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| Building on what students already know How can I respond to students in ways that improve their learning? |

### Introduction

Inquiry-based teaching assumes that students do not arrive at sessions as ‘blank slates’, but as actively thinking people with a wide variety of skills and conceptions. Research shows that teaching is more effective when it assesses and uses prior learning so that the teaching may be adapted to the needs of students (Black & Wiliam, 1998). Prior learning may be uncovered through any activity that offers students opportunities to express their understanding and reasoning. It does not require more testing. For example, it can take the form of a single written question given at the beginning of a session to elicit a range of explanations that may then be discussed. This process, often referred to as formative assessment, may be defined as:

*"… all those activities undertaken by teachers, and by their students in assessing themselves, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged. Such assessment becomes ‘formative assessment’ when the evidence is actually used to adapt the teaching work to meet the needs." (Black & Wiliam, 1998 para, 91)*

### This module considers the different ways this can be done and focuses on the following questions:

How can problems be used to assess performance?

How can this assessment be used to promote learning?

What kinds of feedback are most helpful for students and which are unhelpful?

How can students become engaged in the assessment process?

### Activities

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*Acknowledgement:*

In preparing this material, we acknowledge the permissions given by the Bowland Charitable Trust to adapt the professional development resources, *Bowland Maths*, that they had previously funded us 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. The original sources are:

Swan, M; Pead, D (2008). *Professional development resources*. Bowland Maths Key Stage 3, Bowland Trust/ Department for Children, Schools and Families. Obtainable in the UK from: <http://www.bowlandmaths.org.uk>.

Swan, M; (2005). *Improving Learning in Mathematics*, challenges and strategies, Department for Education and Skills Standards Unit. Obtainable in the UK from <http://tlp.excellencegateway.org.uk/pdf/Improving_learning_in_maths.pdf>

### Related research to help your planning for this module.

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| Black, P., & Wiliam, D. (1998). *Inside the black box: raising standards through classroom assessment*. King's College London School of Education.  Now published by GL Assessment:  <http://shop.gl-assessment.co.uk>  This short booklet offers a summary of the extensive research literature into formative assessment. It shows that there is clear evidence that improving formative assessment raises standards, and offers evidence showing how formative assessment may be improved. This booklet is essential reading for all teachers. | Description: black box |
| Black, P., & Harrison, C. (2002). *Working inside the black box: Assessment for learning in the classroom*. King's College London School of Education.  Now published by GL Assessment:  <http://shop.gl-assessment.co.uk>  In this booklet, the authors describe a project with teachers in which they studied practical ways of implementing formative assessment strategies and the effect this had on learning. The section on feedback and marking (pages 8-9) are particularly relevant to this module. | Description: Working inside the black box |
| Black, P., Harrison, C., Lee, C., Marshall, B., & Wiliam, D. (2003). *Assessment for learning: Putting it into practice*. Buckingham: Open University Press.  This book gives a fuller account of the earlier booklets *Inside the black box* and *Working inside the black box*. It discusses four types of action: questioning, feedback by marking, peer- and self-assessment and the formative use of summative tests. The section on feedback and marking (pages 42-49) is particularly relevant to this module, while the section on peer and self-assessment (pp 49-53) is relevant for the next CPD module. | Description: AfL |
| Hodgen, J., & Wiliam, D. (2006). *Mathematics inside the black box*. King's College London School of Education. Now published by GL Assessment:  <http://shop.gl-assessment.co.uk>  This booklet applies the above findings specifically to Mathematics. It considers some principles for Mathematics learning, choice of activities that promote challenge and dialogue, questioning and listening, peer discussion, feedback and marking, and self and peer assessment. This booklet is essential reading for all mathematics teachers. | Description: math in black box |

## Activity A: Introducing formative assessment

#### Minimum time needed: 10 minutes.

###### The different types and purposes of assessment.

Invite participants to discuss the following issues:

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| * Why do you assess students? * What different purposes do your assessments serve? Make a list. |

Their list of reasons might include: diagnosing difficulties; celebratingachievement; motivating students; selecting students for classes; maintaining records to keep teachers and parents informed of progress; to assess teaching methods.

