USING STUDENTS' MISTAKES TO PROMOTE LEARNING

PROFESSIONAL DEVELOPMENT GUIDE

Introduction

This module is intended to help teachers reflect on the nature and causes of students' mistakes and to consider ways in which they might use them constructively to promote learning. This process, which involves teachers in interpreting students' responses to better understand the cause of students' errors, is fundamental to formative assessment because the decisions teachers make about their teaching are based on their students' current understandings.

It is suggested that three discussion activities take place:

- **Assessing students' responses to diagnostic questions**.
  This involves examining some genuine student responses and trying to identify the thinking that is behind the errors.
- **Diagnosing the causes of errors.**
  This involves thinking about various mistakes and the local generalisations that often cause them.
- **Responding to errors and misconceptions**.
  This involves considering research advice on the best way to respond to mistakes and errors.

Note that there are two different sets of handouts; one for teachers of science and one for teachers of mathematics.

Activities

Time

Approximately 2 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: Assessing students' responses to diagnostic questions

In this activity, participants begin to look at a selection of assessment tasks, the responses students might give to these tasks, and how best to respond to students.

Hold a brief discussion about the usefulness of analysing student work with the teachers.

- What do you gain from analysing student work?

They may suggest:

- developing an understanding of particular students' levels of understanding;
- seeing what sort of errors commonly occur within a given topic;
- using other students' responses to help predict how their own students will answer.

Now look together at the samples of student work on **Handout 1**: *Sample student work.* The examples used are taken from the following lessons:

- Interpreting distance-time graphs (Middle School, mathematics)
- Increasing and decreasing quantities by a percent (Middle School, mathematics)
- Interpreting algebraic expressions (High School, mathematics)
- Who has the juiciest apple? (Middle School, science)

Ask the teachers to look at each of the students' responses and answer these questions.

- 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?

Once the participants have discussed the samples of student work, point out that there are possibilities to involve the students in the process if assessing their own work by peer or self-assessment. For example, students could use a check-list that includes common mistakes to help them think about their previous response and identify errors on their own. Note that there is more information on how to involve students in assessing their own work in the module *Students becoming assessors*.

Provide the teachers with **Handout 2**: *Sample follow-up questions* and discuss these suggested follow-up questions, taking into account the teachers' responses to the questions on **Handout 1**, and hold a more general discussion about providing feedback for students, perhaps using the questions here to guide the discussion. Note that giving feedback (particularly to problem-solving tasks) is also addressed in the module *Introducing Formative Assessment.*

- Do you normally give feedback to students in the form of questions?
- What are the advantages of using questions rather than more directive guidance?
- Can you suggest better questions than the ones provided?

Activity B: Diagnosing the causes of errors

This activity is intended to encourage teachers to see that student errors may be due to deep-rooted misconceptions that should be exposed and discussed in classrooms. *This activity is for teachers of mathematics.*

To begin, hold a discussion about students' mistakes in mathematics. Ask the teachers what they think about errors and how they use them. These questions could help you get started.

- Why do students make mistakes in mathematics?
- What different types of mistakes are there? What are their causes?
- How do you respond to each different type? Why?

Focus particularly on the possible causes of mistakes. Ask the teachers to discuss in pairs, and make a list of possible causes of mistakes. When they have had some time to discuss, bring the group together and share their lists of causes. The lists might include:

- lapses in concentration, hasty reasoning, memory overload or a failure to notice important features of a problem;
- symptoms of alternative ways of reasoning, or 'misconceptions'.

Discuss misconceptions, pointing out that they should not be dismissed as 'wrong thinking' as they may be *necessary* stages of conceptual development. Also discuss the process of formative assessment, emphasising the importance of teachers understanding the cause of student errors so that they can decide what to do next.

Issue **Handout 3**: *Generalisations commonly made by students.* Give the teachers a few minutes to read it through, and ask them if they recognise some of these generalisations from their own teaching. Ask them if they can contribute some more examples to this list and to add these in the space on **Handout 3**.

Explain that such statements may have been valid in the students' previous experiences, but no longer hold in a new mathematical context. They work in limited domains that do not generalise. For example, when children deal solely with natural numbers they infer that 'when you multiply by ten you just add a nought'. Later on, this leads to errors such as 3.4x10 = 3.40. Many 'misconceptions' in students' work may be attributed to the use of such *local generalisations*.

Discuss the following questions together:

- Can you think of other generalisations that are only true for limited domains?
- For what domains do the following generalisations work?
  When do they become invalid?

  - If I subtract something from 12, the answer will be smaller than 12.
  - The square root of a number is smaller than the number.
  - All numbers may be written as proper or improper fractions.
  - The order in which you multiply does not matter.

Activity C: Responding to errors and misconceptions.

This activity is intended to encourage teachers to explore different ways of responding to students' errors.

Issue teachers **Handout 4:** *Handling students' errors*. (For science teachers, this is Handout 3). Ask them to read, and make comments on, the following two common ways of reacting to pupils' errors and misconceptions. Give them enough time to answer the questions on **Handout 4**.

- **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."
- **Use them** as learning opportunities:
  "I actively encourage students not to hide mistakes when they make them, and to learn from them."

Discuss these two opposing approaches with the teachers.

Which approach resonates with your own practice?

Encourage them to talk about challenges to using mistakes, such as students' reluctance to share their errors and the time it takes to unpick the thinking behind mistakes.

Now issue teachers with **Handout 5:** *Principles to discuss.* (For science teachers this is **Handout 4**). This summarises the advice given in the research regarding how to approach misconceptions.

Ask teachers to work in pairs to discuss the principles. Ask them to critique the advice and to consider what they would add.

- What do you think of the advice?
- What would you add?
- Is there anything you would remove?

Conclude the session with a general discussion about students' mistakes. Ask the teachers to collect examples of student mistakes in their classrooms ready to share with the group at a later session.