Emerging Communities for Mathematical Practices and Assessment (EnCoMPASS): An Online Practice Space for Teacher Noticing and Wondering

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Introduction

Noticing important aspects of student work (e.g. Professional Noticing (van Es & Sherin, 2002)), interpreting and evaluating student thinking and providing high-quality feedback are seen as high leverage practices and are "likely to lead to large advances in student learning" (Ball, Sleep, Boerst, & Bass, 2009, p.461). However, improving the quality and efficiency of these noticing practices often proves to be challenging (Ball, 2001). Further, while the value of teachers working to improve their practice through explicit focus on student thinking is well documented (Levin, Hammer, & Coffey, 2009), few models for professional development and technological scaffolds exist.

Essential to the process of noticing student work is the ability to take students' ideas seriously. This requires teachers to get outside of themselves and engage in a process of seeing the student's perspective (Teuscher et al., 2015; Gehlbach & Brinkworth, 2012). Our work has scaffolded a communicative process of *double reflection*. Double reflection allows teachers to think about the math they are teaching as a doer of math. They can then reflect on how their process of work is related to the work that their student has engaged in. Double reflection is reinforced through the Notice and Wonder paradigm that is built into the EnCoMPASS environment we present here.

The EnCoMPASS environment was designed to provide an online practice space to support teachers to focus attention on student problem solving; engage in thoughtful interpretation of authentic student mathematical thinking; and ultimately a mechanism to use their analysis to craft feedback for students. The primary features of the environment include:

- identifying significant excerpts of student problem solving (words, phrases, diagrams, etc.)
- annotating these excerpts using the Math Forum's Noticing & Wondering scaffold to describe both why the utterance was significant and aspects that were unclear or emerging questions
- organizing the excerpts and annotations into a folder structure that can be pre-populated or emergent (for example, organizing students' excepts as evidence of particular strategies

The work on the EnCoMPASS environment included cycles of design, implementation, analysis, and revision of the environment.

Initial Conjectures

1. Double reflection enhances teachers abilities to interpret student work, and develop targeted and specific feedback.

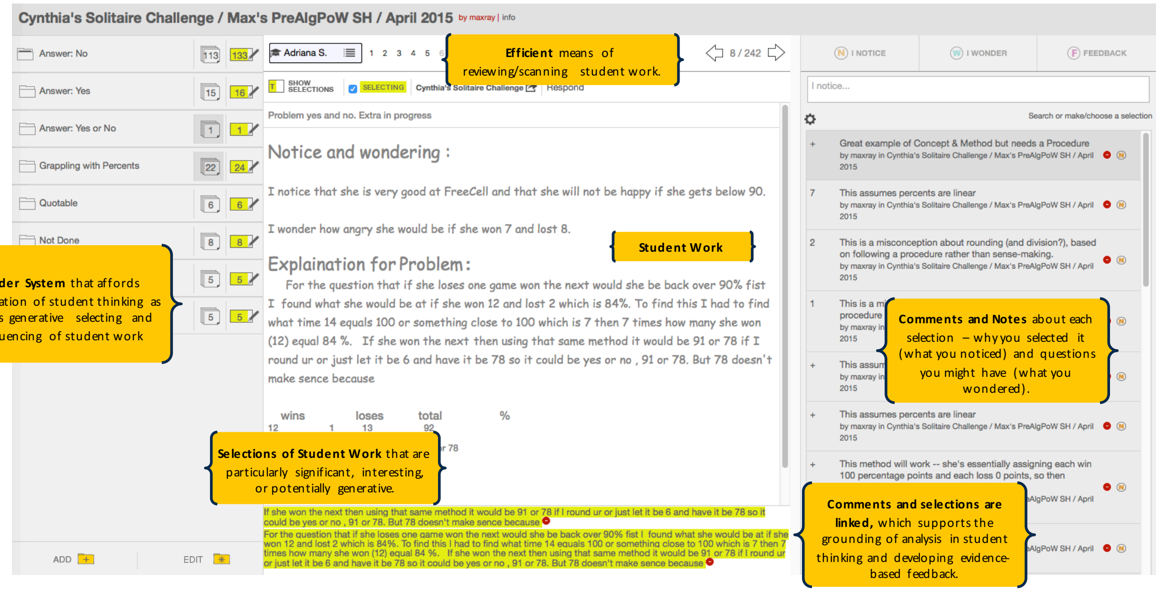
2. Online environments can be designed and leveraged to scaffold teachers as they attempt to engage in productive mathematical discussions (such as the 5 Practices articulated by Smith and Stein (2011)).