To summarize, there are two main purposes of assessment:

* *Summative assessment* - to summarise and record overall achievement at the end of a course, for promotion and certification. Most ‘high stakes’ tests and external examinations are designed for this purpose. Summative assessment is also used to evaluate the relative effectiveness of a particular course, teaching method, or even an institution.
* *Formative assessment* – to recognise achievements and difficulties at the beginning or during a course, so that teachers and students can take appropriate action. This type of assessment forms an integral part of all learning.

**The potential of formative assessment to improve learning.**

Briefly mention the research evidence that sets out the case for formative assessment. This is summarized by Black and Wiliam in several accessible publications for teachers (see opposite), most of which are freely downloadable on the internet. These researchers set out to find out whether or not improving formative assessment improves learning. “We checked many books and nine years' worth of more than 160 journals, and earlier reviews of research. This process yielded 580 articles or chapters to study. We prepared a review using material from 250 of these sources. All… studies show that… strengthening… formative assessment produces significant, and often substantial, learning gains. These studies range over ages, across several school subjects, and over several countries…” (Black and Wiliam, 1998).[[1]](#footnote-1)

This module will examine the implementation of formative assessment, based on this and other research. A second module will explore the role of self and peer assessment.

## Activity B: Teachers' own experiences of formative assessment

#### Minimum time needed: 10 minutes.

**What do teachers know about their students and what consequential action do they take?**

Ask participants to work in pairs, considering the following questions.

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| * Think of two students in your class, one who is particularly strong and one who is finding the work very difficult. Take it in turns to describe the students' strengths and difficulties to your partner, in as much detail as possible. * How did you become aware of these strengths and difficulties? On what evidence do you base your judgements? Test results? Memories of oral responses during lessons? Observations of the student working? Written work? * In what ways do your assessments of these students affect your lesson planning?  Give examples. |

**What difficulties do teacher encounter?**

Issue participants with copies of **Handout 1**: *Difficulties with formative assessment*.

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| * How far are the criticisms on the handout valid in your context? * If any are, then what may be done about them? |

### Handout 1 Difficulties with formative assessment

Description: A_Handouts

## Activity C: Principles for formative assessment

#### Minimum time needed: 20 minutes.

Issue participants with a copy of **Handout 2**. The ideas presented here are all drawn from research into formative assessment.

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| * Bearing in mind the difficulties discussed in Activity B, how would you suggest that your formative assessment practices be improved? * Discuss the principles outlined on **Handout 2**.   + Which of these do you currently use in your own teaching?   + Which do you find most difficult? Why? * What other principles do you think are important? |

Issue copies of **Handout 3**.

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| *"It's all very well telling us to assess our students, but how can a busy teacher know what is going on inside 30 individual heads?"*   * How would you answer this teacher? * What strategies do you have for finding out what students are thinking in your lessons? * Discuss the two suggestions shown on **Handout 3**, and watch the movies to see these in action. * Suggest some further strategies for making reasoning more evident. | *Description: Picture 10* |

The two strategies described on Handout 3 and on the **movies** accompanying this activity may help to make reasoning more 'visible'.

**Mini-whiteboards** are an indispensable resource for the following reasons:

* When students hold their ideas up to the teacher, it is possible to see at a glance what *every* student thinks.
* During whole class discussions, they allow the teacher to ask new *kinds* of question (typically beginning: ‘Show me an example of....’).
* They allow students to, simultaneously, present a range of written and/or drawn responses to the teacher and to each other.

