SHAPING THE PROFESSIONAL GROWTH OF MATHEMATICS FACULTY WHO TEACH PROSPECTIVE SECONDARY TEACHERS

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Professional development (PD) that supports faculty in teaching courses for prospective secondary teachers, especially courses focused on mathematical knowledge for teaching, are largely absent from higher education, despite the need to improve instruction in these courses. This study examines a novel PD program whose structure was inspired by rehearsals (Lampert et al., 2013). We analyzed PD discussions throughout the year using an instructional triad framework, and we interpreted the PD structure using Clarke and Hollingsworth's (2002) Interconnected Model for Professional Growth. We suggest that a rehearsal-inspired pedagogy offered opportunities for faculty growth in attending to student contributions.

Keywords: Mathematical Knowledge for Teaching, Undergraduate Education, Professional Development

Recent policy documents agree that secondary mathematics teacher preparation must attend to developing teachers' mathematical knowledge for teaching (MKT) (Conference Board of the Mathematical Sciences, 2012; Association of Mathematics Teacher Educators, 2017). Although there is promise in simulating practice to develop teachers' MKT in ways that coordinate mathematical and pedagogical sensibilities (Biza et al., 2007; Stylianides & Stylianides, 2010), such tasks are uncommon in undergraduate content courses for pre-service secondary teachers (Lai & Patterson, 2017). To expand opportunities for developing MKT in content courses, the project Mathematics of Doing, Understanding, Learning, and Educating for Secondary Schools (MODULE(S^2)) has developed curricular materials for Algebra, Geometry, Modeling, and Statistics undergraduate content courses for prospective secondary teachers. To support enacting these materials, MODULE(S^2) provided a year-long professional development (PD) program for mathematics faculty. This PD included activities inspired by teaching rehearsals (Lampert et al., 2013; Ghousseini, 2017), and aimed to support attending to prospective teachers' thinking.

In this study, we drew on the MODULE(S^2) data to examine*: How does a rehearsal-inspired pedagogy shape the interactions among mathematics faculty during a professional learning experience?*

Theoretical Perspective

Throughout this paper, *student* refers to a prospective secondary mathematics teacher, and *instructor* refers to a mathematics faculty member. Following Lampert (2001) and Cohen, Raudenbush, and Ball (2003), we model instruction as attention to relationships formed between instructors, students, and content. In this view, learning occurs as students work to develop, understand, and strengthen their relationship with content and each other; meanwhile, instructors enact their practice through relationships with content and with students, in addition to their

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relationship with student learning whereby they attend to and are influenced by the student-content relationship.

Following Clarke and Hollingsworth (2002), we view professional growth as "an inevitable and continuing process of learning" (p. 947). They conceptualized teacher professional growth as an "Interconnected Model" of dynamics among four domains: the Personal Domain (i.e., a teacher's individual knowledge and beliefs), the Domain of Practice (i.e., all forms of professional experimentation), the Domain of Consequence (i.e., inferred outcomes of instructional decisions), and the External Domain (i.e., entities outside the teacher's self). They argued that professional growth, such as that shaped by PD, can be represented through "change sequences" of reflection and enaction.

Teaching rehearsals can shape teachers' professional growth (Ghousseini, 2017; Lampert et al., 2013). Initially conceived to support novice K-12 teachers, rehearsals provide opportunities to "simulate and analyze manageable chunks of interactive teaching before enacting them with students in classrooms" under the guidance of knowledgeable practitioners (Ghousseini, 2017, p. 188), followed by a collaborative debrief discussion. We hypothesized that rehearsal-inspired experiences could provide opportunities for professional growth for mathematics faculty, particularly in developing capacity for attending to student thinking.

Data and Method

Design of Rehearsal-Inspired Experiences

The PD for the instructors teaching with the MODULE(S^2) materials spanned the summer prior to teaching and the academic year. A cornerstone of the PD was a series of *rehearsal lessons*: in the summer, each piloting instructor planned a lesson from the materials and then taught the other instructors, who took on the role of acting students. To assist the instructors in planning their rehearsal lessons, the facilitators provided a planning guide with prompts intended to support attending to student thinking. Facilitators video-recorded the lesson and immediately played the recording to all participants. During the viewing of the recording, facilitators provided instructors an observation guide framed toward noticing student thinking in the rehearsal. The video viewing was followed by a facilitator-led debrief.

