Designing Learning Experiences for Mathematics Teacher Preparation

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Abstract

The literature underscores the importance of authentic learning environments for developing preservice teachers' dispositions and skills for teaching mathematics. Hence, teacher preparation programs often include methods courses embedded within K-12 schools. Utilized to a lesser extent, however, are campus-based interactions with school-aged children. In this action research study, I investigated how such communications embedded within a mathematics methods course influenced preservice teachers' learning. Grounded theory underpinned my inquiry, and findings portrayed the interactions as promoting 1) a stance for teaching mathematics visually, and 2) recognition of existing connections concerning a) disciplinary topics, b) course readings, and c) participants. In this article, I highlight features for educators to consider when designing teacher learning experiences both within schools and on campus.

Keywords: teacher candidates, clinical experiences, mathematics education

The literature underscores the importance of deeply connected, realistic experiences within teacher preparation coursework (McDonald, Kazemi, et al., 2013). Hence, mathematics teacher preparation standards call for increased authentic learning environments for preservice teachers (PTs) to develop knowledge, skills, and dispositions for teaching mathematics (Association of Mathematics Teacher Educators (AMTE), 2017).

Responses include models that embed methods courses within K-12 schools; however, there remains a sparsity of evidence for specific features of those models that best support PT learning (Swartz et al., 2018a). Even less prevalent is inquiry around how campus-based interactions with school-aged children contribute to teacher preparation.

Focused on this lens of inquiry, I engaged in an action research study to identify features of campus-based interactions that support mathematics teacher preparation. Such pursuit responds to the Association of Teacher Educators' (ATE) *Standards for Teacher Educators*, Standard 3, a criterion that calls upon teacher educators to "engage in inquiry and contribute to scholarship that expands the knowledge base related to teacher education" (ATE, 2020). My findings address ATE's Standard 5 with implications for effective teacher education coursework design. I am not implying that campus-based interactions with school-aged children should replace school-based ones. Instead, I highlight features for educators to consider when designing teacher learning experiences both within schools and on campus.

Literature Review

AMTE tasks teacher preparation programs, through its standard entitled, *Students as Learners of Mathematics*, with providing extensive authentic experiences within mathematics methods coursework that develops PTs' understanding of how students think and learn about mathematics (AMTE, 2017). This shift in teacher education toward practice prompts those in the

field to reimagine pedagogy that affords diverse opportunities to interact with school-aged children.

Kazemi (2018) draws attention to one's design of coursework and the importance of contemplating how design shapes what and how PTs learn. She promotes "pedagogies of enactment" that afford novice teachers opportunities to *do* the teaching practice within the context of methods courses to learn about the practice of teaching.

Swartz et al. (2018a) add their recommendation for "mediated field experiences" where a mathematics teacher educator "mediates" opportunities, in the moment, for PTs to engage in classroom realities; for example, creating a lesson plan, teaching a lesson, and reflecting on teaching. Campbell & Dunleavy (2016) concur, stating that without the presence of the mathematics educator during authentic experiences, a PT may apply university knowledge inappropriately, or struggle to notice or make sense of teaching techniques that yield unexpected happenings.

Furthermore, Virmani et al. (2017) encourage designing authentic experiences in partnership with schools. In agreement, the National Council of Teachers of Mathematics (NCTM, 2014) states:

> Only when preparation programs purposefully engage with schools, not just in schools, will their clinical preparation become truly robust in ways that maximize candidates' skill development and therefore their abilities to support the mathematics learning of students. (p. 37)

One semester, it became challenging for me to incorporate school-based experiences into my mathematics methods course due to scheduling factors. These circumstances allowed me to inquire about the influences of campus-based interactions with school-aged children (interactions) on PT learning.

I designed these interactions in partnership with a local school, and a situative stance guided my inquiry. Greeno (2006) states:

> In a situative study, the main focus of analysis is on performance and learning by an activity system: a collection of people and other systems. In a situative study, individual cognition is considered in relation to more general patterns of interaction….The goal is to understand cognition as the interaction among participants and tools in the context of an activity. (pp. 83-84)

Studying the interactions as an activity system, I drew from grounded theory (Corbin & Strauss, 2008) to guide my data analysis. My research question was: How can campus-based interactions with school-aged children embedded within a mathematics methods course shape PT learning?