**Posters** are also a powerful way of helping students to externalise their thinking. This use does not require 'polished', 'complete', 'attractive' products but rather they should be seen as working documents. Perhaps the simplest way of using a poster is for students to solve a problem collaboratively, explaining the thought processes involved at every step. A second use of posters is to find out what they already know about a given topic. In the diagram shown on Handout 2, the teacher asked students to write down all they knew about *y*=2*x*-6. As a class, the diagram was developed on the whiteboard. Students were then given a variety of equations (the level of challenge was varied appropriately) and were asked to produce their own poster. The discussion enabled the teacher to assess how much learners knew about equations and how well they were able to link the ideas together.

### Handout 2: Principles for formative assessment

### Description: A_Handouts copy.pdf

### Handout 3: Making reasoning visible.

### Description: Reasoning.pdf

## Activity D: Analyse students’ responses to problem-solving tasks

***Minimum time needed: 20 minutes***

**Handout 4** presents three problems together with four student responses on each. The tasks are: *Counting Trees, Cats and Kittens, Security Cameras.*

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| * Read through all three tasks then choose one task that will be most suitable for a class you will soon teach. If you are working on this module in a group, it will be helpful if each participant chooses the same problem, as this will facilitate the follow-up discussion. * Consider the four student responses. What does each student’s response tell you about his or her capacity to use each of the processes: *represent, analyse, interpret and evaluate, communicate and reflect*? |

**Handout 5** offers some comments on students’ responses to each of the tasks.

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| * If you were the teacher of these students, what feedback would you give them, to help them improve their responses? Try to frame this help in the form of oral questions you could ask in the classroom. You may find it helpful to refer to the generic questions given on **Handout 6**. * Watch the video of three teachers discussing the feedback they gave on the three problems. | Description: Picture 9 |

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| Handout 4: Assessment tasks and sample responsesDescription: A_Handouts copy_Primas.pdf | Handout 5: Improving students' responses through questioningDescription: A_Handouts copy_Primas.pdf |
| Handout 6: Suggestions for questionsDescription: A_Handouts copy_Primas.pdf | |

## Activity E: Analyse students’ responses to concept-focused tasks

***Minimum time needed: 20 minutes***

On **Handout 7**, we present four mathematical topics and some sample student work on each one.

Ask participants to assess each response and try to identify the reasoning that lies behind each one.

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| * What does the student appear to understand? Where is your evidence? * List the errors and difficulties that are revealed by each response. * Try to identify the thinking that lies behind each error. * What feedback would you give to each student?   There are two common ways of reacting to pupils' errors and misconceptions:  (i) Avoid them whenever possible: "If I warn pupils about the misconceptions as I teach, they are less likely to happen. Prevention is better than cure."  (ii) Use them as learning opportunities: "I actively encourage pupils to make mistakes and learn from them.   * What is your view? |

Routine practice on standard problems does little to help students overcome common mistakes and misconceptions in mathematics. This is particularly true when teachers try to avoid difficulties arising by beginning each lesson with explanations and demonstrations and following this with carefully graded questions.

**Handout 8** is a one-pageresearch review by Askew and Wiliam. This describes some research that was conducted in Britain over the past 30 years on dealing with student errors and difficulties.

What do teachers feel about the dilemmas presented in this paper?

- is it possible to present examples where rules do not work?

- do teachers share the view that it is counter-productive to teach simpler examples before more complex examples?

### Handout 7: Assessment tasks and sample responses for concepts

Description: A_Handouts copy_Primas

## Activity F: Observe formative assessment in action

#### Time needed: 15 minutes.

In this activity, you are provided with **video extracts** of Andrew, Dominic and Amy exploring how formative assessment may be used to promote students learning. They are using the three tasks from **Activity D**.

In an earlier lesson, these teachers had asked students to sit in different places and attempt one of the tasks individually, with no help. They then collected in their students' responses, assessed the work qualitatively and prepared written feedback in the form of questions. The film clips you are about to see are taken from the follow-up lesson. Students have returned to their normal places and most have solutions that are different to those of their partners.

