Success with Tasks that Promote Problem Solving

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Growing up, my two sons were often subjected to math tasks at the kitchen table. Sometimes I provided tasks to supplement what they were learning in school, to provide an additional challenge or a different perspective than their course textbook. As they got older, I gave them tasks I wanted to incorporate in my own classroom, and used their thinking, approaches, and roadblocks to help me plan my instruction with my students. Reflecting back on these kitchen table math sessions, I recall several tasks that sparked interest and excitement in my kids. Although both are grown, when they come home to visit I'll still share a kitchen table math task I think they'd find fun and will spark interesting dinner conversation. Reflecting on the best of these, I'd categorize them as tasks that promote reasoning and problem solving.

In *Principles to Actions*, NCTM reminds us that "Effective teaching of mathematics engages students in solving and discussing tasks that promote mathematical reasoning and problem solving and allow multiple entry points and varied solution strategies (p. 17)." We can see an obvious connection to the Standard for Mathematical Practice 1: "Make sense of problems and persevere in solving them," and a rich task will also provide the opportunity for students to engage with other math practices, such as SMP 2: Reason abstractly and quantitatively, SMP 5: Use appropriate tools strategically, and SMP 7: Look for and make use of structure. Teachers can learn a lot about how a student is thinking mathematically by watching them completing a rich task, and knowing how they are thinking helps substantially in moving them closer to deep understanding of mathematics. When a task is closed, with a narrow entry point and limiting solutions to a single approach, we might only be able to discern whether students can or cannot complete that approach, and we have less actionable information for instruction with that student.

Closed task: Find the perimeter of a rectangle with length 12 cm and width 4 cm.

Open task: Construct three different rectangles with a perimeter of 32 cm.

Although a strong task is necessary, simply presenting students with the task does not guarantee that deep thinking and reasoning will occur. Teachers' use of probing questions and instructional moves that keep the thinking as the student's responsibility are more likely to result in problem solving and reasoning with the task.

For instance, I recently revived kitchen table math with my son Logan and his girlfriend using the *Packing a Truck* task from the Shell Center (http://map.mathshell.org/lessons.php?unit=6310&collection=8). The problem asks students to determine the number of 50 cm x 60 cm x 80 cm boxes that can be packed into a truck whose interior dimensions are 245 cm x 250 cm x 890 cm. A logical approach is to divide the volume of the truck by the volume of one box; however, this approach doesn't consider the arrangement of the boxes within the interior of the truck, and therefore falls short of the actual maximum number of boxes. When Logan cranked out this calculation, his girlfriend asked, "How would you actually load those boxes into the truck?" This (brilliant!) question forced Logan to think and reason more carefully about his approach.

In using rich tasks with students in the classroom, it is important that we anticipate student responses and plan strategic questions that will further their thinking, rather than direct them down a specific path that may or may not align with their own understanding. The Shell Center and other high-quality resources for rich math tasks often provide sample

questions that teachers can use during instruction, and using these types of questions frequently will help us to come up with them on our own.

My younger son Logan and his girlfriend humoring me with kitchen table math in October, 2016.

One of the biggest challenges facing classroom teachers is the lack of rich math tasks within their curricular resources. This can create a feeling of pressure to create tasks from scratch—a difficult ask of anyone, let alone a busy math teacher! Although there are some great online sources of strong tasks, such as NCTM's Illuminations, Achieve the Core, Illustrative Mathematics, the Shell Center's Mathematics Assessment Project, and Dan Meyer's blog, it is also quite possible for teachers to make reasonable adaptations to their existing materials to provide better opportunities for students to reason and problem solve.

In her recent publication, *Mathematical Mindsets*, Jo Boaler suggests six questions that can help teachers create or adapt tasks that support problem solving and reasoning:

1. Can you open the task to encourage multiple methods, pathways, and representations?
2. Can you make it an inquiry task?
3. Can you ask the problem before teaching the method?
4. Can you add a visual component?
5. Can you make it low floor and high ceiling?
6. Can you add the requirement to convince and reason?

Boaler does point out that it is not necessary to attend to all six questions each time, but she is "confident in saying every task will be made richer by paying attention to at least one of the … six questions (p. 77)."

Many of you are already finding success with tasks that promote reasoning and problem solving in your own classrooms. Some of you may be struggling to get started. Either way, know that your students will benefit from your work to include these experiences, and that I—and the entire Board of the Colorado Council of Teachers of Mathematics—appreciate the hard work you do each and every day!

References

(2014). *Principles to actions*: *Ensuring mathematical success for all*. Reston, VA: NCTM, National Council of Teachers of Mathematics.

Boaler, J. (2016). *Mathematical mindsets: Unleashing students' potential through creative math, inspiring messages, and innovative teaching*. San Francisco: Jossey-Bass.