3. Online environments provide different channels of communication and interaction that can lead to potentially significant reflection and learning –about specific tasks, content and student-centered instruction – as well as position teachers to be more effective in the moment of instruction.

Methodology

Fifteen mathematics teachers participated in online activities as part of a masters program; they used the online environment and collections of student work designed to support teachers' reflective practices. In order to explore the effectiveness of our attempts to support teacher development around anticipating student work, we report on teachers' performance on their own and then with the software and themes that emerged through a process of iterative coding and constant comparative methods.

Data included online interactions during class (discussion boards, class assignments and interactions in the software) and informal conversations and emails with students.



Results

After 8 weeks of looking at student work, teachers began solving mathematics problems in multiple ways to prepare for looking at student work. In week 1, all of the teachers solved the problem in only one way and 82% of those solutions were an algebraic approach. In week 8, 81% of teachers solved the problem more than one way. Our conjecture is that these changes are a result of teachers beginning to value seeing multiple types of thinking in students' work and of the utility of their own problem solving in order to engage in double reflection..

Teachers' interest in classifying and examining multiple aspects of student work was highlighted by using the online environment and it's ability to categorize portions of student work into different folders.

- "I really liked that you decided to put student work into multiple folders. This is a great way to see all the different thought processes they are having. My group didn't do this, but I can definitely see the value" (Craig M., week 4).
- "I definitely see the advantage to placing student work in each and every appropriate folder to help understand student thinking ." (Jerry P., week 4)

Teachers displayed emergent shifts in self-reported goals and visions for instruction

- "I think it would be great to show several student responses and have the whole class discuss what they notice and wonder about each (similar to what we have been doing this term). This would provide great opportunities for the students to reflect, evaluate, and revise their mathematical thinking" (Sarah C., Week 4)
- "Rather than identifying the incorrect answers and providing correct work to one problem, sharing all work both right and wrong has a distinct advantage in allowing every student to see math done through the ideas that best fit their thought process" (Jerry P., Week 9)

Teachers close examination of student work revealed the importance of their own problem solving in order to engage in double reflection.

- "I learned that students will have strategies that I would never have anticipated. Recognizing this will help me be better at anticipating because it reminds me that even when I try to anticipate potential solutions, I must be flexible, expect the unexpected, and be open to working with strategies I had not anticipated. Being flexible when grouping students prevents me from forcing a categorization on students that does not apply to them. I may also need to try the problem myself using their strategy." (Talia, Week 10)
- "There are ALWAYS students that surprise me with the way they think and I will never be able to anticipate. I've taken from this class though the fact that the more I anticipate the less that can surprise me. It also helps if I've already anticipated different solutions/methods to know how to handle and question the students who DO surprise me with a different method/thinking. " (Jenny, Week 10)

Conclusions

Reflecting on our initial conjectures, we saw that the online tool supported teachers to see the student work from the students' perspective and not just their own perspective on mathematics. That decentering process allowed them to engage in double reflection and to name the importance, not just of solving the problem themselves, but also of solving it using the same strategies as students had used (Teuscher et al., 2015; Gehlbach et al., 2012). We also saw the use of the tool supported teachers to classify students' solutions in myriad ways and use those classifications to inform instructional strategies, some of which included creating opportunities for peer to peer analysis.

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