Methods

Participants

During a 14-week semester, 23 undergraduate PTs in their third year of study, and enrolled in a 3-credit elementary mathematics methods course, engaged in four first- through fourth-grade interactions. Each interaction included approximately 20 heterogeneously grouped students enrolled in a nonpublic school located in the New York metropolitan area. The interactions were part of a broader university-school partnership where both parties shared learning spaces to support student learning, exposure to college surroundings, teacher preparation, and professional development.

Design of Interactions

I aligned the interactions with the participating school's instructional needs as advised by the principal to allow PTs to meaningfully and purposefully interact with school-aged children. The principal conferred with in-service teachers on appropriate topics for the interactions. A visual approach underpinned instruction to develop PTs skills for cultivating conceptual understandings and related analysis skills.

The interactions, spaced two weeks apart, occurred during scheduled course times in a campus setting that reflected an everyday classroom. The in-service teacher for each participating grade attended, along with colleagues below and above that grade, to showcase instructional approaches across grade levels. After rehearsing instructional activities before each interaction, PTs co-taught and reflected upon content, student thinking, and pedagogy both individually and collectively with the children, in-service teachers, and accompanying principal.

Author-Researcher Perspectives

It is critical to acknowledge and respond to a researcher's stance in a qualitative project since the researcher becomes the instrument for collecting and analyzing data (Glesne, 2006). I allocated time for reflection on subjectivity and its implications on my position as the researcher. To enhance the validity of findings, I utilized multiple data sources and collection methods (Maxwell, 2012).

During analysis, I remained attuned to disconfirming evidence and evaluated findings against contrasting explanations (Yin, 2009). Throughout, I exercised reflexivity by acknowledging my views about teaching and learning mathematics; this guarded against inflecting personal positions into research data. I controlled bias by sharing results with

participants to incorporate member checking and ensure consistency in data reporting (Grbich, 2007).

Data Collection

Before the interactions, PTs wrote autobiographies to describe a) personal experiences learning mathematics, and b) perspectives on themselves as future mathematics teachers. After each videotaped interaction, PTs wrote "takeaways" to identify aspects they found intriguing, surprising, or disturbing.

I kept field notes on my observations of all participants during the interactions. Between interactions, I conducted reflective taped group discussions with PTs and myself. These field notes, along with transcriptions of group discussions, became part of a reflective journal I kept to document activity and related dialogue. At the semester's close, PTs wrote final reflections to share perspectives concerning the interactions' influences on their learning.

Analysis

I conducted open coding of the autobiographies to determine any emerging themes, categories, and patterns (Gay et al., 2009). I followed this procedure for the group discussions, final reflections, and my reflective journal. I formatted the PTs' takeaways as individually listed sentences (statements), and eliminated non-specific statements. For example, I did not include, "It was nice to spend time with the children," for analysis; while I did include, "The Exchange Game played before the addition example readied the children for regrouping." I then open coded the remaining 81 statements to surface any themes, categories, and patterns.

Throughout analyses, I exercised triangulation to validate data. I cross verified findings stemming from the PTs' statements with those from coded group discussions, final reflections, and my reflective journal. I reviewed results from these data sources with those from the

autobiographies to monitor developing knowledge, skills, or dispositions for teaching mathematics.

I considered antecedents and consequences while comparing findings and conducted an organizational review. I reflected on how the interactions were connecting with institutional goals, programming, and course objectives. To visualize factors appearing to influence PT learning, and to consider missing elements, I conducted concept mapping.

Findings

Autobiographies revealed the majority of PTs (65%; 15 of 23) struggling with mathematics as learners, and only 35% of PTs (8 of 23) intended to use hands-on materials as future mathematics teachers. PTs' statements portrayed the interactions as promoting 1) a stance for teaching mathematics visually (60%, 49 of 81), and 2) recognition of existing connections (59%, 48 of 81). Concerning existing connections, three emerging categories revealed the interactions serving to a) illuminate disciplinary connections, b) anchor course readings, and c) stimulate collective learning among participants. Analysis of group discussions, final reflections, and my reflective journal coincided with findings gleaned from the statements.

