Engagement in quantitative subjects: Classroom discussions

Benefits of classroom discussions

Classroom discussions can be a powerful active learning method to employ in your teaching.

By encouraging students to communicate and justify their ideas to others as well as evaluate and interrogate the ideas and arguments of their peers, they can encourage the development of students' higher order thinking (or logic) skills. Moreover, regular use of discussions can help establish a norm that all students actively discuss mathematical ideas in the classroom (be it in small group or plenary discussions), thereby fostering students' accountability. Both **logic development** and **accountability** are two dimensions of effective active learning practices that are discussed in more detail in (Eddy *et al*, 2015).

Classroom discussions can steer students away from a rote approach to learning (thoughtlessly applying methods and processes to standard problems) towards a deeper engagement with the subject matter. Moreover, this might be achieved without extensive rewriting of existing class activities by (i) having students provide arguments supporting both their strategy choice and strategy implementation in order to justify their results, and (ii) requiring that these arguments be grounded in the intrinsic mathematical properties of the components involved. The two aspects of reasoning highlighted in this example ((i) plausibility and (ii) anchoring) are defining characteristics of **creative mathematical reasoning**, (Lithner, 2015), a sort of opposite to imitative reasoning that characterises (though is not confined to) rote learning.

Overview

However, it can be challenging not only to initiate and sustain such discussions but also to incorporate these into a coherent quantitative class.

In *5 Practices for Orchestrating Productive Mathematics Discussions*, authors Margaret S. Smith and Mary Kay Stein outline 5 practices to engage students in classroom discussions that can contribute meaningfully to the class and help advance students' understanding of the content.

Specifically

1. **Anticipating** students' likely responses.
2. **Monitoring** students' actual responses.
3. **Selecting** particular students to present their work.
4. **Sequencing** students' responses in a particular order.
5. **Connecting** different students' responses to each other and to the key ideas of the class.

The authors also stress a preliminary practice involving setting goals and selecting an appropriate task; however, many teachers may find this beyond their agency to do.

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Implementation

The following steps could apply to either individual work or small group work.

1. Anticipating

When anticipating the strategies that students will employ when approaching the given task, you should also consider how they might apply these and where they might stumble. Moreover, consider what misconceptions or common errors are likely to arise?

Solve the task yourself, using a variety of strategies that will be available to your students, rather than relying on past solutions (particularly if they are not your own).

2. Monitoring

While students are working on the task, circulate the room and interact with students to gauge their progress (and also gauging the accuracy of your predictions). Provide whatever interventions you think would be helpful for students (correcting misconceptions, providing hints, etc) and take note of what students have done (including errors).

3. Selecting

Using your observations decide what work to share with the rest of the class. Your choice should be informed by the goals of the task and the class. You may, for example, wish to highlight a broad range of strategies for a single problem, or perhaps focus on the various incorrect and inefficient strategies to address common learning issues.

Selection necessarily suggests that not all student work on a particular task will be presented. While this may need to be balanced across the entire session (or perhaps several sessions), your choice should primarily serve the intended learning outcomes of the immediate activity.

4. Sequencing

Decide in what order to present selected work. Different orderings will therefore serve different purposes and generate different discussions. What ordering sense for your particular task/class? Increasing rigour? Increasing sophistication? Degree of unusualness?

You should also consider how and when you will address errors and misconceptions.

5. Connecting

Once you have chosen a sequence of student work, ensure that the connections are made, not just between different students' work but also to the key ideas of the session. This is where the narrative you have decided for this task should come to the fore. This could be done directly by you or indirectly through the use of questions and thinking exercises for your students: remember that students should be encouraged to evaluate and critique arguments of their peers when not presenting their own.

Again, the narrative should be informed by, and serve, the intended learning outcomes of your session.

Further reading

See our guidance on asking questions in quantitative classes for ideas on how to phrase discussion tasks and prompts.

The five practices listed above are comprehensively discussed in

> Smith, Margaret S., and Mary Kay Stein. 2011. *5 Practices for Orchestrating Productive Mathematics Discussions*. Reston, VA: National Council of Teachers of Mathematics.

While the examples in this book come from pre-university levels the ideas they explore are nonetheless valid at the tertiary level. For example, the following paper discusses their application to a typical first year undergraduate course in calculus.

> Nabb, K., Hofacker, E. B., Ernie, K. T., & Ahrendt, S. (2018). Using the 5 practices in mathematics teaching. The Mathematics Teacher, 111(5), 366–373.

Accountability and logic development are dimensions of good active learning practice discussed in

> Eddy, S. L., Converse, M. S., & Wenderoth, M. P. (2015). PORTAAL: A Classroom Observation Tool Assessing Evidence-Based Teaching Practices for Active Learning in Large Science, Technology, Engineering, and Mathematics Classes. CBE-Life Sciences Education, 14(2), 1–16.

If classroom discussions are not easily implementable in your classes, or you would simply like to expand your use of active learning techniques, this paper identifies 21 elements of active learning across 4 dimensions of good practice, and is well worth the read.

Creative mathematical reasoning is discussed in

> Lithner, J. (2015). *Learning Mathematics by Creative or Imitative Reasoning.* In Selected Regular Lectures from the 12th International Congress on Mathematical Education (pp. 487–506). Springer International Publishing.

This paper discusses the problems associated with rote learning, and offers some interesting insights into how the imitative reasoning that underpins it can manifest even unintentionally.