MATHEMATICS INSTRUCTORS' ATTENTION TO INSTRUCTIONAL INTERACTIONS IN DISCUSSIONS OF TEACHING REHEARSALS

Lindsay Czap
Middle Tennessee State University
lnc4a@mtmail.mtsu.edu

Sally Ahrens
University of Nebraska - Lincoln

Alyson E. Lischka
Middle Tennessee State University
Alyson.Lischka@mtsu.edu

In our project, we develop curricular materials to support prospective secondary teachers' development of MKT and provide professional development (PD) opportunities for instructors who will teach with these materials. In this paper, we examine the ways in which mathematics faculty engage in the teaching rehearsal debriefs included in the PD to answer the question: To what instructional interactions do instructors of mathematics content courses attend during rehearsal debriefs enacted in PD? Findings show that mathematics instructors attend to all types of interactions but attention is influenced by instructors' mathematical knowledge.

Keywords: Mathematical Knowledge for Teaching, Teacher Education – Preservice

Purpose of the Study

The preparation of secondary mathematics teachers spans content and pedagogy, and includes development of mathematical knowledge for teaching (MKT; Ball et al., 2008; CBMS, 2012; AMTE, 2017). However, teachers perceive a disconnect between tertiary mathematics experiences and secondary teaching practice (Goulding et al., 2003; Ticknor, 2012; Wasserman et al., 2018; Zazkis & Leikin, 2010). To address this disconnect, the MODULE(S^2) Project (Lischka et al., 2020) has designed educative curricular materials (Davis & Krajcik, 2005) to be implemented in undergraduate mathematics content courses, including those often taught by mathematicians (Murray & Star, 2013), that situate mathematical content in pedagogical settings and utilize high-leverage teaching practices (e.g., Ball et al., 2009). To provide support for instructors implementing the materials, the project organizes professional development (PD) opportunities in which instructors receive support in enacting elements of the materials with which they may be unfamiliar. One tool used in the MODULE(S^2) Project PD is teaching rehearsals with group debriefs (Ghousseini, 2017).

Although there is much literature regarding PD with K-12 mathematics teachers (e.g., Farmer et al., 2003; Loucks-Horsley et al., 2010), there is less known about how tertiary instructors interact with and take up PD. The purpose of this paper is to draw on the experiences of the MODULE(S^2) Project PD in an exploratory case study (Yin, 2014) to develop more understanding of PD with tertiary instructors. We address the following research question: To what instructional interactions do instructors of mathematics content courses attend during rehearsal debriefs enacted in PD?

Theoretical Perspective and Framework

We define *instruction* to be the "interactions among teachers and students around content, in environments" over time (Cohen, et al., 2003, p.122). Calling upon Lampert (2001) and Cohen and colleagues (2003), these interactions can be modeled by an instructional triangle (see Figure 1), which demonstrates the interactions between teachers, students, and content.

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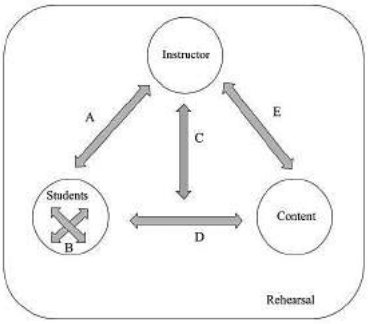

Figure 1: The instructional triangle

Approximations of practice (Grossman, et al., 2009) are useful in supporting teachers to gain experience with and knowledge of the various interactions demonstrated in the instructional triangle. One such approximation is a teaching *rehearsal* in which novice instructors are engaged in the "deliberate practice of well-specified instructional activities" with support from knowledgeable others (Ghousseini, 2017, p. 191). Teaching rehearsals provide instructors the opportunity to engage in approximations of future instruction supplemented by knowledgeable feedback. Ghousseni concluded that the structure of these rehearsals provided prospective secondary teachers the opportunity to "improve their performance in response to feedback that drew on mathematics and student learning of mathematics" (p. 198), bringing together the development of teaching practice and understanding of content knowledge. We build on Ghousseini's work with rehearsals and guided debriefs in the context of PD with tertiary instructors and assert that teaching rehearsals and debriefs may similarly provide opportunities for mathematics instructors to develop teaching practice and content knowledge needed for the preparation of prospective secondary teachers.

Methods and Modes of Inquiry

Contexts, Participants, and Data Sources

The participants in this study were three mathematics faculty from different undergraduate institutions who were engaged in PD for the implementation of MODULE(S^2) Project materials for an algebra content course. Henceforth these mathematics faculty will be referred to as *participants*. Data collected for this study includes video recording of the three teaching rehearsals, video recording of the respective three debriefs, artifacts from the rehearsal lessons, and reflections from the participants.

During a teaching rehearsal, one participant takes on the role of *acting instructor* and the remaining participants take on the role of *acting students* (i.e. the prospective teachers in the undergraduate courses in which materials will be implemented). During a teaching rehearsal, the acting instructor prepares a lesson from the MODULE(S^2) materials and teaches for approximately 10 minutes. These ten minutes of rehearsal are video recorded, then immediately played back to all participants. Following the viewing of the recorded rehearsal, a facilitator from the MODULE(S^2) project conducts a debrief in which participants discuss what occurred in the recorded lesson. For this report, we focus on the videos of these debriefs.

