

2026

## Incorporating a Three-Stage Teaching Rehearsal Arc in an Elementary Math Methods Course

Paula Jakopovic

University of Nebraska at Omaha, [paulajakopovic@unomaha.edu](mailto:paulajakopovic@unomaha.edu)

---

**Recommended Citation:**

Jakopovic, P. (2026). Incorporating a three-stage teaching rehearsal arc in an elementary math methods course. *Midwest Journal of Education*, 3(1). <https://doi.org/10.69670/mje.3.1.10>

*Connecting Theory to Practice*

---

**Incorporating a Three-Stage  
Teaching Rehearsal Arc in an  
Elementary Math Methods Course**

Midwest Journal of Education

211-239

Volume 3, Issue 1, 2026

DOI: <https://doi.org/10.69670/mje.3.1.10><https://mje.williamwoods.edu/>**Paula Jakopovic****Abstract**

Many teacher preparation programs lack content-specific practica, leaving elementary preservice teachers (PSTs) with limited opportunities to rehearse mathematics instruction before student teaching. This article explores how number talks and microteaches can function as intentionally sequenced approximations of practice within an elementary mathematics methods course to address this gap. Using a practice-based teacher education (PBTE) framework, the course engaged PSTs in a three-stage rehearsal arc that leveraged cycles of representation, decomposition, and approximation, beginning with low-risk number talks and progressing to collaboratively planned and individually enacted microteaches. These structures provided scaffolded, repeatable opportunities for PSTs to gradually learn to enact high-leverage practices such as eliciting student thinking, orchestrating discussion with the five practices, and integrating talk moves. The discussion highlights the design contribution of the three-stage arc and offers practical guidance for implementation. Implications suggest that embedding intentionally sequenced teaching rehearsals can strengthen PSTs' capacity to engage in ambitious, equity-focused teaching practice before entering the classroom.

**Keywords**

Elementary Education, Mathematics Education, Preservice Teacher Preparation, Microteaching

**Corresponding Author:**

Paula Jakopovic, Associate Professor  
Teacher Education, University of Nebraska at Omaha  
Roskens Hall 406P  
6005 University Dr N  
Omaha, NE 68182  
Email: [paulajakopovic@unomaha.edu](mailto:paulajakopovic@unomaha.edu)

ORCID: 0000-0002-9554-9201

## Introduction

In order to effectively prepare preservice teachers (PSTs) to be well-equipped with the skills and competencies to support student learning across diverse educational settings, teacher preparation programs must be strategically designed to integrate theory and practice opportunities (Association for Advancing Quality in Educator Preparation, 2023). Practicums, or field experiences, are typically considered a cornerstone of these programs, as they provide PSTs with opportunities to plan and enact lessons in real world contexts (e.g., Emerson et al., 2018). In secondary education, PSTs engage in field experiences and clinical practice opportunities that are tailored to their specific content areas, however, in many elementary education programs practicums are designed to develop more generalized pedagogical knowledge and experiences. In both cases, PSTs can experience a disconnect between what they are learning as disciplinary theory in methods classes and their experiences in the field (e.g., Jao et al., 2020). For content areas such as mathematics, where many elementary PSTs lack self-efficacy in their ability to effectively teach mathematics (Brown & McNamara, 2011; Kaasila et al., 2012; Lutovac & Kaasila, 2014), it is of critical importance that teacher preparation programs provide structured opportunities for PSTs to practice and hone their pedagogical content knowledge. Practice based teacher education (PBTE) offers a potential pathway for discipline specific methods courses to support PST development (e.g., Kavanagh et al., 2023) in ways that can supplement more traditional field experiences. Within the discipline of mathematics, structures such as number talks and microteaches can be used as low stakes opportunities for elementary PSTs to engage in scaffolded practice teaching opportunities in their methods courses. By utilizing a PBTE approach to incorporate these structures across the span of a methods course, teacher educators can provide an intentionally designed progression of teaching approximations that strengthen PSTs' confidence and competence engaging in research informed mathematics teaching practices.

