

# Learning from mistakes and misconceptions: Gaining the skills

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## Summary

Many students who appear to understand a topic at the end of a unit, do not retain that even for a few months. Better long-term learning depends on developing a robust understanding with many connections to other topics and applications. Diagnostic teaching achieves this by helping students learn to detect, understand and correct misconceptions in their own and their fellow students' work. This strategy and its associated tools provide teachers with effective support for developing the pedagogical and mathematical skills involved.

## Challenges addressed

*Students see scores, not weaknesses.* My students often want to know if their answer is correct, or what score they got on a test; they don't want to go beyond that and look into *why* and *how* they got what they did. Yet that is the only way they are going to improve.

*My students don't remember things.* Most teachers teach, day by day, a considerable amount of material which the students apparently learn, with at least some immediate success. Yet, a few months later, they find that much of it has been forgotten – and it shows in the test scores.

*Lack of long term learning* describes much the same challenge.

## The strategy

Research aimed at remedying this, for both students and teachers, has led to the development of the method of *Diagnostic Teaching*. This method promotes long-term learning and transfer from the immediate topic to wider situations. The key aspects are the identification and exposure of pupils' misconceptions and their resolution through 'conflict-discussion'. Conceptual diagnostic tests play a part both in helping pupils to become aware of their misconceptions and enabling the teacher to observe progress.

## Background

Teachers often begin a lesson with explanations and demonstrations followed with practice exercises. This routine can obscure the common mistakes and misconceptions that students have. Research has shown that teaching becomes much more effective if common mistakes and misconceptions are systematically confronted and explored within the classroom.

## Principles

Diagnostic teaching lessons typically begin with a problem that exposes the variety of students' existing thinking. Students are then confronted with the cognitive conflicts that emerge from these different ways of thinking. New insights are constructed through reflective discussion, leading to deeper understanding. This approach is challenging for

teachers but research shows that it develops connected, long-term learning in their students.

Well-structured support is always important in helping teachers tackle new challenges of pedagogy. *Learning from mistakes and misconceptions: Classroom materials* has been developed to provide this support for classroom teachers. *Learning from mistakes and misconceptions: PD materials* has been developed to support leaders where 'live' professional development is possible to further support teachers in developing diagnostic teaching skills.

### **Implementing the strategy**

Having decided to explore diagnostic teaching:

- Download the free components of the *Learning from mistakes and misconceptions: Classroom materials* tool from the web.
- Discuss them with a colleague and agree to work on it together. Each choose a suitable class, for which one of the topics treated in the tool is appropriate.
- Organize the materials in the tool. Read the references given there. Plan together what you will do, step by step at a reasonable pace that fits your schedule.
- If you can, get your colleague to observe your lessons and discuss them with you – and vice versa. Try with another class, adapting your approach in light of the observations.
- As you gain confidence, move on to try some of the other topics.

