Introduce diagnostic teaching

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Summary

Many students who appear to understand a topic at the end of the teaching 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 to learn to detect, understand and correct misconceptions in their own and their fellow students work. This strategy and its associated tools will help leaders to provide teachers with effective support for developing the extra pedagogical and mathematical skills involved.

Challenges addressed

Lack of long-term learning. So many students don't seem to remember things from one year (or sometimes one month!) to the next. They can do it at the end of the unit but it seems to run into the sand. As a result, a lot of time each year is spent on review

Research also shows that conventional methods of teaching typically produce short-term gains, but with substantial loss over periods of a few months. For related reasons, state tests, and national and international surveys of mathematics attainment, show disappointing levels of achievement and relatively small yearly gains.

My students don't remember things makes much the same points.

The strategy

Research aimed at remedying this, for both students and teachers, has led to the development of the method of *Diagnostic Teaching*. This promotes long-term learning and transfer from the immediate topic to wider situations. The key aspects of this method 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. The strategy for a leader is therefore to organize courses to help teachers develop Diagnostic Teaching skills. The tools associated with this strategy provide appropriate support.

Background

Feedback is important in guiding any system; in education it is often weak. The method of *Diagnostic Teaching* has been developed through research to help remedy this, for both students and teachers. It contributes to long-term learning and promotes transfer from the immediate topic to wider situations. The key aspects of this method 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.

Principles

The approaches developed in the program are based on the following principles:

- Lessons focus on specific difficulties.
- Questions create a tension or cognitive conflict that needs resolving.
- Activities provide opportunities for meaningful feedback to the students.
- Lessons include time for whole class discussion

- Opportunities are provided for pupils to 'consolidate' what has been learned

Each professional development course tackles both content and processes issues, as outlined in the NCTM Standards.

Implementing the strategy

The group of teachers with whom you wish to work will have ideas about the problem of lack of long-term learning and its solution. If, when these have been pursued, the challenge of the problem is sufficiently evident, it provides a suitable basis for introducing the *General Introductory Course.*

This course consists of two sessions of about 1.5 hours each, followed by a trial lesson in the teachers' own classrooms, then a follow-up meeting of about 1 hour to review the experience using samples of their own students' work, and to plan further work. Detailed suggestions and resources are provided.

This should be followed, if possible, by the series of five similar *Topic-Specific Courses,* each on a key topic.

For a single one-off professional development event (a full day or part of a day), we suggest you use the *General Introductory Course*. The topic specific resources will support a follow-up sequence of professional development events.

How can it be organized?

A single one-day meeting and/or a sequence of six weekly sessions, is suggested. It will, of course, be useful to gain the support of the local Math superintendent and of the principals of the schools concerned.

It is more-than-helpful if two or more teachers from each school take part; they can then support each other in the new teaching approach.

Other support

Gaining the teachers' initial interest and commitment will be helped by starting with a discussion of the problem of *lack of long-term learning*. Once the course is under way, it can be expected that the insights gained into teaching and learning will more than maintain their interest. See also the strengths and challenges quoted above.

