Doctoral Student Research Briefs

School of Education

Drexel University

Research Brief No. 9

Mathematics Teachers Professional Development: A Virtual Boundary Encounter

By

Anthony Matranga
PhD Student
Drexel University

Supervising Professor: Dr. Jason Silverman

Volume 1 Number 9 February 2017

Published on February 3, 2017 by the School of Education at Drexel University

Mathematics Teacher Professional Development: A Virtual Boundary Encounter

Anthony Matranga

Drexel University

Abstract

This study examined 21 practicing teachers' participation in an online community-based professional development course. This study integrated a web-based assessment environment into the online course. The tool was designed to function as a boundary object and mediate a virtual boundary encounter with the Math Forum. Teachers' interactions mediated by the tool and the discussion board (DB) was examined. Results indicate that the virtual environments mediated interactions around core mathematical ideas in qualitatively different ways. Conclusions are drawn regarding the potential of the virtual boundary encounter to mediate teachers' development of mathematical knowledge for teaching.

Aim

Research and policy demand ambitious goals for mathematics instruction, which include calls for problem-based learning, peer-to-peer argumentation and formative assessment practices (NCTM, 2000). Professional development (PD) is crucial for achieving these goals and supporting teachers' instructional change. Community-based PD, in particular, provides context for the collective development of mathematical and pedagogical content knowledge, opportunities for teachers to reimagine their instructional practice, and has shown to support teachers' instructional change (Vescio, Ross, & Adams, 2008). There are shortcomings to school-based communities; for example, it is often difficult for teachers to fit community into their daily schedule and local school districts' norms for instruction typically do not align with those called for by research and policy. Online communities can address these shortcomings as teachers are not constrained to collaborate while at work and norms that emerge in alternative contexts are transferable into teachers' instruction (Van Zoest, Stockero, & Taylor, 2012). There is a lack of research on teachers' participation in online communities. To fill this gap, the following research question was posed: How does the virtual environment facilitate teachers' participation in online community-based PD?

Problem

This study is framed by the conceptual framework communities of practice (Wenger, 1998). This study conceptualizes mathematics teacher PD as participation in boundary encounters, which is an interaction between communities of practicing teachers and teacher educators (Sztajn, Wilson, Edgington, & Myers, 2014). Sztajn et al. (2014)

regard this as a boundary encounter because teachers and teacher educators engage qualitatively different practices, particularly when engaging with students' ideas. This study extends this idea and facilitates a *virtual boundary encounter,* which is a boundary encounter mediated by a web-based assessment environment designed to scaffold activities that are consistent with the practices of the Math Forum — a leading group for mathematics education in the United States (Shumar, 2009) — and enhance the process of analyzing student work. The tool supports user's focus on the details of student thinking and grounding their analysis in student thinking. After participants engage these activities they share their analysis with colleagues in the form of feedback. In this way, the assessment environment mediates participants' engagement in collective mathematical activity. These activities are also consistent with the Math Forum's practice of assessing student thinking. Thus, the tool is designed to simulate an encounter with the Math Forum because working with the tool is consistent with engaging activity with the Math Forum.

Methods

This study investigates 21 practicing teachers' participation in an online PD course. The content-based course engages teachers in reasoning about functions. The assessment environment was integrated into this course to mediate participants' interactions around their mathematics work. The tool has features that enhance the process of assessing student thinking as it allows users to highlight aspects of students' work, make comments on these highlights, and categorize students' work into folders. The DB also facilitated teachers' mathematics work. A grounded theory approach was applied through axial coding procedures and the iterative analysis of themes (Glaser & Strauss, 1999). This study is part of a larger study that conducted an analysis of norms. In such analyses, certain types of evidence are acceptable for documenting the emergence of norms, such as the *explicit discussion* of mathematical activity and instances of *challenge* between participants (Dean, 2005). Analyses focused on these types of interactions.

Findings

Findings from this study indicate that teachers interacted around core mathematical ideas mediated by the web-based tool and DB in qualitatively different ways. Mediated by the web-based tool, participants frequently challenged one another to engage mathematical reasoning that focuses on quantities and relationships to explain why graphs have particular visual features. Mediated by the DB, participants explicitly discussed their mathematical activity and collectively reflected on the core mathematical ideas in the course. Table 1 provides an overview of the analysis. The reader will notice that in interactions mediated by the DB there were no challenges, while there were 52 challenges in those mediated by the web-based tool. Conversely, there were 20 explicit discussions in the DB and zero in the assessment environment.

