IMPROVING LEARNING THROUGH QUESTIONING

PROFESSIONAL DEVELOPMENT GUIDE

Introduction

This module is designed to help teachers to reflect on:

- characteristics of questioning that encourage students to reflect, think and reason;
- ways in which teachers might encourage students to provide extended, thoughtful answers, without being afraid of making mistakes;
- the value of showing students what reasoning means by 'thinking aloud'.

Activities

Time

Approximately 1½ hours

Acknowledgement:

In preparing this material, we acknowledge the permissions given by the Bowland Charitable Trust to adapt the professional development resources, Bowland Maths (www.bowlandmaths.org), that they had previously funded the University of Nottingham to produce for the UK. This includes many of the handouts and most of the video extracts. Additional resources were also adapted from *Improving Learning in Mathematics*, a government funded program in the UK and from the *Mathematics Assessment Project* funded by the Bill and Melinda Gates Foundation.

Activity A: Reflecting on the questions we ask

Teachers ask many different types of questions and these serve many different purposes within a lesson. Give teachers time to discuss the following questions in pairs and small groups. Ask them to consider a few specific examples and think about the purpose of the question, the expected responses from students and their actual responses.

Ask them to record their collective ideas on a copy of **Handout 1:** *Thinking about why we ask questions*.

- What different types of questions are there?
- What different functions do these questions serve?
- Which types of questions do **you** use most frequently?

Then hold a plenary discussion to collect and share ideas. As teachers suggest different purposes, ask them to give particular examples.

Teachers ask questions for many possible reasons, such as listed here:

- to interest, engage and challenge;
- to assess prior knowledge and understanding;
- to stimulate recall, in order to create new understanding and meaning;
- to focus thinking on the most important concepts and issues;
- to help students extend their thinking from the factual to the analytical;
- to promote reasoning, problem solving, evaluation and the formation of hypotheses;
- to promote students' thinking about the way they have learned;
- to help students to see connections.

In a classroom situation, asking a question is a first step towards a process of formative assessment as the students' responses provide the teacher with some indication of the student's knowledge and understanding. However, the student responses need to be interpreted by the teacher before he or she can decide what to do next. For example, an incorrect response could have been the result of a careless slip, for which no remedial action is required on the part on the teacher. On the other hand, the incorrect response may have resulted from a lack of understanding, in which case the teacher would want to take some remedial action. The teacher will use his or her knowledge of the students and the context, often using follow-up questions as well, to make judgments about what the responses of the students mean in terms of their understanding.

Handout 2: *Common mistakes when asking questions* shows a list of some of the more common mistakes that teachers make in their use of questioning.

Ask teachers to discuss in pairs or small groups the impact of these common mistakes on student learning and write some notes in the column 'unintended effect' on Handout 2.

Finally, ask them to think about the mistakes that they make in their own questioning.

- What mistakes do you make when asking questions?
- What are the unintended effects of each of these mistakes?

Activity B: Types of questions that develop thinking and reasoning

Some questions can be more effective in developing student thinking and reasoning than others. It is important to elicit evidence on where the students are in their understanding and to decide what feedback to give them in order to move their learning forward.

Ask the teachers to use their own experience to find examples of particular types of questions that stimulate student thinking. Ask them to record their collective ideas on a copy of **Handout 3:** *What types of questions develop thinking and reasoning?*

What conclusions can they reach by considering these examples? Ask teachers to consider:

- The types of questions that promote thinking and reasoning.
- Examples that you have recently used that stimulated students' thinking.
- The implications of these ideas for your own practice.

Afterwards give them copies of **Handout 4:** *Five principles for effective questioning*. This summarises some research findings about questioning. It shows that effective questioning displays the following five characteristics:

- The teacher plans questions that encourage thinking and reasoning. (The module *Introducing formative assessment* provides a list of such questions that could be used in the context of problem-solving tasks.)
- Everyone is included.
- Students are given time to think.
- The teacher avoids judging students' responses.
- Students' responses are followed up in ways that encourage deeper thinking.

Invite teachers to discuss the research findings in small groups.

- Which of these principles do you usually implement in your own teaching?
- Which principles do you find most difficult to implement? Why is this?

Activity C: Observing and analysing a problem-solving lesson

This activity focuses on a video recording of a specific lesson:

- to show the effects of using different questions in the classroom;
- to help teachers reflect critically on their own classroom practice.

Explain to the group that, for this activity, a particular lesson is used.

