it.

There are two common reasons for this. One is that the children are inexperienced in this approach and find it difficult to accept responsibility for the decision making required and need a lot of practise to develop organised or systematic approaches. The other reason is that the teachers have yet to develop a questioning style that guides, supports and stimulates the children without removing the responsibility for problem-solving process from the children.

Types of Questions
Within the context of open-ended mathematical tasks, it is useful to group questions into four main categories (Badham, 1994). These questions can be used by the teacher to guide the children through investigations while stimulating their mathematical thinking and gathering information about their knowledge and strategies.

1. Starter questions
These take the form of open-ended questions which focus the children’s thinking in a general direction and give them a starting point. Examples:
   How could you sort these.......?
   How many ways can you find to ...... ?
   What happens when we ........ ?
   What can be made from.....?
   How many different ...... can be found?

2. Questions to stimulate mathematical thinking
These questions assist children to focus on particular strategies and help them to see patterns and relationships. This aids the formation of a strong conceptual network. The questions can serve as a prompt when children become 'stuck'.
(Teachers are often tempted to turn these questions into instructions, which is far less likely to stimulate thinking and removes responsibility for the investigation from the child).
Examples:
   What is the same?
   What is different?
Can you group these in some way?
Can you see a pattern?
How can this pattern help you find an answer?
What do think comes next? Why?
Is there a way to record what you've found that might help us see more patterns?
What would happen if....?

3. Assessment questions
Questions such as these ask children to explain what they are doing or how they arrived at a solution. They allow the teacher to see how the children are thinking, what they understand and what level they are operating at. Obviously they are best asked after the children have had time to make progress with the problem, to record some findings and perhaps achieved at least one solution.
Examples:
What have you discovered?
How did you find that out?
Why do you think that?
What made you decide to do it that way?

4. Final discussion questions
These questions draw together the efforts of the class and prompt sharing and comparison of strategies and solutions. This is a vital phase in the mathematical thinking processes. It provides further opportunity for reflection and realisation of mathematical ideas and relationships. It encourages children to evaluate their work.
Examples:
Who has the same answer/pattern/grouping as this?
Who has a different solution?
Are everybody's results the same?
Why/why not?
Have we found all the possibilities?
How do we know?
Have you thought of another way this could be done?
Do you think we have found the best solution?

Levels of Mathematical Thinking
Another way to categorise questions is according to the level of thinking they are likely to stimulate, using a hierarchy such as Bloom’s taxonomy (Bloom, 1956). Bloom classified thinking into six levels: Memory (the least rigorous), Comprehension, Application, Analysis, Synthesis and Evaluation (requiring the highest level of thinking). Sanders (1966) separated the Comprehension level into two categories, Translation and Interpretation, to create a seven level taxonomy which is quite useful in mathematics. As you will see as you read through the summary below, this hierarchy is compatible with the four categories of questions already discussed.

1. Memory: The student recalls or memorises information
2. Translation: The student changes information into a different symbolic form or language
3. **Interpretation**: The student discovers relationships among facts, generalisations, definitions, values and skills

4. **Application**: The student solves a life-like problem that requires identification of the issue and selection and use of appropriate generalisations and skills

5. **Analysis**: The student solves a problem in the light of conscious knowledge of the parts of the form of thinking.

6. **Synthesis**: The student solves a problem that requires original, creative thinking

7. **Evaluation**: The student makes a judgement of good or bad, right or wrong, according to the standards he values.

**Combining the Categories**

The two ways of categorising types of questions overlap and support each other.

For example, the questions:
- Can you see a pattern?
- How can this pattern help you find an answer? relate to Interpretation, and;

the questions:
- What have you discovered?
- How did you find that out?
- Why do you think that? require Analysis, and;

the questions:
- Have we found all the possibilities?
- How do we know?
- Have you thought of another way this could be done?
- Do you think we have found the best solution? encourage Evaluation.

In the process of working with teachers on this topic, a table was developed which provides examples of generic questions that can be used to guide children through a mathematical investigation, and at the same time prompt higher levels of thinking.

**References**

Badham, V. (1994) What’s the Question?. Pamphlet 23. Primary Association for Mathematics (Australia)


[http://nrich.maths.org/2473](http://nrich.maths.org/2473)