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Launching a Discourse-Rich Mathematics Lesson

Adapted from literacy instruction for use in mathematics, the think-aloud strategy models mathematical thinking.

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The idea of elementary school students working together on mathematical tasks is not new, but recent attention to creating purposeful discourse in mathematics classrooms prompts us to revisit discourse-promoting strategies for mathematics lessons. The Common Core's Standards for Mathematical Practice (CCSSI 2010) encourage teachers to foster opportunities for students to make conjectures, analyze situations, and create and argue solutions with one another. The type of purposeful discourse that promotes these behaviors supports the development of students' conceptual understanding (NRC 2001) around high cognitive-demand tasks (Smith and Stein 1998). However, facilitating this type of discourse is no easy feat. How can teachers implement a lesson that promotes purposeful mathematical discourse? In this article, we focus on the beginning of a lesson that is organized around a high-demand task; that is, we focus on the launch phase of the lesson, when the teacher is getting students ready to work on the task.

Model think aloud 1

OK, boys and girls, let me tell you how I work on this problem so you can do it, too. If you read it carefully, you will see that it asks for how many plates in all are on the table. Let me read the problem again: "Jason put 4 large plates and 8 small plates on the table. How many plates are on the table in all?" [*Repeat "How many* in all" *slowly and with emphasis on* "in all."]

Hmm [*pausing*]. When someone asks me "in all," it usually means I should be using addition because this means I am putting things together. So, I look for the numbers in the problem. Hmm, there are 4 plates and then 8 more plates. [*Write* 4 *on the board, then say, "Eight* more*," with emphasis on "more*."]

So, I have 4 and 8 *more*; that is 4 + 8 [*complete the math sentence on the board, writing* "+ 8"]. Well, now I can do this because I know the question. [*Complete the sentence on the board to read* "4 + 8 =____."]

The answer to 4 + 8—we already know that, we learned it in first grade. Four plus eight is twelve, so I can complete the problem.

To support the launch of this mathematics lesson, we have borrowed the think-aloud strategy from literacy (Davey 1983). Teachers use think alouds in reading instruction to help students attend to their own thinking and comprehension (Bereiter and Bird 1985). Studies showed that when teachers demonstrate the use of a think aloud, students learn how to monitor their comprehension (Baumann, Jones, and Seifert-Kessell 1993), leading to better understanding of text in developing readers (Kucan and Beck 1997). Further, think alouds encourage students to share their own thinking.

The goal of demonstrating a think aloud to launch a mathematics lesson around a high-demand task is for teachers to model both the type of thinking that develops conceptual understanding as well as how to share one's thinking. Jackson and her colleagues (2012) noted that how the teacher sets up the task during the launch determines whether all students are "in the game." They explained that how the task is set up "impacts both what students *and* the teacher are able to achieve during a lesson" (p. 24), highlighting the importance of the launch for the success of the lesson. A think-aloud demonstration before releasing students to think and discuss thinking around a high-demand task is a profitable tool for launching a lesson that promotes purposeful mathematical discourse for all students.

Teachers learning mathematical think alouds

As part of a forty-hour, yearlong professional development project in All Included in Mathematics (AIM), we introduced the think-aloud strategy to participating second-grade teachers. We presented the think aloud as one way to launch a lesson around addition and subtraction story problems to promote purposeful mathematical discourse that develops conceptual understanding. As the professional development sessions progressed, teachers reported developing success using the think aloud. They noted that the think aloud got their second graders engaged and also helped students get started working on the problems. Teachers noted that students more readily shared their thinking with one another in lessons launched with a think aloud. However, in learning to use think alouds, teachers had to carefully consider what constituted an appropriate think aloud, that is, a think aloud that modeled the kinds of mathematical thinking they wanted to foster in their students.

As an introduction to the strategy, teachers first considered two versions of a mathematical think aloud for the following story problem:

> Jason put 4 large plates and 8 small plates on the table. How many plates are on the table in all? (Fuson 2009, p. 208)

Teachers discussed how each think aloud set up students for doing mathematics, including mathematical vocabulary and discourse. In these discussions, teachers pointed out that think aloud 1 is prescriptive and models, on the basis of key words, the operation that students should carry out. On the other hand, think aloud 2 reveals a teacher's thinking and presents students with a model for how to think aloud through the problem. Teachers concluded that think aloud 2 is more in line with their goals for launching the story problem.

