

## PREPARING TO ELICIT STUDENT THINKING: SUPPORTING PST QUESTIONING IN AN UNIVERSITY TEACHING EXPERIENCE

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*This study examines how preservice teachers (PSTs) plan for and enact questions that elicit student thinking during an early field experience. We analyzed teaching videos and their corresponding lesson plans from 17 PSTs over 34 lessons in a field experience in a freshman-level university mathematics class. Our findings show PSTs tended to use three types of questioning sequences when teaching, with the quality of questioning in those sequences linked to the quality of planned questions. Findings described here discuss the implications for supporting PSTs' lesson planning during early field experiences.*

Keywords: Teacher Education – Preservice; Teacher Educators; Classroom Discourse

Being able to elicit and respond to student thinking is a core practice of ambitious teaching (Gotwals & Birmingham, 2016). In order to elicit student thinking, teachers need to: (1) select a task that affords opportunities for eliciting, (2) anticipate student thinking, (3) know the learning goal and assess students' proximity to the goal, and (4) plan questions to deepen student understanding (Boerst et al., 2011; Orr et al., 2020; Shaughnessy et al., 2019; Sleep & Boerst, 2012; TeachingWorks Resource Library, 2020). Each of these components of eliciting student thinking is complex. The complexity of this practice makes it difficult for novice teachers, whether being utilized through simulations or in face to face interactions with students (Shaughnessy & Boerst, 2018). One-way math teacher educators (MTEs) help preservice teachers (PSTs) prepare for this complex practice is through lesson planning. In this brief research report, we share findings from a project that explored the following questions: *During the UTE, to what extent did PSTs enact questions as planned? How did the quality of planned questions correspond to the quality of questions as enacted?*

### Methods

This project analyzed data collected for a larger project studying the effects of the *University Teaching Experience* (UTE) model for secondary mathematics PST learning across three different teacher preparation programs<sup>1</sup>. In the UTE, PSTs teach an entry-level undergraduate mathematics course while taking their first methods course (Bieda et al., 2019). PSTs plan, enact, and reflect on a series of lessons while being supported by MTEs. The MTEs support the PSTs through providing feedback on lesson plans, in-the-moment coaching and leading post-lesson debriefs. In addition to the support of their MTEs, the PSTs are also supported by a mentor teacher who is the course instructor for the mathematics course. Throughout the course of the UTE semester, PSTs teach at least two lessons and observe other PSTs teach while working with mathematics students in groups. In this brief report, we will only present findings from data collected at our university site.

### Data Collection

During the implementation of the UTE in fall 2018, there were 17 PSTs. The PSTs planned and taught lessons in pairs, resulting in seven pairs and one group of three. The PSTs taught two lessons over the course of the semester in a college algebra course. The first lesson was roughly half the class period (~40 minutes). The second lesson was the entire class period (~ 80 minutes). Lesson enactments were captured using Swivl robot video-recording (www.swivl.com) and audio from the class sessions was later transcribed. PSTs completed lesson plans for each session following a

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modified version of the Think Through a Lesson Protocol (TTLP) (Smith et al., 2008) and shared with MTEs for feedback through Google Docs.

### Data Analysis

In order to understand the relationship between the quality of questions enacted as compared to the quality of questions planned, all the questions in the lesson plans and the transcribed enacted lessons were coded based on the Instructional Quality Assessment Academic Rigor (AR) for Teachers' Questions rubric (Boston, 2012). This tool was selected because reliability and validity has been established (Boston & Wolf, 2006). For any question written in the plan or asked of students during the lesson, it was assigned one of 6 question types: probing, exploring mathematical meaning and relationships, generating discussion, procedural or factual, other mathematical, and nonmathematical (Boston, 2012). Examples of each type from our data are represented in Table 1.

Question Type	Example
Probing	Why does this work?
Exploring mathematical meaning and relationships	Why do you think that would work, to switch P and M, given what we've been doing with the other inverses?
Generating Discussion	Looking at these examples here, take a second, look at them, and think, which of these relations or graphs are functions?
Procedural or Factual	Is it invertible?
Other Mathematical	Any questions on how we did those few steps?
Nonmathematical	Why would technology affect the prison rate?

