Discourse as a tool for literacy across disciplines: Strategies and examples from the math classroom

by Ryan Seidel

Imagine a math classroom. The picture in your mind probably reverts back to your childhood of memorizing times tables, doing long division and reading black and white worksheets filled with problems. These are the memories and experiences of our K-12 teachers and often the experiences of our students today. As educators we often teach the way we were taught. This focus on skills first is akin to a reading lesson that never moves beyond phonics or reading nonsense words day after day and never encouraging comprehension of literary texts. Mathematical learning can be so much more.

In order to help develop a math literate society students need to attend to more than procedural learning. In the Common Core State Standards for Mathematics, rigor is one of three significant shifts demanding equal attention to procedural, conceptual and application based learning (National Governors Council, 2010). Traditional methods of sit and get or endless reams of procedural worksheets do little to deepen conceptual understanding, nor do they allow for application of mathematics in real world situations. This reinforces the view of mathematics as a tool, or subject to be memorized and studied in isolation. Discourse and argumentation is a practice that allows opportunities for students to engage in deeper understanding about mathematical ideas and to build discipline based literacy across subject areas.

Defining Discourse

Discourse in mathematics has a long history wherein mathematical ideas and theories are studied and explained verbally, through writing, or using models. Traditionally this communication occurs from teacher to student in the form of examples, lectures and questioning. As teachers, our understanding of mathematical ideas is reinforced through our communication to students. Likewise, when students are encouraged to engage in mathematical discourse with each other, they deepen their own understanding of concepts. This discourse does not have to be strictly verbal but should be focused on communicating understanding. The National Council of Teachers of Mathematics (2014) states:

> "Mathematical discourse includes the purposeful exchange of ideas through classroom discussion, as well as through other forms of verbal, visual , and written communication.
> The discourse in the mathematics classroom gives students the opportunities to share ideas and clarify understandings, construct convincing arguments regarding why and how things work, develop a language for expressing mathematical ideas, and learn to see things from other perspectives" (p. 29).

The idea of discourse as a social learning practice reinforces the belief that learning occurs through the interaction and renegotiation of experiences with how students understand the world. Discourse allows students to communicate understanding and evaluate it based on the experiences and reasoning of peers.

The Overlap of Math, Science and ELA Practices

Discourse is also a linking practice for academic disciplines in the classroom. Chuek's (2013) analysis of learning practices in Science, Mathematics and English Language Arts (ELA) found commonalities in student practices across disciplines. The practice of discourse and argumentation overlaps these disciplines (Figure 1) as students use evidence to communicate and support their reasoning.

This overlap reinforces the idea that discourse is a practice that deepens learning and understanding. The precise communication of student thinking with evidence transcends disciplines and is a key practice that teachers should use no matter the content of a lesson.