Teachers in the professional development session worked in pairs to practice using the think aloud in ways similar to the second example. Later, they worked in their school groups to plan a lesson in which they launched student work on a story problem using the think-aloud strategy. After videotaping the implementation of think alouds in their classrooms, teachers watched their own think aloud and reflected on their work.

Implementing mathematical think alouds

Four teachers from a school planned a lesson on comparison story problems and chose the following problem to launch the lesson:

> Jane and Ernie have some apples. Jane has six apples, and Ernie has nine apples. Who has more apples? How many more? (Fuson 2009, p. 222)

The following is an excerpt from one teacher's mathematical think aloud, which is in many ways similar to what a few teachers reported.

> So, I'm gonna show you how I would think about this problem. . . . If I was gonna solve it, how I would think and what I would do. First I would read the problem to myself [*pausing*]. Jane has six—I'm going to draw a picture of six—and Ernie has nine. I'm going to draw a picture of how many Ernie has.

With her drawings, the teacher wanted to offer students a model that showed how she thought about the problem.

Successes and challenges

Teachers' reflections described think aloud as a way to launch a lesson that supports purposeful mathematical discourse. One teacher reflected, "I feel like my think aloud set my students up for success when later they worked similar story problems with their group."

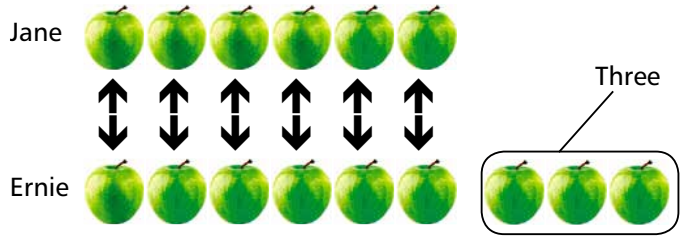
Another teacher explained, "I think that this activity encouraged discourse [after the launch]. [Students] discussed with their partners and others at their tables what they discovered."

A third teacher shared, "I think that verbalizing strategies and using vocabulary such as *more* or *less* enabled the children to use more precise language when sharing their work with each other."

Thus, overall, teachers saw value in using this strategy. Their reflections, however, also highlighted some challenges. The first challenge considered was the question of exactly how far into solving a problem they should model the situation. In their reflections, teachers shared such comments as these:

FIGURE 1

Below is a rendition of a teacher's final diagram on the board. To conclude her think aloud, she said, "So, when it asks how many more, there are three more that Ernie has. I could also say that there are three less than Jane has. It's the same thing."



- At the end, I felt that I was just modeling a strategy [to solve the problem] and not including what I was thinking along the way.
- Anyway—math wise—I am not sure if I "crossed the line" from think aloud to showing how to solve the problem. I was trying to provide a visual, but it seemed like maybe, in the end, I was just solving it.

Teachers noted that when they used a particular drawing (see **fig. 1**) in the think aloud to actually solve the problem, students solved similar subsequent problems by copying the representation the teacher had used. Thus, teachers wondered whether students were still

Model think aloud 2

OK, boys and girls, let me tell you how I think about this problem to help me understand it. First, I read the problem very carefully and think about what the story is telling me. Let me do that: "Jason put 4 large plates and 8 small plates on the table. How many plates are on the table in all?"

OK, so, let me think about that: Jason is setting the table. He first sets the large plates, and there are 4 of them. Then he gets the small plates, and he puts them on the table as well. There are 8 of those on the table, so I am going to have to show all of them. Small plates and large plates, they are all on the table. I am going to make a drawing [*pausing*]. Let me do that and read my problem one more time.

So, if I have the table here like Jason, I put 4 large plates and 8 small plates on the table. Now, the question I have to answer is how many plates are on the table. I want to know the number of plates on the table. OK, I can see what is on the table and what Jason did to set it up. Let me tell you that this is my drawing, but you do not have to draw it the way I did. I just wanted to show you how I think about the problem to help me see it. And I will leave the rest to you [*pausing*] . How many plates are on the table?

