



11-2019

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Eryn M. Stehr
Georgia Southern University

Lindsay M. Keazer
Sacred Heart University

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Recommended Citation

Stehr, E. M., & Keazer, L. M. (2019). Supporting prospective teachers' development of relevant and authentic mathematics stories. In S. Otten, A. G., Candela, Z. de Araujo, C. Haines, & C. Munter (Eds.). *Proceedings of the forty-first annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp.1131-1135). St. Louis, MO: University of Missouri. Retrieved from <https://www.pmena.org/pmenaproceedings/PMENA%2041%202019%20Proceedings.pdf>

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SUPPORTING PROSPECTIVE TEACHERS' DEVELOPMENT OF RELEVANT AND AUTHENTIC MATHEMATICS STORIES

Eryn M. Stehr
Georgia Southern University
estehr@georgiasouthern.edu

Lindsay M. Keazer
Sacred Heart University
keazerl@sacredheart.edu

Supporting prospective elementary teachers (PTs) to develop mathematics problems with contexts that reflect their students' lives is a challenge that remains to be explored. We began this work by conducting collaborative action research to explore PTs' development of mathematics problems that were relevant and authentic to PTs' own lives. We engaged in iterative cycles of action research by asking PTs to write mathematics stories, followed by our review and discussion of the themes we saw and sharing selected examples with PTs during class discussions. Findings after three cycles of data collection suggest that PTs' mathematics contexts became more story-like and personally authentic, and the authors (mathematics teacher educators) developed a clearer understanding of their goals for supporting PTs' development.

Keywords: Culturally Relevant Pedagogy, Instructional Activities and Practices

Scholars of equity in mathematics education have established that teaching mathematics is not a neutral enterprise, and that teachers' choices of mathematical problems convey messages to students about what issues mathematics is useful for addressing (e.g., Felton, 2010; Gutiérrez, 2007; Gutstein & Peterson, 2013). How teachers learn to identify mathematics problem contexts that mirror students' diverse lives and experiences is not yet fully understood. As mathematics teacher educators, we (the authors) realized that our students (elementary prospective teachers) may not yet have sufficient experiences working with children to connect mathematics to children's cultures beyond superficial ways. Thus, this collaborative action research focused on supporting prospective teachers (PTs) in telling mathematical stories that reflected their own lives and cultures, as a first step towards developing the ability to see relevant mathematics in the world around them and eventually connect mathematics to their future students' cultures.

We began the project from a shared value for supporting the development of PTs' decision-making and creativity about how to contextualize mathematics learning opportunities in meaningful ways. We asked the guiding question: How can we support PTs in telling mathematical stories that are relevant and authentic to their lives, homes, and communities?

We engaged in iterative cycles of action research by asking PTs to write mathematics stories, followed by our review and discussion of the themes we saw. Then we presented examples to PTs during class discussion and prompted them to continue to search for mathematics contexts within their lives. While we each engaged in independent analysis of our own PTs' data, a second and integral part of our professional learning opportunity was collaborative action research (Capobianco & Feldman, 2006): discussing our noticings and wonderings through phone calls and emails as our distinct goals and strategies emerged.

Literature Review

Mathematical problems communicate messages about what is normal in our world and what issues mathematics is useful for addressing (Felton, 2010), and teachers' choices of mathematics problems influence the messages communicated. Some teachers have difficulty developing

contexts that connect to students' experiences (Rubel, 2017), or risk making connections to students' cultures in superficial ways (Author blinded).

We see culturally relevant contexts as an important way to connect to students' lives and experiences (Ladson-Billings, 1994). Developing relevant mathematics contexts reveals the power and potential of mathematics as a tool to understand students' culture, community, or the broader world (e.g., Gutiérrez, 2007, Gutstein & Peterson, 2013).

Developing authentic mathematics problem contexts--particularly contexts that are authentic to students--was another idea that motivated our work. We align our definition of authentic contexts with that of the youth-centered perspective described by Buxton (2006), who outlined three perspectives of authentic contexts based on a review of science education research literature. The youth-centered perspective is "grounded in useful truths for solving students' real problems" (Brickhouse, 2001, cited in Buxton, 2006, p. 698). Aligned with this definition, we wanted PTs to develop their ability to identify real problems existing in their own lives that mathematics would be useful for understanding and solving.

