

Classroom discourse (Mathematics)

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Teresa Maguire and Alex Neill (2006)

Mathematical classroom discourse is about whole-class discussions in which students talk about mathematics in such a way that they reveal their understanding of concepts. Students also learn to engage in mathematical reasoning and debate.

Discourse involves asking strategic questions that elicit from students both how a problem was solved and why a particular method was chosen. Students learn to critique their own and others' ideas and seek out efficient mathematical solutions.

When to use

Discourse can be used at any time during a unit of work.

It can:

- be used to determine what students are thinking and understanding in order to build bridges between what they already know and what there is to learn;
- offer opportunities to develop agreed-upon mathematical meanings or definitions and explore conjectures.

The theory

While classroom discussions are nothing new, the theory behind classroom discourse stems from constructivist views of learning where knowledge is created internally through interaction with the environment. It also fits in with socio-cultural views on learning where students working together are able to reach new understandings that could not be achieved if they were working alone.

Underlying the use of discourse in the mathematics classroom is the idea that mathematics is primarily about reasoning not memorization. Mathematics is not about remembering and applying a set of procedures but about developing understanding and explaining the processes used to arrive at solutions.

How the strategy works

Well-designed distractors provide alternatives that identify particular misconceptions. Providing a number of alternatives may scaffold the students' thinking.

When a class of students offers a range of responses and strategies to solve a problem, discussion arises over the validity of each response. This gives the class the opportunity to explore and reach a common agreement on which method(s) would be successful and/or most efficient.

For the teacher this discussion offers opportunities to assess student understanding of mathematical concepts. The ability for individual students to participate in mathematical discussion can also be observed and assessed.

What to do

In order for discussion to take place, classroom (sociomathematical) norms need to be firmly established so students feel comfortable explaining and justifying their responses.

Establishing this classroom culture can be done by:

- expecting students to explain and justify their answers, whether they are correct or not;
- emphasising the importance of contributing to the discussion by explaining their strategy rather than producing correct answers;

- expecting students to listen to and attempt to understand others' explanations;
- commenting on or redescribing students' contributions while notating the reasoning for the class on the board;
- having other students pose clarifying questions to the student explaining the problem;
- expecting students to explain why they did not accept explanations that they considered invalid;
- using students' names to label agreed-upon conjectures, e.g., "Natasha's rule"

Paul Cobb (2006) states that there are two parts to a mathematical explanation. The calculational explanation involves explaining **how** an answer or result was arrived at – the process that was used. A conceptual explanation involves explaining **why** that process was selected – what are the reasons for choosing a particular way. In this way students have to be able to not only perform a mathematical procedure but justify why they have used that particular procedure for a given problem.

Ways to encourage **calculational** explanations:

- Pose a problem and expect students to find their own way to a solution.
- Ask questions that are designed to keep students puzzling like "How are we going to figure this out?" "What should we do?" "Who has an idea?" "I don't understand. How will that work?"
- Listen and watch rather than indicate whether responses are right or wrong.
- Use True/False or open number sentences or statements to generate a range of answers that require individuals to justify them. Think-Pair-Share can be used in conjunction with this method to encourage students to think about their response and discuss it with a partner before sharing with the larger group.
- Use questions that encourage **a range** of responses. For example:
 - "Who has a different way to solve the problem?"
 - "What is a different way to do this?"
 - "Who has another way to think about this?"
 - "Would someone like to add to that idea?"
 - "Can you explain what John just said in your own words?" followed by "John, does that describe your idea?"

Ways to encourage **conceptual** explanations:

- Use questions that require students to justify their own and other's answers
For example:
 - "Why do you agree with that?"
 - "Why do you disagree?"
 - "Is this true for all numbers?"
 - "How can we know for sure?" (these question are precursors to mathematical proof)

Limitations

- Students may not arrive at an agreed-upon answer during their discussion. The teacher has to decide when to step in and provide an explanation, when to model, and when to ask pointed questions that can shape the direction of the discourse. One way to overcome this is to ask "If someone from the classroom next door said '.....' what would you say?"
- The teacher needs to be able to anticipate responses and respond spontaneously to students.
- The teacher needs to develop a deep knowledge of mathematics concepts and principles in order to understand the reasons behind students' errors. A teacher needs to have one eye on the underlying mathematical concepts while the other eye is focused on the current understandings of the students.
- Some students may have difficulty explaining their reasoning.

Adapting the strategy

Classroom discourse has been used in research projects that have led to ARB resources. In Neill's 2005 set article on estimation, refer to the 'Method' section and Figure 2 which describe an extended process that includes discussion.

This strategy has similarities to other strategies where students are required to explain and justify a position or point of view. Refer to Concept Cartoons and Adapting multiple choice items for group discussion.

Examples of ARB resources that can be used for classroom discourse

Maths

Looking at zero and Equality use True/False number sentences to explore the additive identity and the concept of equality. These can easily be used as whole-class discussion starters.

Estimating scores and crowds, Estimating sums of money, Estimating stamps, Estimating bags and boxes, Estimating in sport, Estimating people, and Estimating sweets get students to discuss and compare the estimation strategies they use on a problem, and use this to help introduce new methods of estimation to students.

Who is estimating? Addition, Who is estimating? Multiplication, and Estimation or not? ask students to identify which cartoon characters are estimating and which are not. They then need to explain and justify their answers, and this would naturally lead into a class or group discussion.

Selected references

Burns, M. (2005). Looking at How Students Reason. *Educational Leadership*, 63 (3), pp. 26-31.

Chapin, O'Connor & Anderson. *Classroom Discussions: Using Math Talk to Help Students Learn*. Retrieved Feb 5, 2014, from http://www.toolkitforchange.org/toolkit/documents/541_39_ttlclassdiscuss.pdf

Cobb, P. (2006) *Supporting Productive Whole Class Discussions*. Retrieved May 31, 2006, from <http://www.nzmaths.co.nz/sites/default/files/Numeracy/References/PaulCobb.ppt>

Neill, A. (2005) Estimation exposed. *set: Research information for teachers*, 1, 48-53.

Schifter, D. (1996). A Constructivist Perspective on Teaching and Learning Mathematics. *Phi Delta Kappan*, 77 (7), 492-499.

Resource List

- Estimating sums of money
- Estimating scores and crowds
- Who is estimating? Addition
- Estimating bags and boxes
- Estimating in sport
- Estimating stamps
- Equality
- Estimation or not?
- Different addition number sentences
- Looking at zero