In-service Teachers Find The Value of Doing Math Together Utilizing Web-based Technology as Part of a Virtual Professional Development

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Virtual professional development increases meaningful and diverse learning opportunities for in-service teachers (Darling-Hammond & McLaughlin, 2011). As part of virtual professional development the participants in this study engaged in doing math collaboratively and began thinking about mathematical and pedagogical decision making within their classrooms. Prelinminary results suggest that participants valued the time to think flexibly about their own work and that of others and begain to learn to recognize the hidden decisions they were making when solving a problem that it may benefit their students to know.

Study context

Through our three-part online professional development workshop series, we focus on supporting teachers as they work collaboratively to not only develop mathematical and pedagogical knowledge, but also incorporate this knowledge and experience into their classroom practice. The professional development activities hinge on the beginning activity that requires completion of a mathematical task utilizing the web-based technology, sharing thinking about the mathematical knowledge needed to complete the task, and discussing the various solution paths for the task. Traditionally, math has been centered around procedural calculations where students and teachers are not in touch with the real-world problems and contexts of the math they are doing (Francis & Jacobsen, 2013). We know that mathematical experiences for students should be meaningful. Thus, professional development experiences should be the same for teachers (Francis & Jacobsen, 2013). In this brief paper, we report on the teachers' participation and experiences in the early phases of our project focused on collaboratively doing math in online spaces and using that work as a catalyst to begin thinking about the mathematical and pedagogical decision making. This work in progress is focused on data from the first workshop of the three-part series.

Theoretical Framework/ Literature review

Several researchers argue that conventional professional development for math educators has become stagnant and irrelevant (Francis & Jacobsen, 2013, Marrero et al., 2010, Taton, 2015). Like students, teachers approach mathematics with beliefs and anxieties (Schoenfeld, 2016), many of which stem from their own education and the culture-wide negative perception of math (Taton, 2015). As math has traditionally been taught prioritizing rote procedures instead of creative problem solving, math educators need professional development that encourages collaborative, personalized, and engaging mathematical problem solving (Francis & Jacobsen, 2013). Professional development that centers these aspects helps teachers deepen their own mathematical understanding, decenter, and feel more confident in supporting students (Kane & Saclarides, 2020).

Beyond providing geographic flexibility, online teacher professional development (oTPD) can provide meaningful and diverse learning opportunities for educators (Darling-Hammond & McLaughlin, 2011). In a meta-analysis of oTPD research, Dede, et al. (2009) found that most initiatives applied a communities of practice framework. Online teacher professional development that focuses on collaborative mathematical problem solving specifically can lead to collective knowledge building for both learning and teaching mathematics (Francis & Jacobsen, 2013). Marrerro, et al. (2010) found that educators not only felt that oTPD was beneficial for professional development, but that they could apply what they had learned to the classroom. More than anything else, teachers reported that they enjoyed the collaboration with fellow teachers, appreciating that they could network and learn amongst other educators without traveling at all.

Research Methods

We investigated teachers thinking about and engagement with online problem-solving utilizing software designed to not only capture the solution path, but also allow for selecting, commenting, sorting and feedback. The paper focuses on the initial thinking, experiences, and decision making processes of participants (n=34) as they engaged in workshop one of the professional development series. We explore the research question: In *what ways do teachers find value in doing math together utilizing an online problem solving and investigative software?* In particular, we seek to understand the value teachers place on doing problem solving together as a way to highlight their mathematical decisions.

We focused this study by reviewing participants' discussion board posts from early in the workshop as well as data from post-workshop interviews with the participants (see Table 1). Data analysis included a three-phase process, beginning with pre-coding, where the entire project team reviewed the entire data corpus multiple times to become familiar (Ravitch & Carl, 2015). The second phase featured constant comparative coding of the specified data by at least two members of the research team. In this phase, every effort was made to capture the theoretically significant ideas (such as language about engaging in math together, learning from each other, and using the software to share mathematical thinking). As part of this multiple coding phase, the team met to discuss various codes, how codes aligned or diverged, and what stood out during the process. In the final phase, the research team resolved any inconsistencies in the coding that had not already been discussed and developed and tested conjectures regarding themes in the coded data. They met to generate a theoretical memo that was based on both the field notes and the patterns and themes from the coded data (Miles et al., 2014).