As we considered ways to support PTs in developing mathematics problems with culturally relevant and authentic contexts, Radakovic, Jagger, and Jao's (2018) account of PTs writing mathematical poetry inspired us to provide PTs an opportunity to write their lives into mathematics stories. We hoped this open-ended task would encourage their creativity and hone their ability to see mathematics problems that were real within their worlds.

Method

We engaged in a model of collaborative action research (Capobianco & Feldman, 2006), collaborating around a common goal while allowing our voices, philosophies, and teaching methods to remain distinct. Carr and Kemmis (1986) conceptualized teacher action research as a self-critical inquiry into one's practice with the goal of improving and developing a better understanding of practice. Teacher action research enables us, as teacher educators, to study our own practice through cycles of action and reflection (Reason & Bradbury, 2008). Collaboration strengthens opportunities beyond those of individual action research (Capobianco & Feldman, 2006), as teacher researchers support each other in the refinement of their individual inquiries while serving as "critical friends" (Kemmis & McTaggart, 1988).

We conducted action research working with K-8 PTs in two distinct contexts: Eryn's project is situated in a number and operations content course, and Lindsay's project is situated in an elementary mathematics methods course. Eryn's PTs have not yet been accepted into the teacher education program. Her course is the first mathematics-for-teachers course they experience. Over the semester, she hoped to support her PTs to notice mathematics relevant to the course as well as authentic to their lives. Lindsay's PTs are seniors in an elementary mathematics methods course during the semester prior to student teaching. She hoped to help PTs learn to better recognize the mathematics already embedded in their lives and in the local community and write mathematics problems that captured this.

Data Collection and Analysis

Two types of data were collected: data from PTs' mathematics stories and data on instructors' actions and reflections. PT data was collected through PTs' mathematics stories written as classwork, transcribed by the instructors into Excel. Instructor data was collected through email discussions, meeting notes, and researcher journals (writing brief ten-minute reflections after meetings or class sessions). We met for discussion and exchanged emails throughout the semester, before and after each writing prompt was given to PTs.

Data collection spanned 6 weeks as we engaged in three cycles of action research, collecting PTs' mathematics stories in weeks 1, 3, and 5. We conducted interim analysis of the data during the week between each data collection cycle. This consisted of repeated reviews of the data, noticing categories and themes in an informal grounded theory approach (Creswell, 2007). As part of our collaborative action research, we then discussed with each other the themes we were noticing in our data. We each selected individual PT responses that stood out to us and discussed how these responses were distinct from the themes we saw in others. The process of identifying themes and distinct examples within PTs' responses allowed us to better understand differences and clarify our goals for the next steps of our action research. This analysis informed our implementation of a class discussion of PTs' stories the following week: we each shared selected PT responses during class discussion and asked PTs what they noticed about different examples. Then PTs were given the prompt again the following week. A later, second round of analysis occurred after all data was collected, following a more formal approach to grounded theory (Creswell, 2007).

Findings

We present findings regarding PTs' mathematics stories and our learning as mathematics teacher educators, contextualized by describing the actions taken by each instructor in their course. Because the courses and instructors were different, course activities were tailored to the course and the action research strategies that emerged were also distinct.

Author Eryn

During week 1, I asked PTs to write a response to: "Word problems in the classroom are not always realistic. Thinking about the math in this course, write one example of math you have noticed in your home, your life, or your community." To connect this prompt to our mathematics course content, I prompted PTs to incorporate mathematics concepts from the course as they searched for mathematics contexts reflecting their lives. After reviewing responses, I noticed that PTs' mathematics contexts felt impersonal and lacked detail or context. This observation triggered my learning and made me aware that I wanted to push PTs to make their descriptions more story-like, and also to consider how to make them authentic: to solve real mathematics problems that they saw in their lives (Buxton, 2006). After categorizing PTs' responses, I shared a series of selected responses with them in a week 2 discussion. Examples ranged from impersonal stories or stories with minimal description to a detailed story about a PT's interaction with her younger brother around dividing pepperonis evenly between pizzas in a Lunchables.