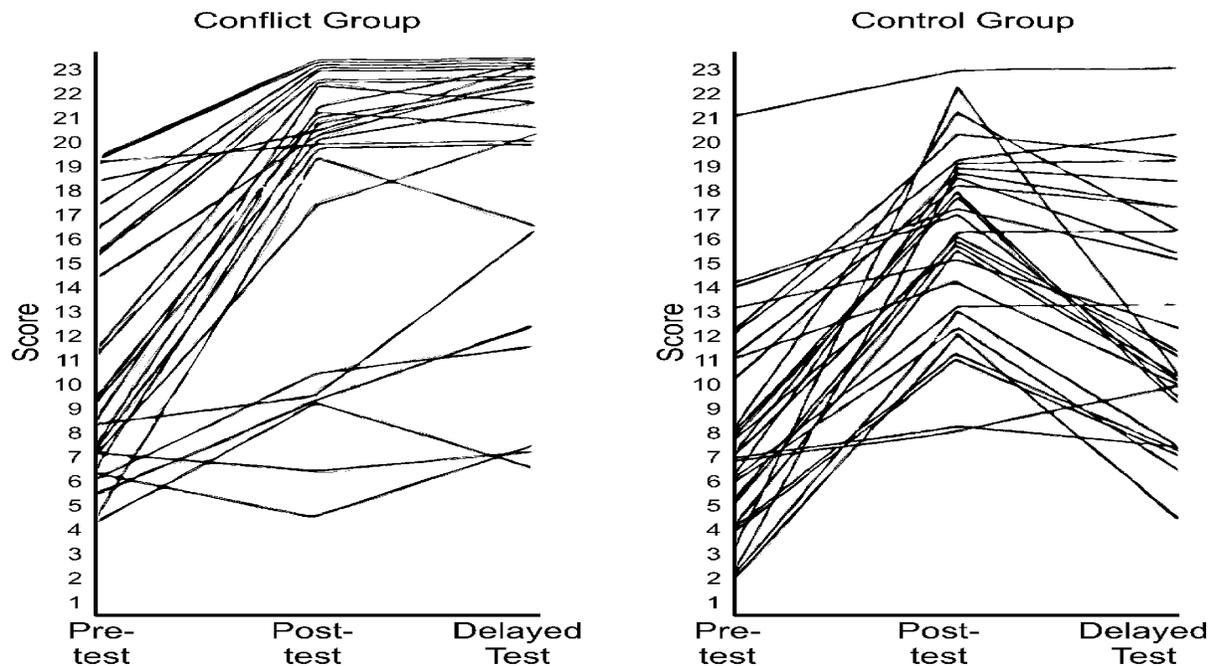
After a while, you will be able to devise diagnostic tests and lessons on further topics, according to the needs of the class.

### **Evaluative evidence**

There is *research evidence* that shows, across a range of topics, that the diagnostic teaching approach leads to much better long term learning than methods, which avoid analyzing and understanding misconceptions.

This is summarized in Askew, M. and D. Wiliam (1995). *Recent Research in Mathematics Education 5-16*. London, HMSO.

The dramatic gains in long-term learning that diagnostic teaching produces are shown in the graph below, typical of those from a sequence of teaching experiments, showing individual student scores of matched groups in pre-, post- and delayed-tests on the topic.



The Control Group was taught with a mainstream curriculum that avoids any analysis of errors. The Conflict Group is so called because of the *cognitive conflict* (only cognitive!) that arises in diagnostic teaching when students find different answers, and have to sort out their different modes of reasoning and *why* some produce errors.

Theoretical background and reports of some of these teaching experiments can be found in

Bell, A. 1993a. Principles for the design of teaching. *Educational Studies in Mathematics* 24, 5-34.

Bell, A. 1993b. Some experiments in diagnostic teaching, *Educational Studies in Mathematics* 24, 115-13.

Additional topic-specific references are given in the lesson resources.

### Strengths

This approach:

- Helps students develop a *robust cognitive structure* that enables long-term learning
- Students take more responsibility for their own learning – a key aspect of higher performance, across mathematics and the wider curriculum.
- There are rewards in the satisfaction of meeting students' real problems, and of achieving robust learning for students

### Likely challenges

- Establishing a more effective *classroom contract*. Teacher-student and student-student discussion of the mathematics is central to this activity. It needs to be handled in a facilitative non-directive way, so that students feel responsible for their own learning.
- Extending the variety of learning activities and the teaching strategies needed to support them. Many teachers will benefit from specific professional development

support of the kind set out in *Learning from mistakes and misconceptions: Supporting teachers*.

## Tools

*Learning from mistakes and misconceptions: Classroom materials* is designed to support diagnostic teaching. It provides a set of tools that includes:

- a *General Introduction* on the principles of the method illustrated in two topic areas, with two model diagnostic lessons.
- five *topic-specific courses* on the use of the method in some key mathematical topics – *Decimals and Fractions, Number Operations, Functions and Graphs, Algebra, and Geometry*.

Each of these packages contains:

- diagnostic tests
- guidance for scoring and interpreting responses
- samples of student work
- teaching materials
- outlines for professional development sessions

They describe a variety of modes of use.

These materials are designed to be used by individual teachers or groups on their own.

They are also suitable for use in leader-run professional development workshop sessions to provide valuable additional support (see *Learning from mistakes and misconceptions: Supporting teachers*).

## References

The articles containing evaluative evidence, cited above, provide useful background reading.