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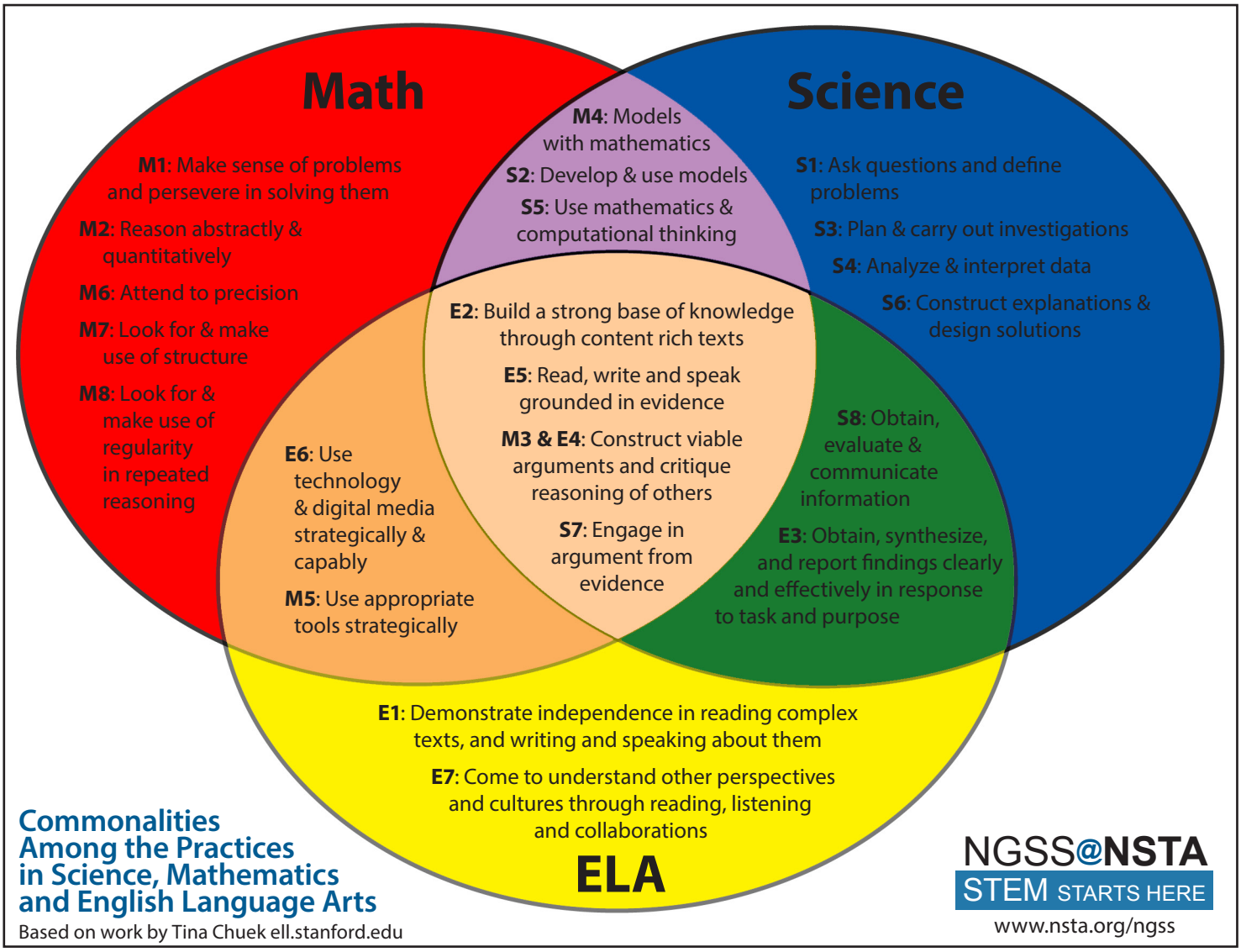

Figure 1. Discourse as an overlap of student practices across disciplines.

Three Strategies from the Math Classroom

Below are three strategies that I have used in our district to help promote evidence-based discourse, building literacy in mathematics across all three components of rigor. Though we use them in mathematics lessons, they can (and should) be adapted for use across other disciplines.

Number Talks. This classroom routine is a structured discussion that helps build number fluency by eliciting and building on student strategies. Typically the teacher displays a mental math problem (e.g. 23 +14) and asks students to solve the problem mentally. The teacher then elicits strategies from students seeking and building on different understandings of the procedures. Students can ask questions of each other encouraging justification of their strategies. In our schools, teachers frequently cite that fluency in number sense skills is the restrictive factor in deepening understanding. If a student, engaged in a mathematical problem,

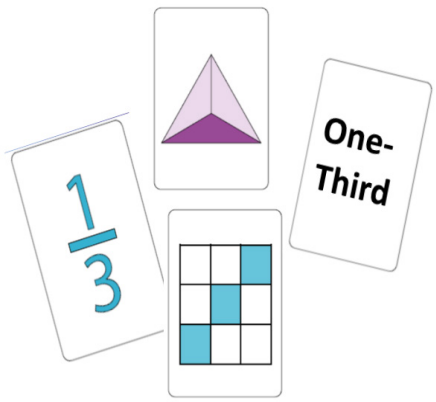

Figure 2. An example of a card matching.

spends all their cognitive energy adding two fractions as one step in the problem, they are unable to take away any greater understanding being developed by the whole process. Number talks help build the conceptual understanding and procedural fluency in basic operations thereby allowing students to be more successful in more complex problems.