Table 1: Summary of coding

	DB		Assessment Environment	
Week	Explicit discussions	Challenges	Explicit discussion	Challenges
3	6	0	0	7
4	4	0	0	13
5	2	0	0	13
6	8	6	0	19

Mediated by the web-based tool, participants critiqued colleagues' mathematics work. In week four, participants were tasked with explaining the behavior of the function $y=\sin(x^2)$. Cindy reviewed Summer's[1] work and challenged her to refine her mathematical explanation in a particular way. Cindy highlighted the following from Summer's work: "As the x-values get farther away from the origin the graph waves get close and closer together;" and then Cindy provided the following feedback: "I wondered if you can explain this using the relationship between the underlying quantities instead of just describing what the graph looks like." In this way, Cindy questions Summer's approach and pushes her to explain why the graph has particular visual features. This is a representative example of the way in which participants challenged one another to engage mathematics explanations in ways that align with course goals.

Mediated by the DB, participants collectively reflected on their mathematical activity. For example, Paul initiated one of these conversations: "I am gaining a greater appreciation as to why we are focusing so heavily on the relationship between quantities - the fact that we need to talk about these relationships in order to be able to get at the 'why.'" In response to Paul's post, Chloe says, "I am also gaining a greater appreciation for these ideas because prior to these activities, I would only be able to explain the different properties of the sine function and not why these properties are true." In this way, Chloe agrees with Paul and relates this idea to the more specific case of trigonometry and sine functions. Taken together, this interaction initiated a shift in the class's discourse and contributed to the reification of their mathematical activity.

Conclusion

The virtual boundary encounter impacted teachers' norms for collaboration and mathematical discourse. Typical patterns in teachers' collaboration include sharing and comparing ideas while keeping differences in perspectives private (Grossman, Wineburg, & Woolworth, 2001; Zhang, Liu, Chen, Wang, & Huang, 2017). Silverman (2012), on the other hand, found that teachers who questioned and challenged colleagues to engage mathematics in specific ways were more likely to show significant gains in Mathematical

[1] All names are pseudonyms to protect the identity of the participants

Knowledge for Teaching (MKT) — the mathematics correlate to pedagogical content knowledge (Shulman, 1986). This study illustrated that the virtual boundary encounter supported teachers frequently questioning and challenging colleagues, thus breaking down norms of agreement and creating an environment where teachers were more likely to have gains in MKT. Future research is needed to understand how the web-based tool supported occasions of challenge between teachers.

References

Dean, C. (2005). *An analysis of the emergence and concurrent learning of a professional teaching community.* (Unpublished Doctoral Dissertation), Department of Teaching and Learning, Vanderbilt University, Nashville, TN.

Glaser, B., & Strauss, A. L. (1999). *The discovery of grounded theory: Strategies for qualitative researcher*. Hawthorne, NY: Aldine de Gruyter.

Grossman, P., Wineburg, S., & Woolworth, S. (2001). Toward a theory of teacher community. *The Teachers College Record, 103*(6), 942-1012.

NCTM. (2000). *Exucitive Summary: Principle and standards for school mathematics*. Reston, VA: National Council of Teachers of Mathematics.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 4-14.

Shumar, W. (2009). Communities, texts, and consciousness: The practice of participation at the Math Forum. In J. K. Falk & B. Drayton (Eds.), *Creating and sustaining online professional learning communities*. New York, NY: Teachers College Press.

Silverman, J. (2012). Exploring the Relationship between Teachers Prominence in Online Collaboration and the Development of Mathematical Content Knowledge for Teaching. *Journal of Technology and Teacher Education, 20*(1), 47-69.

Sztajn, P., Wilson, P. H., Edgington, C., & Myers, M. (2014). Mathematics professional development as design for boundary encounters. *ZDM, 46*(2), 201-212.

Van Zoest, L. R., Stockero, S. L., & Taylor, C. E. (2012). The durability of professional and sociomathematical norms intentionally fostered in an early pedagogy course. *Journal of Mathematics Teacher Education, 15*(4), 293-315.

Vescio, V., Ross, D., & Adams, A. (2008). A review of research on the impact of professional learning communities on teaching practice and student learning. *Teaching and Teacher Education, 24*(1), 80-91.

Wenger, E. (1998). *Communities of practice: Learning, meaning, and identity*: Cambridge university press.

Zhang, S., Liu, Q., Chen, W., Wang, Q., & Huang, Z. (2017). Interactive networks and social knowledge construction behavioral patterns in primary school teachers' online collaborative learning activities. *Computers & Education, 104*, 1-17.

Author Biography

Anthony is a 4th year PhD student in the school of education. His background is in

mathematics and mathematics teaching and learning. Prior to entering the PhD program, Anthony taught high school mathematics for five years in an urban school district in New Jersey. Anthony's research explores the ways which online community-based professional development and technology impact mathematics teacher learning and instructional change. In particular, his work concentrates on how technology mediates the emergence of online communities of teachers, teachers' persistent engagement in online communities, and the role of informal leaders in online communities.

Published on February 3, 2017 by the School of Education at Drexel University