Give them **Handout 5:** *Observing a lesson,* and ask them to think about the *Sharing petrol costs* task. They might like to discuss their emerging solutions with a colleague, before comparing the two solutions shown. Point out that there is space on the handout for them to make their response to the question:

- Compare the two solutions. Which do you consider better and why?

Explain that you will now watch a video recording of a British teacher teaching the lesson[1]; briefly discuss the other questions on the handout, thus making the teachers aware of what to look out for as they watch the video. Now, as a group, watch the **Activity C Video:** *Gwen's lesson*.

Video: Gwen's lesson

- Which of the following principles can you see Gwen using in her lesson? Give examples.
  - Plan questions that encourage thinking and reasoning.
  - Ask questions in ways that include everyone.
  - Give students time to think.
  - Avoid judging students' responses.
  - Follow up students' responses in ways that encourage deeper thinking.
- What do you think students learned in this lesson?

[1] http://map.mathshell.org/pd/modules/4_Questioning/html/videos_c1.htm

The following are examples of Gwen using the principles. Participants might provide more examples.

- Plan questions that encourage thinking and reasoning.

  Gwen has carefully planned the lesson so that the focus is not on answers but on reasoning. She begins the lesson by emphasizing that lesson will be focused on the quality of students' thinking, reasoning and explaining, and on listening to each other. This message is reinforced throughout by her interactions with students:

  "Do you want to explain to me why that is fair?"; "How are you thinking of the journey? Can you explain to me...?"; "How are you going to work out...?"; "What else is there that might help you? That's all I'm going to say. Keep thinking."

- Ask questions in ways that include everyone.

  Gwen has introduced a 'no hands up' rule, so that she can choose who will respond to her questions and so that students continue to think while responses are made. She tries to encourage a range of responses and asks students to comment on each other's responses.

- Give students time to think.

  Gwen gives students time to think individually before discussing, so that they all have something to share.

- Avoid judging students' responses.

  Gwen collects the students' initial ideas and writes these on the board. She asks follow---up questions for clarification ("Just explain a little bit more about that.") and thanks them for their contributions, but does not judge responses with 'Well done', or 'That's not quite right.'

- Follow up students' responses in ways that encourage deeper thinking.

  For example, Gwen invites students to elaborate: "Can you just say that again?"; asks students to think aloud: "Can you explain your thinking Alex?"; cues alternative responses: "Bethany, what do you think is best out of Hannah's suggestions?".

Note: The professional development module *Introduction to formative assessment* also considers, in some detail, ways in which teachers can respond to students' answers to problem-solving tasks.

Activity D: Solving a problem by 'thinking aloud'

This activity is intended to stimulate further reflection on the way in which questions can be used by considering a particular example involving 'thinking aloud'. In this case questioning and discussion form part of the process of solving a problem, in conjunction with student explanations of their thinking.

Teachers usually present science and mathematics as a set of tidy results and procedures. Students often don't recognise the invisible, messy processes that go on inside the heads of scientists. One reason why some students are reluctant to persist is that they do not recognise that it is perfectly natural to get stuck, make mistakes, backtrack and look for alternative strategies. It is helpful, therefore, for a teacher to model these processes by tackling a problem from start to finish, 'thinking aloud' and involving the class by careful questioning.

Try working out an answer to the following problem, 'thinking aloud' as you do so:

About how many dentists are there in your country?

Afterwards think what it would feel like, doing this with a class, not knowing the answer beforehand.

If you are working with a group of teachers, two volunteers should now tackle the problem publicly, thinking aloud at the front of the room. The other teachers should take the role of the students and try to assist when asked to do so.

Afterwards, discuss other possible strategies that might help students recognise the mental processes that scientists and mathematicians use every day. These may include, for example, the following:

- Making a video of yourself and some colleagues solving a problem, while thinking aloud and discussing this with your class.

Video: 'Thinking Aloud'[2] shows a group of British teachers solving a problem

- Students watching or reading biographies of mathematicians and scientists as they talk about their struggles and breakthroughs. See for example, Andrew Wiles' story on Youtube: http://video.google.com/videoplay?docid=8269328330690408516
- After working on a problem, reading solution attempts produced by other students can reveal errors, and the multiple trials and dead ends that have been encountered. Ask the students to work together to find, correct and comment on the 'errors in reasoning'. They should also comment on where the reasoning was good so that they can use these ideas again.

[2] http://map.mathshell.org/pd/modules/4_Questioning/html/videos_e1.htm