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| Watch the video and consider:   * What different kinds of assessment can you see? * What is the purpose of each kind of assessment? * What do both the teachers and students learn? | Description: Picture 11 |

In the video, you will see:

* Andrew exploring how students respond to his feedback on the "counting trees" problem;
* Amy listening to, then questioning individuals as they try to share their ideas and produce joint solutions to the "security camera" problem;
* Dominic listening to presentations from students on their methods and reasoning for the "cats and kittens" problem;
* Amy concluding her lesson by asking students to describe how they have used her feedback to improve their work.

## Activity G: Plan and report back on an assessment lesson

#### Minimum time needed: 30 minutes before the lesson 20 minutes for the pre-lesson assessment 30 minutes to prepare feedback 60 minutes for the lesson 15 minutes for reporting back

###### Planning the lesson

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| Plan your own lesson using one of the problems.  Plan a time for students to tackle the problem on their own without help.  Plan how you will assess this work, give feedback and conduct a follow up lesson.  Collect samples of students' work to show how their thinking has changed. These will be discussed at the follow-up session.  To help your planning, you may now like to watch the 10-minute video that shows Andrew teaching the Counting Trees problem from Activity D. He is following the lesson plan on Handout 9. | Description: Picture 7  Andrew's lesson |

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| The pattern of activities on handout 9 is as follows:   * Give the problem before the lesson and ask students to attempt it. (20 minutes) * Collect in the work and prepare some constructive, qualitative feedback. * In the follow-up lesson, reintroduce the problem to the class. (5 minutes) * Students work alone, responding to the feedback using mini whiteboards. (5 minutes) * Students work in pairs to improve their solutions. (10 minutes) * Students share their approaches with the class. (15 minutes) * Students continue with the problem or extend the problem. (20 minutes) | Handout 9: A formative assessment lesson plan Description: A_Handouts copy_Primas |

###### Reporting back on the lesson

After you have taught the lesson, reflect on what happened with a group of colleagues.

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| Take it in turns to share stories of the assessment strategies you used.   * How did you collect and assess evidence of your students' work? * What did you learn from this evidence? * What did students learn from the follow-up lesson? * What are the implications for you mathematics teaching more generally? |

## Activity H: Consider the effects of feedback on student learning

#### Time needed: 20 minutes.

So far we have focused on the teachers’ role in providing assessment feedback to students. In this activity we will consider the use students make of different types of feedback and the impact this has on their learning.

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| Watch the video of Andrew's students as they discuss the impact of assessment feedback on their learning.  Which of their comments strike you as particularly perceptive and important?  What are the implications of their comments? | Description: Picture 8 |

**Handout 10** presents some results of research from Black and Wiliam (1998) into the relative merits of feeding back assessment information to students in different forms. In particular it compares the effects of feeding back quantitative information in the form of marks, levels and rankings with the effects of offering qualitative information in the form of specific, content-focused feedback.

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| Compare the students' comments with the research quotes given on **Handout 9.** The dangers of giving marks, levels, rewards and rankings  * What are the implications of this for your practice? * What would happen if you stopped giving marks or levels on pupils’ work? * Why are so many teachers resistant to making this change?  The advantages of giving clear, specific, content-focused feedback  * What are the implications of this for your practice? * Does this kind of feedback necessarily take much longer to give? |

Research shows that students benefit most from feedback that:

• Focuses on the task, not on grades or scores.

• Is detailed rather than general.

• Explains why something is right or wrong.

• Is related to objectives

• Makes clear what has been achieved and what has not

• Suggests what the student may do next

• Offers specific strategies for improvement

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| Conclude this module by discussing some ways of applying what you have learned in this PD module to the other mathematics lessons that you teach.   * How could you involve pupils in improving your assessment practices? |

### Handout 10: The effects of feedback on student learning

Description: A_Handouts copy_Primas

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1. Paul Black and Dylan Wiliam, "Assessment and Classroom Learning," Assessment in Education, March 1998, pp. 7-74. [↑](#footnote-ref-1)