In week 3, I revised the prompt to emphasize the need for developing story-like contexts, changing the word *realistic* to *authentic*, and prompting for a detailed math story instead of one example. I also shared my own example of a mathematical story from my life. I discussed how situations authentic to one person, are not necessarily authentic to another. After reviewing PTs' week 3 responses, I noticed that many PTs followed a structure and context similar to my story. This noticing helped me refine my goals: to support PTs in developing an ability to recognize new ways that mathematics might be used as a tool to investigate the world around them and problems interesting to them, rather than using my example as a template. As part of my analysis of PTs' responses, I made notes of responses that demonstrated this use of mathematics.

Accordingly, during week 4 I shared selected examples of PTs' mathematics stories that better illustrated my goal of using mathematics to explore their own curiosities in their lives. I also shared the story of students learning fraction operations while studying a problem of concern for them: school overcrowding (Turner & Font Strawhun, 2007). I revised the prompt in

week 5 to emphasize using mathematics to “help you make sense of or critically examine situations in your home, life, or community.” Many responses seemed to describe ways PTs had used mathematics to make sense of situations in their lives. It seemed that the more personal mathematical stories were written to be more complex and less solveable than a typical mathematics story problem.

Author Lindsay

As part of my mathematics methods course, PTs had the opportunity to read several articles related to relevant mathematics contexts and teaching mathematics for social justice (e.g., Felton, 2010; Turner & Font Strawhun, 2007). At each data collection I gave PTs the prompt: “Word problems in the classroom are not always realistic or connected to peoples’ experiences. Let’s look for ways to bring in math from our own culture. What math have you noticed in your home, your life, or your community?”

When I reviewed my first set of responses during week 2, I was initially disappointed to see that many PTs’ responses felt like generic lists of mathematics contexts that may have been told to them during their socialization into school mathematics (e.g., money, time, cooking), and that sounded akin to typical story problems found in traditional textbooks. In contrast, a few PTs’ responses stood out as examples that illustrated mathematics embedded in their personal experiences or uniquely connected to their community. This clarified my understanding of my goals, as these personal mathematics stories (as we began to call them) signified the development of a PT’s ability to self-identify connections between their lives and mathematics. Identifying instances of mathematics in their lives seemed quite different from regurgitating mathematics contexts that they had learned from their past school mathematics experiences. In the class discussion the following week, I provided a series of selected responses and asked PTs to comment on what differences they noticed across them. I provided several list-like responses on the first slide, followed by four PT examples that were contextualized in a personal and story-like way. PTs noticed the more story-like nature of the examples that I highlighted and began to emulate that in subsequent data collection opportunities.

After completing the second and third rounds of data collection and continuing to facilitate class discussions around selected examples of PTs’ mathematics stories, I saw shifts occurring in PTs’ responses. Their responses became noticeably lengthier and developed more personal and story-like qualities. While PTs had developed their story-like descriptions of mathematical contexts, however, I realized that they had not yet given the contexts specific enough quantities to make them into mathematical tasks. This seemed to be a direct reflection on what I had brought their attention to during class discussions, and what I had not yet emphasized. This provided me with a next-steps goal for my action research in the future.

Discussion

The process of conducting collaborative action research around a common goal allowed us to reflect together on our learning as mathematics teacher educators, through the process of developing PTs’ lenses to “see” mathematics in the world around them and to tell mathematical stories that reflected relevant and authentic experiences of their own. Our mathematics teacher educator learning as a result of this research centered on three key themes: a) refining our understanding of what relevant and authentic mathematical stories looked like by identifying developing evidence in PTs’ work, b) recognizing PTs’ desire to simply follow prescriptive instructions rather than hone their creativity, and c) identifying the power of our actions and expressed values on influencing PTs’ responses. The repeated action of presenting PTs’ with

examples of their peers' mathematics stories seemed to accomplish multiple purposes: to value the PT's contribution, as well as provide positive peer pressure by providing new illustrations of the ways that mathematics could be connected to life in authentic and personally relevant ways. These themes will be unpacked in detail during the presentation.

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