**Table 1: Examples of Question Types**

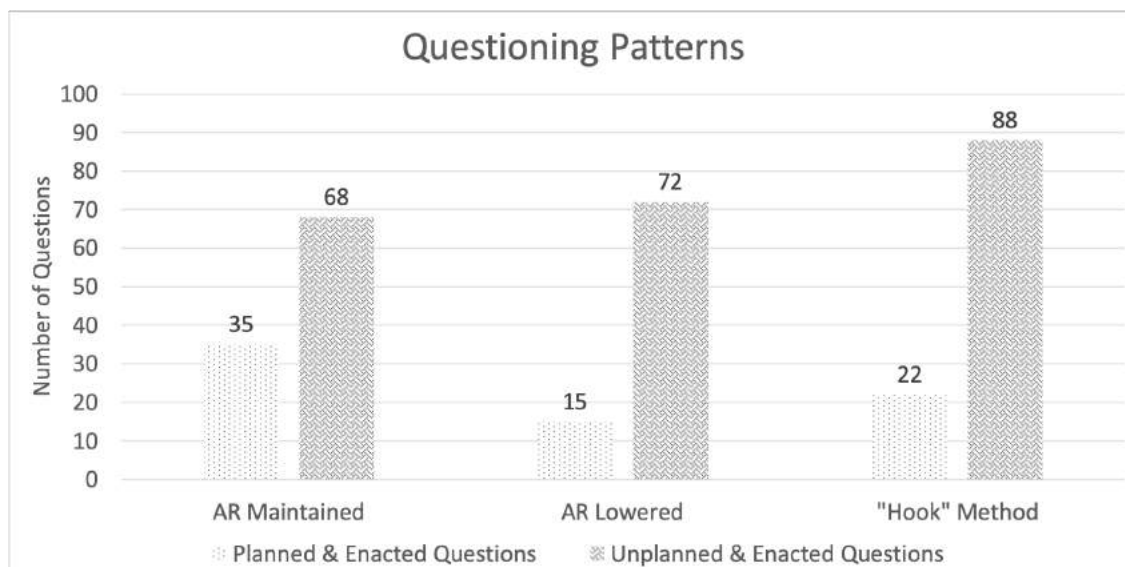
For the enacted lessons, we narrowed the data to examine only situations where PSTs engaged in sequences (sustained questioning) involving AR questions, thus excluding any questions that were primarily procedural or factual, other mathematical, and non-mathematical. We segmented lesson transcripts into questioning sequences by determining when the PST asked the initial question to elicit student thinking around a specific question. Then, we identified a sequence end when the PSTs moved to another topic. We analyzed these sequences and generated three categories to describe the patterns of questioning in these sequences. Afterwards, we compared the enacted sequences to the portion of the lesson plan with corresponding content. We looked for patterns in how the questioning sequences evolved depending upon whether PSTs had asked questions that were planned or unplanned. In the section below, we share our findings about the patterns that surfaced related to describing relationships between planned and enacted questions.

### Findings

We discovered that PSTs utilize three distinct questioning sequences when they asked questions involving Academic Rigor (AR). In the first type, PSTs maintained AR throughout the sequence. In this type, PSTs began with an AR question, the students responded, and the PSTs continued to ask AR questions throughout the sequence. The second type of questioning sequences involved PSTs reducing the AR. In this type, the PSTs started with an AR question, the students did not respond, and the PSTs lowered the AR of the questions for the remainder of the sequence. The third type –the “hook” method – emerged when PSTs began with a non-AR question, which “hooked” the students to respond, and then the PSTs raised the AR of the questions for the remainder of the sequence.