Three teaching rehearsals occurred during the PD, giving each participant the opportunity to serve as an acting instructor once and as an acting student in the other two rehearsals. The lessons chosen for the three rehearsals were respectively on the concepts of inverse functions, the covariational view of functions, and relations. The general goal of the rehearsals and debriefs was to develop instructors' skills in enacting the high-leverage practices embedded within the curriculum materials. Thus, our goal was for instructors to focus on interaction C in Figure 1.

Analysis

Two researchers separately coded each debrief video using a priori codes based on the instructional triangle framework and then came together to reconcile their coding. We categorized every statement made by participants during the debrief as referencing interaction A, B, C, D, or E as labeled in Figure 1. To clarify the coding, consider the following vignette from the debrief of the rehearsal on the topic of covariational and correspondence view of a function:

> During a discussion regarding the clarity of a hypothetical secondary student's quote in the lesson materials, the acting instructor comments that they did not realize that the quote could be misleading until one of the acting students pointed out its obscurity. In reaction to this comment, an acting student stated a way in which they had misinterpreted the quote during the rehearsal lesson. A second acting student followed this with an insight into this misleading quote that they discussed with a fellow acting student during the rehearsal.

Using the categories of interactions indicated in Figure 1, the acting instructor's statement would be coded as referencing a category C interaction, the first acting student's statement as referencing a category D interaction, and the second acting student's statement as referencing a category B interaction. We describe the trends that emerged in codes across the three debriefs to reveal evidence of participants' attention to aspects of instruction during the debrief discussions.

Results

During Debrief 1, participants discussed a rehearsal in which the acting instructor taught a lesson on the topic of relations and their inverses. The debrief began with an acting student commenting on how the acting teacher's use of precise mathematical language when discussing the definitions of range and codomain could, "promote students' mathematical precision." A second acting student shifted the conversation toward how the acting instructor used both table and ordered pair representations of relations during their lesson. The acting instructor replied, "our goal [in the rehearsals] is to have multiple representations." The same acting student continued by asking if the discussion of defining the domain and codomain sets "had emerged as a consequence of [their] discussion" during the rehearsal. "Yes...this comes up all the time when I talk about functions and relations...I think that it is really important" replied the acting instructor. Participants continued the discussion of leveraging student reasoning by pointing out that the acting instructor had written a suggested incorrect answer on the board. "Was the teacher giving enough space?" the acting instructor asked the group, wondering if students had enough individual thinking time during the rehearsal, as the debrief concluded.

In Debrief 2, participants discussed a rehearsal in which the acting instructor taught a lesson on how a secondary student may think about the topic of correspondence and covariational views of functions. "I really liked how the instructor asked 'why, as a teacher, would it be important to figure out their reasoning?'" an acting student commented to begin the debrief. "The teacher kept a complete poker face and let us go with that," a second acting student pointed out when the acting students incorrectly categorized the hypothetical student's view of a function. Some confusion as to whether this categorization was actually incorrect arose from this statement. For the remainder of the debrief, the participants discussed the acting instructor's and acting students' conceptualizations of the difference between a correspondence and covariational view of a function. "I guess the 'co' in covariation and correspondence means that you have to look at both variables," the acting instructor responds to an acting student claiming that correspondence only requires reasoning with one variable.

In the final debrief (3), participants discussed a rehearsal in which the acting instructor taught a lesson on the topic of graphs of relations. "I liked...having the chance to have individual thought...before getting into groups," an acting student began the debrief. They then pointed out a

moment in which the acting instructor admitted to the acting students that they were unsure themselves of the answer to these questions. The acting instructor responded that they wanted to explore the questions with a "level of authenticity." During the rehearsal, the acting instructor posed a question that encouraged the acting students to think about the differences between the definitions of a graphs of a relation and of an equation, which acting students said "seemed open ended." "You said 'let's look at an example'," an acting student pointed out an instructional decision to move the lesson forward. The acting instructor then stated that they aimed to collect "helpful student comments or quotes that [the instructor] can then revisit." From this, the participants discussed how they know when it is appropriate to use different teaching strategies. Table 1 displays how our coding reflected the discussions in these three debriefs.

Table 1: Instructional Triangle Coding Counts for the Debriefs

	A	B	C	D	E	Content
Debrief 1	4	0	11	3	6	0
Debrief 2	1	2	21	7	2	13
Debrief 3	4	0	12	0	5	1
Total	9	2	43	10	13	14

Discussion

This study aimed to build knowledge concerning the aspects of instruction to which tertiary instructors attend during debriefs of teaching rehearsals enacted in PD. Our data shows that instructors participating in debrief discussions attended to each component of the instructional triangle, with the majority of the discussions attending to interaction C (how the instructor interacts with students and content together), which was the goal of the PD. However, in one debrief (Debrief 2), the instructors lack of comfort with the mathematical content superseded the ability to focus on student thinking. Instead, attention focused on the content itself. These results show that if the participating instructors are developing necessary content knowledge, this may influence the focus of attention during the debrief.

This work demonstrates that teaching rehearsals are a useful tool to engage tertiary instructors in discussions of student thinking. Further, these results point to the need to structure PD in a way that first supports participants content knowledge development prior to requesting participants to focus on student thinking. Similar research in other content areas is needed to identify concepts for which a focus on student thinking will be best supported by first supporting instructors' content knowledge.

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