Table 1. Data sources informing findings.

Source	Prompt
Discussion Board #2 - Beginning of the workshop	Unpacking your mathematical thinking. - What did you do first when exploring the Eating Contest solution(s) your group? Share any thoughts/questions/comments related to any hidden decisions that came up when you were exploring your solution process. How strange was it to solve the problem in ways that were not what you would do first? The solution that you posted, was it the first way you thought about this problem and how did it help you think about kids thinking? Or did it help you think about kids thinking?
Interview Data - End of the workshop	Sample of questions: a. What did you notice about your own mathematical thinking? b. Have these interactions had an impact on how you think about doing math? c. What were the advantages and disadvantages of doing this work with your colleagues online?

Results

While we continue to analyze data and revise and refine our conjectures regarding emergent themes, preliminary findings reveal participants (1) find the community support they received to have value, (2) sharing their work and seeing the work of others was significant for their understanding of various student solutions, and (3) comparing their own work to that of others opened their eyes to additional ways of thinking and allowed them to reflect on their work. Three major themes arose from preliminary analysis of the results. They are community support, multiple perspectives, and double reflection.

Community support refers to instances where participants mentioned feeling supported by their group. Support came in the form of validating each other's mathematical approach to problem-solving, expanding each other's ideas of how to tackle the problem and providing space for inclusion, safety and emotional support. Workshop participants were in different parts of the country that have different expectations and practices around mathematics instruction. Being able to share their experiences in a technology mediated space provided them with support that would otherwise be difficult and expensive to have. As an example, participant A stated, "I always like to collaborate and read other people's responses because I know we all think differently, and all these people share something so valuable." Additionally, participant B shared, “You know, I'm a people person, so I like synchronous mode… It was good to collaborate. We shared ideas. We worked together.”

Participants also mentioned that working together provided opportunities to get multiple perspectives on the ways that people think about the problem and the strategies that they used to solve it. The software allowed participants to share their thoughts and strategies as well as follow their colleagues' work in an easy to use and accessible medium. Working online also meant that the participants could respond to each other when it was convenient for them to do so. Participant C noted, “Yeah, it [the software] was helpful... it gives me a view of their perspective, and also the way they teach.”

Observing how others approach problem solving allowed the participants to reflect on their own thoughts about the same problem, the decisions they made when solving, and their problem-solving strategies. Participants who engaged in this type of reflection are said to have engaged in double reflection since the process of reflecting on other’s work forces them to think through the same problem that they previously did. Reflecting in this way provides teachers with opportunities to advance their mathematical knowledge by seeing different approaches and strategies for solving a problem. Two examples of this reflection are: participant D stated, “it's fun to look at that and look at how other people interpret each other's work and it's nice to see some of the things that we did similarly and some of the things, ‘Oh yeah, I didn't think about that. It's not that I didn't know about it. It's just that's not something I thought about’” and participant E stated, “I think we teachers get so used to seeing similar problems and then jumping to conclusions. That's one of the reasons I think Notice and Wonder is so powerful. The students see these problems with fresh sets of eyes and bring out so many things I would have never thought of. It can lead to very rich class discussions.“

Based on these preliminary results, the teacher participants benefited from their engagement in two main ways: (1) valuing the time to think flexibly about their own work and that of others as they began thinking about and valuing students’ mathematical ideas and (2) learning to recognize the hidden decisions they were making when solving a problem that it may benefit their students to know.

Implications

The three features discussed (community support, multiple perspectives, and double reflection) have enabled and will enable the team to refine and improve the workshops. For example, in terms of community support we heard the value of synchronous sessions form the participants and increased the number of synchronous sessions in latter workshops. Additionally, the team realized that participants needed more engagement in conversation about the mathematical decisions they were making to increase their reflective practices. Therefore, during the added synchronous sessions, discussion about mathematical thinking and decision making was elicited and facilitated.

As this work continues and the team analyzes more the data, it is our conjecture that by providing participants with research based instructional practices and opportunities to reflect on their work that they may advance not only their mathematics knowledge, but also their pedagogical knowledge.

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