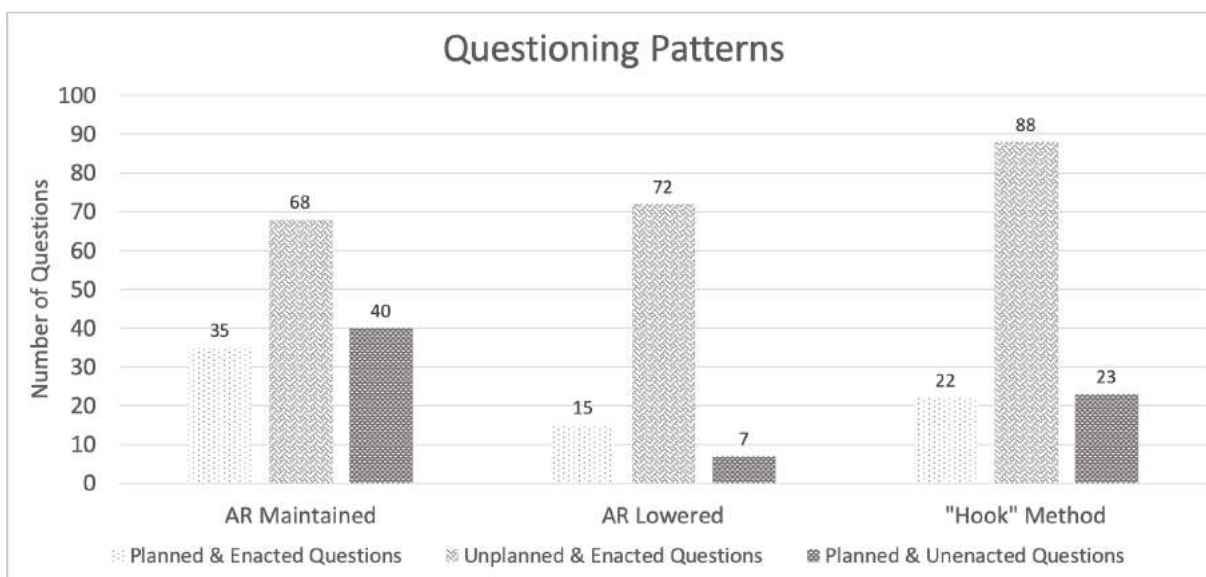
Given our research focus, we wanted to explore the relationship between questions as planned and the emergence of these different types of questioning sequences. When looking at the total amount of enacted questions, as sorted by questioning sequence, we found the most common questioning

sequence was the “hook” method followed by the scenario where the AR is maintained. In further analysis of mapping enacted questions on to the lesson plan, we found PSTs enactment involved more planned questions for sequences where the AR is maintained when compared to the other two questioning sequences (see Figure 1).



**Figure 1: Planned vs Unplanned Questions in Enactment**

Note in Figure 1 that situations where PSTs lowered the academic rigor involved the fewest number of planned questions. To investigate whether planning high-quality questions correlated with a greater number of AR questions in enactment, we also investigated the quality of enacted questions during parts of the lesson where AR questions had been planned (but not enacted). We hypothesized that planning AR questions would ultimately support higher-quality questioning sequences during the parts of the lesson the questions were being employed, even though the planned questions were not asked. Our findings are represented in Figure 2.



**Figure 2: Planned & Unenacted Questions vs Enacted Questions**

Through this investigation we found, in situations where AR is maintained, PSTs not only asked the most planned questions, but they also had the most planned and unenacted questions for these sequences. We also found the reverse was true. In situations where the AR was lowered, PSTs not only asked the least amount of planned questions, but they also had the least amount of planned and unenacted questions (fewer questions overall) suggesting that less attention to those situations in planning affected the quality of their eliciting of student thinking during enactment

### Discussion and Conclusion

Through engaging in the UTE experience, PSTs are given opportunities to plan for and elicit student thinking through questioning while being supported by MTEs. These findings suggest that even with support, PSTs find themselves in classroom situations they had not anticipated and are unsure of how to respond. The situations tend to arise when students have gaps in prior knowledge or engage in the task in an unanticipated way. This is to be expected, as PSTs classroom inexperience often means that they face difficulties with anticipating students' responses (Arbaugh et al., 2019; Taylan, 2018). Improving the quality of PSTs' questioning must involve not only helping them to anticipate student responses, which typically improves with more classroom experience, but also how to draw on high AR questioning when the situation does not unfold as planned. MTEs can provide this support through encouraging PSTs to consider follow up questions, as well as, how the questions align with the learning goals. Giving additional attention to the alignment between the questions and learning goals may result in (the inevitable) unplanned questioning sequences that more likely maintain AR.

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