During the academic year PD, the instructors continued to meet over Zoom with project facilitators. Prior to each meeting, one instructor shared a video recording of a MODULE(S^2) lesson that they implemented in their own classroom with the rest of the group. To begin a meeting, a facilitator prompted the group by asking open-ended questions (e.g., "How are things going?") so that instructors shaped the focus of meetings. Conversations addressed debriefs of the video recording of the participant's lesson, the materials themselves, and instructional experiences that the participants wished to reflect on. In contrast to the debriefs of recorded lessons during the summer portion of the PD experience, the debriefs of recorded lessons during the academic year did not follow particular structures or prompts.

Participants and Data Sources

We focus on one group of three instructors who implemented the Algebra strand of MODULE(S^2) materials. During the summer, they participated in three teaching rehearsals --one for each of the instructors to act as the instructor. During the academic year, they participated in five facilitated meetings, which included debriefs of recorded lessons. The three debriefs of the summer teaching rehearsals were video recorded and were each approximately ten minutes in length. The five meetings during the academic year were also video recorded and ranged from

30-90 minutes each. The transcriptions of these eight recorded debriefs and meetings serve as our data source for this study.

Analysis

The authors used an instructional triangle as an analytic tool. An example of this coding is shown in Figure 1. We have highlighted how these interactions would have been coded in the transcript for these portions. "Teacher" refers to instructors of content courses and "students" refers to prospective teachers.

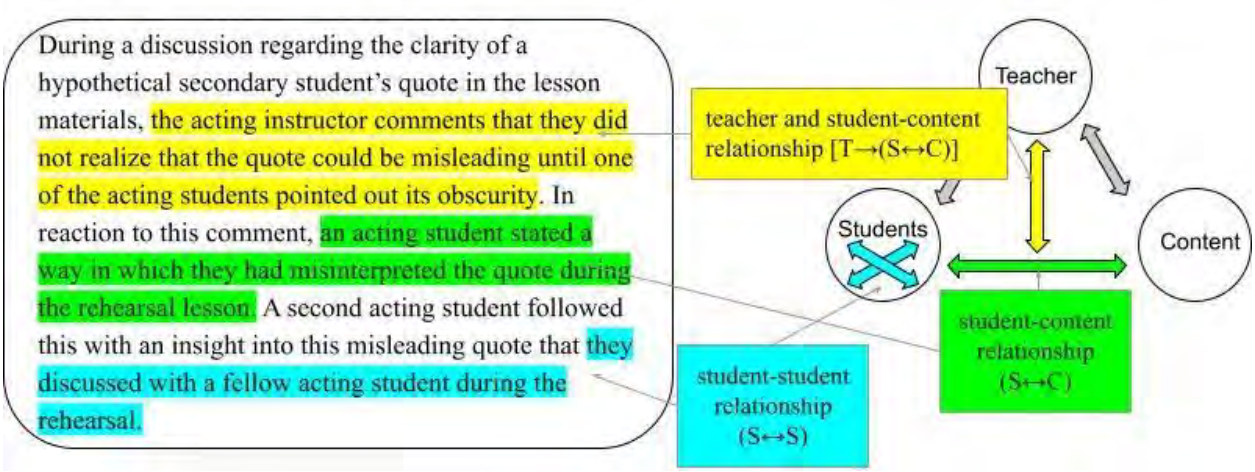


Figure 1: Vignette with categories of interactions highlighted

To understand the role of the PD structure in shaping the interactions between the participating faculty members, we utilized the Interconnected Model of Professional Growth. Specifically, we identified how the materials and activities utilized in the PD operated within the model's four change domains and provided opportunities for reflection and enactment. With these results, we produced a change sequence representative of the opportunities for growth offered by this PD.