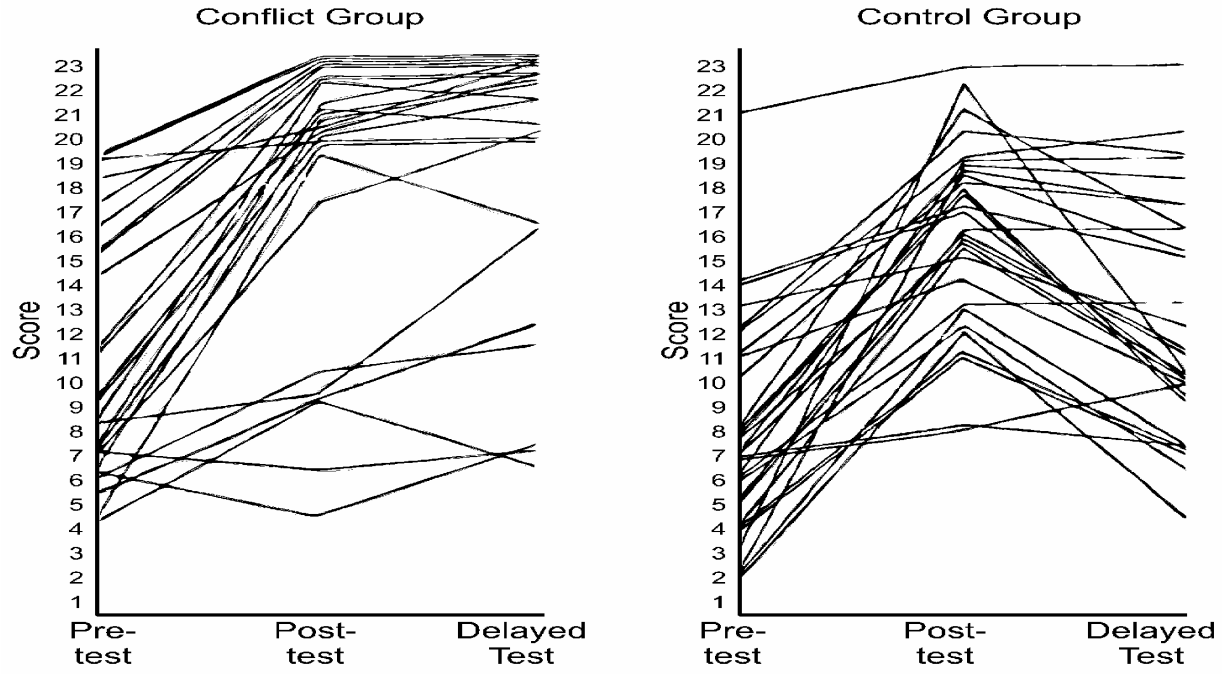
Where a live professional development program is not possible, some teachers will be able to benefit from the response strategy *Gaining Diagnostic Teaching Skills,* and the associated tools. These are more challenging tools designed for use on a 'do-it-yourself' basis.

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 standard "positive only" 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 "positive only" 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.

A theoretical background and reports of some 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,* 115-137.

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

Strengths

- The work deals with the common student misunderstandings.
- This makes the teachers' daily work more rewarding and effective.
- The discussion helps students to build a well-connected body of knowledge, integrating the newly corrected knowledge with the rest of their understanding of the subject.

Likely challenges

- The teaching methods needed may present new challenges for the teachers
- The students have to learn how to engage in meaningful discussion of key points, being willing to expose their understanding, even if they fear it may be wrong
- They need also to learn to listen to other students and to appraise what they say, without antagonism.

Tools:

Helping teachers gain diagnostic teaching skills is a set of tools to support leaders of classroom-focused professional development courses on diagnostic teaching.

The elements in this set of materials include:

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

The materials focus on common student difficulties in a number of the key mathematical topics that trouble students from late elementary grades through early high school: Decimals and Fractions, Number Operations, Functions and Graphs, Algebra, Geometry along with a *General introduction* to the principles of the approach

These resources are designed to be used in a variety of different modes by:

- professional development leaders helping teachers to improve their skills in this area
- teachers in the classroom
- teachers in an extra period (double period) of mathematics
- teachers in after school programs
- teachers in summer school programs
- intervention specialists
- tutors, working with small groups of students in 'extra time'

Gaining diagnostic teaching skills is designed to support this approach. It provides a set of diagnostic teaching tools for teachers that include:

- *a General Introduction* on the principles of the method illustrated in two topic areas, and offers two model diagnostic lessons.
- five *topic-specific courses*, which take the teacher into 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 the following elements:

- 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 set up in a form suitable for

following by individual teachers or groups on their own, but may also be used in these leader-run professional development courses.

References

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