Using Protocols and Open-Ended Tasks to Promote Student Mathematical Discourse

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Lyn Riverstone, OSU

Maria Fung, WOU

The Plan…

- OMLI
  - What is OMLI?
  - Discourse
  - What we learned about the “Best Practices” for teaching mathematics - setting the stage for discourse using norms and group roles
- “Protocols” defined, with a few examples
- What makes a task “open-ended?”
- An example task from a Business Calculus class

What is OMLI?

Oregon Mathematics Leadership Institute (OMLI)

- NSF-funded partnership project—OSU/PSU/TDG/10 OR school districts
  (NSF/EHR–0412553; ODE/Oregon ESEA Title II-B MSP)
- Aimed at increasing mathematics achievement of K–12 students
- 3-week intensive summer institutes in 6 different mathematics content areas and in leadership skills

Mathematics Content Courses at OMLI

- 15 two-hour sessions for groups of K–12 teachers with 4-member instructional teams
- Content areas represented:
  - Number and Operation
  - Geometry
  - Abstract Algebra
  - Probability and Statistics
  - Measurement and Change
  - Discrete Mathematics

Why Focus on Student Discourse?

In addition to a variety of program evaluation activities, the OMLI evaluation includes a research study component that addresses the following research question: Can student achievement in mathematics be significantly improved by increasing the quantity and quality of meaningful mathematical discourse in mathematics classrooms?"

Types of Mathematical Discourse

- Explaining
- Questioning
- Challenging
- Relating
- Conjecturing
- Justifying
- Generalizing

Justification of Mathematical Ideas

- Attention to undefined terms and definitions
- From explanations and generalizations of observed math ideas to answering “why?”
- Oral and written presentation of elementary proofs, from informal to formal

Pedagogical Lessons from OMLI - What Can We Do to Increase the Quantity & Quality of Discourse Among Students?

- Cooperative groups with student-generated norms for cooperation and assigned group roles
- Use of protocols
- Emphasis on higher-level mathematical discourse
- Hands-on, open-ended explorations

Group Norms

- Everyone focuses on doing mathematics
- Everyone contributes and shares ideas
- Everyone strives for deep understanding and asks genuine questions
- Everyone tries to create an atmosphere where taking risks is valued
- Everyone helps his or her group-mates to achieve the group task and to adhere to their roles

Group Roles

- Team Captain: responsible for keeping the group on task, for checking in on everyone's progress and understanding
- Resource Monitor: responsible for supplying materials and directions from instructor for the entire group

Group Roles Continued

- Recorder/Reported: responsible for making sure everyone has notes about each activity; sometimes responsible for representing the entire group in group discussions
- Facilitator: responsible for leading the group discussion and keeping everyone participating; in groups of 3 this role doubles up with the team captain

Protocols

- Pre-determined scenarios of how to complete a task or activity
- Organizational structures of the group process
- Tools for creating an equitable classroom
- Simple (2-step) or very complex ones

Examples of Protocols

- Think-pair-share
- Private think time followed by a simple go-around protocol
- Go-around and share more ideas each time protocol
- Whole group discussion protocols
- Jigsaw puzzle protocols

Facilitation of Higher Level Math Discourse

- Use a group-work protocol to ensure everyone takes part in all types of discourse
- Require justifying and conjecturing as a part of task-setting
- Use a whole-group discussion protocol to wrap up group work; for example, ensure ideas flow from concrete to more abstract

Open-Ended Tasks

- Allow for a variety of approaches or answers
- Make it possible for everyone to be successful
- Generate exciting classroom discussions
- Very effective in the context of protocol-driven facilitation

Graph Sorting Task

- Originally used in a calculus class for Business and Social Science majors with the purpose of reviewing previously-introduced material for the midterm
- Could also be used as an introductory/motivating task, an informal assessment, or in a variety of other ways

Private **Think** Time

(5 minutes - then be ready to share with a partner)

1. Sort the graphs (A)-(G) according to some common characteristic of your choosing (be sure you are able to give *mathematical reasons* for putting particular graphs together in the same category.)
2. Then decide how the graphs you grouped together are *different* from one another.

Pair Up
(10 minutes)

1. Partner #1: Share your graph categories with your partner, giving reasons to support your ideas. Also tell what differences you noticed among the graphs in the same category. Partner #2 listens carefully to Partner #1's ideas during this time.
2. Partner #2: After Partner #1 has shared, ask any clarifying questions needed to understand the thinking and reasoning of your partner.
3. Repeat steps (1) and (2) above with partners switching roles.

Share Out in Whole-class Discussion

- The whole-class discussion protocol you use next will depend on:
  - The learning goals you have set for the task
  - The ideas generated by the students
  - The time you have allotted for the task
- Private think time: write down two or three ideas for how you might proceed with this task
- In a few minutes, we'll ask you to share your ideas (using a protocol!)

Wrap up

- As you worked on this task, using the structure of a protocol, what did you notice?
- What questions do you have about discourse, protocols, open-ended tasks, or anything else?