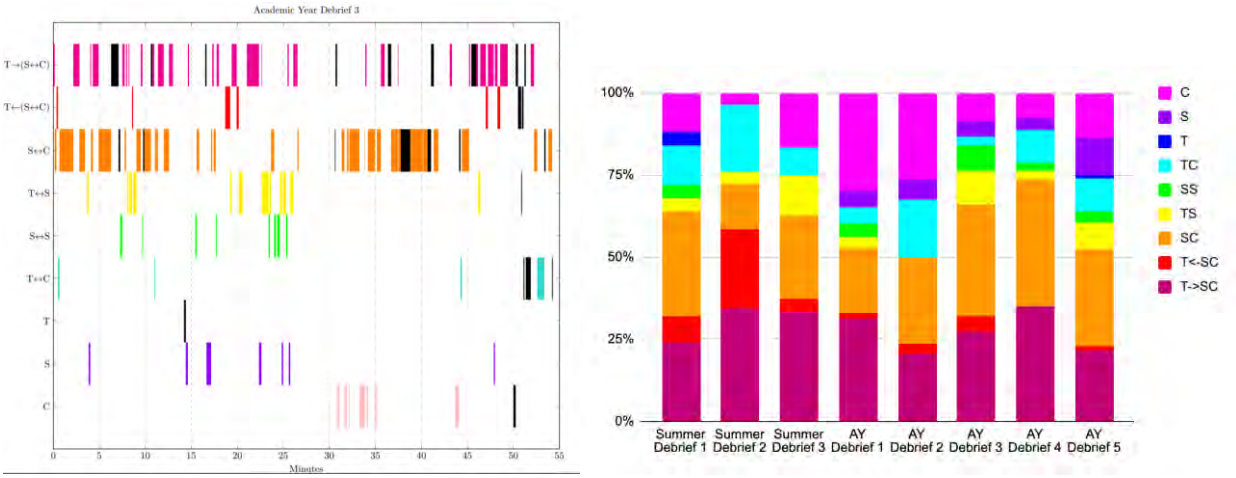
Results

Mathematics Faculty Attention to Students and Content

We created visualizations for all eight debriefs and meetings, one of which is displayed in figure 4(a). The horizontal axis represents the time at which a statement referring to instruction is made, and the vertical axis represents to which particular instructional relationship a statement is referring. Statements about instruction made by instructor participants are shown as a colored block whose horizontal length indicates for how long that particular instructional relationship was being referenced. Statements about instruction made by project facilitators are colored black and indicate length similarly.

As is the case for all eight debriefs, this example displays a high density of statements referring to the student-content relationship (S↔C) and the relationship between the teacher and the student-content relationship [T→(S↔C)]. (Again, "teacher" refers to a mathematics faculty member, and "student" refers to a prospective teacher.) To further investigate this density of codes, the frequency counts for each instructional relationship code are plotted in a stacked bar graph in Figure 4(b). This stacked bar graph reveals that, for all of the eight debriefs and meetings, half or more of the instructional relationships being referred by instructors and

facilitators were to the student-content relationship (S↔C) and the relationship between the teacher and the student-content relationship [T→(S↔C) and T←(S↔C)]. The frequency of references to instructional relationships related to the student-content relationship suggests that instructors maintained a focus on student thinking throughout the entire PD experience.



(a) **(b)**

Figure 2: (a) Visualization of the third debrief during the summer portion of the PD and (b) Stacked bar graph of the frequencies of each code during the eight debriefs

The PD Experience as a Change Sequence

In the space allowed in this brief report, we present only a summary of the results of our analysis of the PD structure using the Interconnected Model of Professional Growth. Our data suggested two change sequences: one for the summer PD structure and one for the subsequent academic year PD structure. Each change sequence used all four change domains and was based on numerous opportunities for enaction and reflection.

We offer two illustrative examples. First, during the summer portion of the PD experience, instructors were given rehearsal planning guides that focused on aspects of student thinking to scaffold the planning of their rehearsal lessons. Planning their rehearsals using these resources were instances of instructors enacting from the External Domain to the Domain of Practice. Second, throughout the academic year, instructors were encouraged to discuss both the practices of the instructors whose lesson has been video recorded as well as their own practice. Reflection on practice that supports prospective mathematics teachers' thinking, whether it be their own or another participant's, are instances of an instructor reflecting from the Domain of Practice to their Personal Domain.

Opportunity for Professional Growth

This study shows promise for adapting and translating the concept of rehearsals to the context of faculty who teach undergraduate mathematics courses. Because mathematics learning is supported in classrooms where there is attention to learners' thinking about the content (e.g., Learning Mathematics for Teaching Project, 2011), this could mean that leveraging an adapted rehearsal pedagogy during PD of mathematics faculty teaching content courses for prospective secondary teachers could support the future teachers' development of MKT. In the case of MODULE(S^2) materials, because the materials connect mathematics and teaching in ways that

are designed to promote MKT, this means that centering teaching on student thinking means centering teaching on student development of MKT.

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