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Let's Talk Math

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A PD program in Salt Lake City is bringing math teachers into the conversation.

As humans, we learn by doing, but we learn best by teaching. Across the education spectrum, examples abound of innovative ways to help students gain deeper mastery by *teaching* a topic. Those we've witnessed recently include a presentation on the young adult novel *The Outsiders*, where each student took on the role of a specific character from the book, and a team science project where students demonstrated mitosis by acting out the process of cell splitting and then answering questions. Sadly, however, we rarely see these kinds of activities in math classes.

Instead, we see a heavy reliance on rote work and prescribed teacher questioning that elicits conditioned responses from students rather than deep understanding. But math, like all subjects, needs intentionally planned discussion time. Rich discussions in math classes can improve students' capacity for mathematical thinking and reasoning—important components of recent standards—and raise achievement (Firmender, Gavin, & McCoach, 2014; NCTM, 2014; National Governors Association, 2010). The questions a math teacher should be asking are not just, "What's the answer?" or "How did you solve this problem?" but "Why is the solution important?", "Can you explain it to others?", "Is there another way you could solve it?", and "What if we changed this variable?"

But this kind of investigative math requires math teachers to serve as facilitators—something they aren't always trained to do. How can we expect in-depth discussions from students when teachers have limited opportunities to engage in deep discourse about mathematics themselves?

In the Salt Lake City School District, Meghan and a cadre of mathematics coaches facilitate a cohort of teachers to help them gain such opportunities. These teachers are part of a paid, credit-earning program (funded by a grant) to engage in inquiry about their own practice while improving their knowledge and use of discourse practices.

The program's main goal is to help cohort teachers, who meet every few weeks in grade-level groups, to embed discourse in what they are already doing. In cohort sessions, math coaches select lessons from

the current curriculum that lend themselves well to hands-on discovery and questioning. The teachers are asked to work on a specific math task or activity while the coaches embed discussion questions, demonstrate math talk moves, and sequence the sharing of "student" work to foster connections that build understanding of mathematical concepts. Rarely, if ever, do facilitators explicitly state what the connections are; instead, they allow the teachers to explain what they see and hear. This serves as a way for teachers to engage in true discourse while seeing how they can use questioning in their own classes.

From Ping Pong to Volleyball

Curtis Chandler (2017), a former Kansas State Teacher of the Year, has written about the predominance of "ping-pong" discussion in classrooms—where information bounces back and forth between the students and the teacher. This is fine as a starting point. But, as Chandler urges, what we really want is for students to work toward conversations that operate more naturally, where they build off "moves" made by one another, as in a volleyball game. The difference is akin to meeting someone for the first time and making small talk versus holding deep conversations with long-time friends. Engaging teachers in professional learning where they, acting as students, ask and answer questions about math concepts in a "volleyball" fashion leads to better teacher facilitation in the classroom.

In the Salt Lake program, teachers are asked to consider how they can shift from teacher-directed communication to student-to-student communication, even while facilitating discussion. Cohort participants learn a series of mathematics talk structures, discussion starters, response frames, and grouping strategies to support this aim. Again, the fact that they engage in these practices as students in the cohort sessions gives them a sense of what powerful discourse feels like in a math class.

The Art of Planning

Yet developing quality facilitation moves to elicit discussion is only one part of the challenge. Teachers must also intentionally plan for discussion-based instruction by identifying questions that already exist in a lesson and then tweaking them to push the depth of knowledge and understanding. They might also need to create structures to support classroom discussions, including shifting the set-up of the room, forming small groups or partnerships, establishing discussion protocols that facilitate equitable talk, setting up and reinforcing talking norms, allowing students time to work independently before responding, and increasing wait time.

Additionally, teachers may need to create language supports that increase equitable participation among students with limited language access. Compared to the language demands of other content areas, mathematics employs the greatest number of concepts per sentence and more complex grammatical processes (Freitag, 1997).

Along the same lines, teachers must plan to address academic vocabulary, a foundational component of making sense of mathematics. Copying vocabulary words and definitions independent of mathematics lessons in action is an outdated, meaningless activity. Instead, effective teachers plan how to explicitly make connections to academic vocabulary right as students are discussing their work and thinking. Teachers can also use academic vocabulary, along with manipulatives, to create access points to difficult concepts for all learners.