Card Matching. Matching activities are instructional routines that ask students to sort through a stack of cards with multiple representations of mathematical ideas (Figure 2) and to match groups of cards that represent the same idea or have a common attribute. Worked on in groups, this routine encourages discussions about the structure of each representation deepening conceptual understanding. As a routine, card matching allows teachers

to reuse the lesson structure with a variety of content to create the cards and students become proficient at using language to compare attributes.

Rich Tasks. The use of procedure based worksheets provides students with repetitive opportunities that reinforce skills; but frequently after the first few problems learning is only reinforced, not deepened. Rich tasks provided students with a low-entry, high-exit experience that allows for multiple approaches and a deepening understanding of the mathematics involved (Henningsen, & Stein, 1997). Typically these tasks are scaffolded to allow a wide variety of students to engage in the problem but also allow for increased difficulty as students work. In one such problem I asked students from 3rd grade through AP Calculus if a straw cut in two places would form a triangle. All these students were able to enter the task and begin exploration of the Triangle Inequality Theorem. Depending on the grade level, students were able to deepen their understanding, thinking about the different types of triangles, the conditions for successfully creating one and even the probabilities that one would be created given random cuts. This task, and many like it, allow for an engagement in mathematics that promotes discussion and argumentation, deepening understanding of mathematics.

Impact and Significance

Eric Hoffer wrote that, "in times of change, learners will inherit the earth; while the learned find themselves beautifully equipped for a world that no longer exists." By focusing on common practices such as discourse, we develop procedural, conceptual and application based understanding that equips students with the literacy necessary to engage mathematical learning. In your classes and schools, I encourage you to move beyond procedural learning. Use discourse as a tool for building experiences that can deepen mathematical literacy.

Resources for discourse in mathematics.

100 Math Discourse Questions. Question stems for use by teachers and students to promote discussion about mathematical ideas.

Levels of Classroom Discourse Rubric. An overview of key components in mathematical classroom discourse including characteristic levels of performance.

Nrich. A collection of mathematical tasks organized by age level and strands of mathematics designed to encourage the application and exploration of mathematics.

Five Practice for Orchestrating Productive Mathematical Discourse (Stein, Engle, Smith & Hughes 2008). A framework for implementing classroom activities to promote discourse and deepening understanding.

References

Cheuk, T. (2013). *Relationships and convergences among the mathematics, science, and ELA practices*. Refined version of diagram created by the Understanding Language Initiative for ELP Standards. Palo Alto, CA: Stanford University.

Henningsen, M., & Stein, M. K. (1997). *Mathematical tasks and student cognition: Classroom-based factors that support and inhibit high-level mathematical thinking and reasoning*. Journal for research in mathematics education, 524-549.

Hufferd-Ackles, K., Fuson, K. C., & Sherin, M. G. (2004). *Describing levels and components of a math-talk learning community*. Journal for research in mathematics education, 81-116.

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

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common Core State Standards for Mathematics*. Washington, DC: Authors.

Sherry D. Parrish. (2011). *Number Talks Build Numerical Reasoning*. Teaching Children Mathematics, 18(3), 198-206.

Stein, M. K., Engle, R. A., Smith, M. S., & Hughes, E. K. (2008). *Orchestrating productive mathematical discussions: Five practices for helping teachers move beyond show and tell*. Mathematical thinking and learning, 10(4), 313-340.