Tips for implementing the think-aloud strategy

Having worked with elementary school teachers on the think-aloud strategy, we believe the following tips may be helpful as you consider how you might implement it in your mathematics classroom:

- Set the expectation for students that think aloud is a time for you, the teacher, to speak, not the students. Students should be engaged in active listening.
- Decide on your purpose. Consider what you want students to attend to when you use the think-aloud strategy.
- Identify mathematical ideas you are using that your students have already encountered. You might use phrases in your think aloud to alert students to important prior knowledge, like "I remember that . . ." or "This is a lot like . . ."
- Consider extra supports you can use to help your students, including English language learners, follow your thinking. Such supports might include drawings, using gestures or physical objects, writing out important vocabulary, and giving synonyms.
- To ensure that you convey your intended goals of sharing your thinking and avoiding taking the think aloud too far, consider writing a script or key talking points before you start. As evident in the teachers' reflections, if explicit procedures are modeled, a diagram reveals the answer, or a direct answer is provided, then the think aloud has gone too far.

thinking about the problem or copying what the teacher had demonstrated.

Because the professional development session focused on strategies to promote purposeful mathematical discourse among students, teachers considered the fact that modeling the think aloud as a strategy in which the teacher did all the talking was a challenge. On reflection, one teacher shared that "many of my students wanted to chime in and help me answer the story problem."

A second teacher reported, "My students were dying to give their two cents, as well, and wanted to answer the questions I was asking myself as I was thinking aloud."

A third teacher described how she resolved this same issue by putting in place a norm for think alouds. She explained, "I had used think aloud to launch the previous two lessons on problem solving before I recorded my launch." A transcript of an excerpt from her classroom video follows:

Teacher: All right, before we get started, let's just review our expectations during think-aloud time. Point to the person whose turn it is to talk [*pausing*]. It is my turn to talk. It is my turn to share with you all of the thoughts that I am having in [my] head and show you what I'm thinking about as I solve the math problem. So, do I need you to call out answers?
Class: No!
Teacher: Do I need you to try to solve the problem?
Class: No!
Teacher: No, I just need you to watch what I'm doing and think about the things that I am doing.

Using a mathematical think aloud in your classroom

When you consider the think aloud as a strategy for promoting purposeful mathematical discourse, it is important to note that a big difference exists between modeling thinking and demonstrating procedures. Regardless of the mathematical goal of your lesson, taking the think aloud too far bypasses the intended purpose of the strategy, which is to model thinking. As evident in the teachers' reflections, if explicit procedures are modeled, if a diagram reveals the answer, or if a direct answer is provided, then the think aloud has gone too far. Your students may be used to seeing teachers or their parents model procedures, so it is important to be explicit with students that you are modeling a way of thinking about a task. You might explain that you want them to be able to attend to your thinking and also be able to talk about their own thinking when they are working on the task. Thus, a mathematical think aloud should also be carefully constructed to set up students for rich conversations with one another about conjectures, multiple strategies, and possible multiple solutions to the tasks that will follow. This careful construction should prompt students to not only talk about their thinking but also listen to and ask questions about one another's thinking.

Making teachers' thinking explicit

Remember, the purpose of the think-aloud strategy is to make teachers' thinking explicit to students. Similar to its use in literacy settings, this strategy requires teachers to consider the purpose of the think aloud and to carefully plan how they might model their mathematical thinking on a problem to students. Without such planning, a teacher's think aloud can

quickly move beyond the scope of the intended goals and objectives of the lesson. One must also consider the specific content focus of the lesson and craft the mathematical think aloud so that it launches an opportunity for students to take responsibility for their learning, communicate their thinking, and evaluate strategies and solutions of others. Although these skills may not initially come easily, by hearing their teacher repeatedly model mathematical thinking out loud, students have common experiences on which to build their thinking in discourse-rich lessons. As these skills develop throughout the school year, all students are afforded opportunities to engage in mathematics.

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