In light of these discussion-planning needs, homework for the cohort teachers often requires them to prepare a lesson plan that integrates specific questioning strategies and discussion structures. Participants also write lesson objectives that include student-friendly learning intentions and success criteria that include at least one vocabulary-specific intention, such as "I can use the words *partition* and *equivalence* to describe my fraction model." Finally, they also rewrite general mathematics explanations to add specificity of language to the lesson. By sharing these planning materials with the cohort and facilitator, participants get feedback on how to refine the specific phrases they will use with students before practicing and recording a video of their class to bring back the next meeting.

Questions to Generate Deeper Math Discussions

Instead of …	Try
Explain your equation.	Relate the problem to your equation. Relate your equation to the model.
How did you solve this problem?	Tell how your work relates to what ___ did.
What steps did you take?	Explain what would happen if we changed the number? The symbol? The shape? The side length?
Show your model.	What drawing could represent this work? What visual aid could support your solution?
What is wrong with this solution?	How could you change the problem to match this work? How would you explain this error to a friend? What misunderstanding led to this error?

Defining Success

For discussions to work well in math classes, clear success criteria are particularly important. Success criteria offer students a chance to understand the tasks before them, and help teachers focus on what they expect from students. There is no one way to craft learning intentions or success criteria, but our cohort focuses on crafting quality exemplars of student work—basically representations, with visuals and text explanations, of ideal problem-solving scenarios. Exemplar solutions that illustrate expectations help students visualize what they need to be able to do and assess their current level of understanding. They can also better position teachers to ask questions that will lead students to the hoped-for learning outcomes. Starting with the end in mind gives teachers an opportunity to scaffold both work and discussions to reach the level of understanding students need to be successful, as well as to identify potential misconceptions they can bring to light through discourse.

Another opportunity for enriching student math talk is to provide an example of a solution that contains errors and have students discuss what went wrong and how it could be corrected. Helping students recognize errors as opportunities to learn, persevere through difficult problem solving, and discuss changes in thinking all create opportunities for self-awareness and mathematical sense-making.

Video Review

It's important for teachers who are learning new strategies to examine and reflect on their lessons. To this end, teachers in the cohort are provided with digital tools—including a Swivl, a robotic camera-mounting device—to video-record their own lessons. As they try new discussion techniques, they record, review, and reflect on their learning through writing, highlighting places where they felt successful and places where they would like feedback or where discourse broke down. They select components of their lessons to share during cohort meetings. During these meetings, small groups review video clips, looking for evidence of planned practices in action, in addition to providing "praises and pushes."

According to Jim Knight (2014), "The power of video is that it cuts through habituation, confirmation bias, and the complexity of teaching and shows a true picture of what is happening" (p. 7). We have found this to be true. The use of video in our cohort training provides a powerful feedback loop to help teachers see their progress and gaps in implementing discourse practices. Since these practices are often new to the teachers, their ability to see what's actually happening in their classrooms is critical.

Learning the Talk

Too often, educators ask students to engage in discussion without creating safe, supported spaces for talk to occur. Surface-level questioning that is teacher-led does not generate the depth of knowledge needed to allow for quality discussion, nor does it push mathematical thinking. Yet for teachers to be

strategic and intentional in creating mathematics discourse, they first have to experience what learning in a discourse-rich environment feels like.

The teachers in Salt Lake City are starting to see a difference from this training. The videos they bring to cohort sessions show a marked increase in student discussion and engagement. Evidence of teacher planning is getting more specific and intentional. And teachers share anecdotal stories of students taking over lessons and instructing each other through asking and answering their own questions.
Recently, cohort participants rated themselves on a four-point scale (where 1 is emergent and 4 is thriving) across 18 dimensions of academic discussion—including structures for discussion, questioning strategies, and equity—both at the start and toward the end of the training course. Every participant reported growth in each category, with overall ratings rising from 1.2 to 3.8 for all teachers. This suggests to us that the program is having an impact on the teachers' sense of efficacy in this important but underutilized area of math instruction.

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