Discussion

Teaching Mathematics Visually

PTs developed a stance for teaching mathematics with concrete manipulatives and related representations; they acknowledged such visual learning as supporting conceptual understandings and skills (see Table 1). This contrast in perspective from that expressed in their autobiographies is worth noting; I realized teaching perspectives can shift if PTs have opportunities to acquire reasons to change. This finding coincides with Cox (2014), who

highlights teachers taking a more metacognitive approach and designing instruction in ways they prefer.

Influential moments include those when PTs' observed the role manipulatives and related representations play in cultivating conceptual understandings and skills. For example, during a task involving pattern finding using sums for ten, PTs acknowledged how concrete objects and related recordings were conducive to first graders noting the commutative property for addition.

Li and Castro Superfine (2018) also found PTs exposure to manipulatives promoting visual learning approaches in classrooms. A further layer to report is that while witnessing a student-centered learning environment involving manipulatives, PTs voiced their increased confidence in the first graders as competent sense makers and knowledge generators. Such exposure to students constructing knowledge is noteworthy since Jackson et al. (2017) highlight how essential it is that teachers acknowledge students' capabilities.

Connections

A sense of connectedness permeated the interactions. PTs acknowledged how multiple disciplinary topics naturally emerged during student conversations around instructional tasks (see Table 1). This is also worth noting since Boaler et al. (2019) report how students unfortunately perceive mathematics as isolated rules and methods.

PTs connected occurrences during the interactions with course readings (see Table 1). In turn, I was afforded opportunities to utilize these occurrences as authentic reference points for anchoring course readings, and enriching course discussions; allowing me to address scholars' recommendations to connect research in meaningful and purposeful ways (Edington et al., 2016).

PTs acknowledged the interactions as opportunities for collective learning (see Table 1). They noted how, by sharing answers and methods, children made thinking visible, showcased

diverse approaches, and highlighted that “different doesn’t necessarily mean wrong." Such acknowledgment supports PTs in meeting AMTE's (2017) expectation that mathematics teachers can analyze different approaches to mathematical work and respond appropriately (Indicator C.1.5). PTs also voiced appreciation for instructional insights they received through co-teaching and peer-assessment opportunities; worth noting as well since studies pinpoint collaboration and collective reflective dialogue as highly effective practices for all school stakeholders (Swartz, et al., 2018b).

Table 1. *PT Representative Statements*

Theme	Statement
Teaching Mathematics Visually	“I was surprised at how much the first graders noticed. The materials visibly and physically helped them see patterns within different ways to compose the number ten."
Connections Disciplinary Course Readings	"One of the first graders noted when half the fireflies were in the jar, and half were in the sky. Another saw how two even numbers or two odd numbers sum to ten. I didn’t anticipate these other topics coming up in conversation.”
Participants	“One of my students hid the fact that they were counting on their fingers as we read about in our last article.”
	“We all learned with and from each other.”

Conclusions

Teacher educators need to strategically and deliberately design authentic learning experiences for developing knowledge, skills, and dispositions for teaching mathematics. Through action research, I uncovered features of campus-based interactions with school-aged children that supported PT's learning.

Specifically, social endeavors with school-aged children designed to showcase visual teaching approaches and disciplinary connections positively influenced PTs' mindset for teaching mathematics meaningfully and purposefully. Also, course readings connected with authentic experiences supported the bridging of theory with practice, as did affiliating multiple stakeholders cultivate a climate for collective learning.

Since a small sample was involved, my findings are not generalizable. However, the close examination of data can contribute to theory about how teachers learn about standards (Yin, 2009). My research offers educators features to consider when designing learning experiences within both schools and on campus to further connect university coursework with authentic contexts; and, ultimately, prepare teachers for the realities of mathematics classrooms.

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