## Literature Review

### Practice Based Teacher Education Cycles

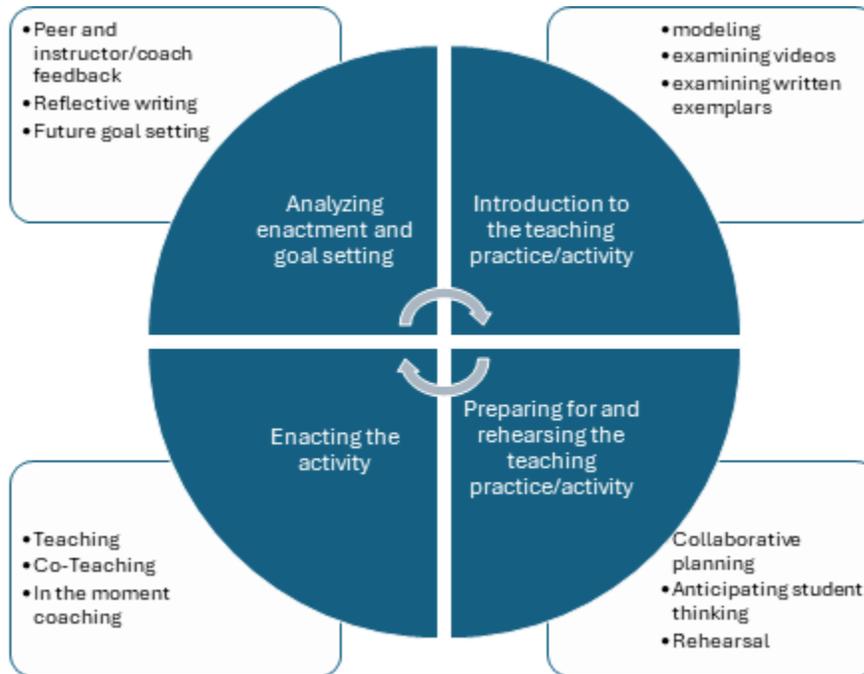
Grossman et al. (2009) proposed PBTE as a three-part framework through which to explore the ways in which pedagogies of practice are taught in teacher preparation programs. *Representation* refers to the ways in which teaching practice is modeled and presented in teacher preparation programs, with the goal of making explicit the facets of professional practice to PSTs. In *decomposition*, teacher educators help PSTs to break down the complex work of teaching into its composite parts to help illustrate the facets of teaching practice that make it more or less effective. *Approximations* provide PSTs with opportunities to practice, in simulated or authentic settings, these teaching practices as a way to connect theory to implementation. When employed in methods courses, PBTE can provide a structure for teacher educators to identify, model, and have PSTs engage in discipline specific high leverage core teaching practices (Core Practice Consortium, 2025) that enhance their competence in designing and implementing effective lessons that support student learning.

McDonald et al. (2013) designed a framework that teacher educators can utilize to facilitate PBTE cycles around core practices (Figure 1). This process begins with modeled examples of the core practice before PSTs engage in co-planning then co-teaching, followed up with opportunities to reflect and set goals for future improvement. Such practice opportunities can be further supported by being paired with coached rehearsals, where PSTs receive feedback and coaching from an instructor or mentor teacher to explore and

refine teaching practices (Kazemi et al., 2016; Kelly-Peterson et al., 2018). Descriptive, timely feedback paired with such reflective opportunities help PSTs to transfer learning to future teaching opportunities (Jakopovic et al., 2024; Van Rooji et al., 2019).

**Figure 1**

*Adaptation of the Practice Based Teacher Education cycle framework (McDonald et al., 2013)*



### Core/High-Leverage Mathematics Teaching Practices

Teaching Works (n.d.) identifies a number of core, high-leverage teaching practices that novice teachers need to learn in order to develop as competent, effective educators that can support the learning needs of diverse student populations. Their list of recommended practices includes setting clear learning goals, designing lessons and lesson sequences, modeling content, engaging students in discussions and activities, and analyzing and interpreting student thinking to make instructional decisions. These practices are well aligned with the InTASC standards (Interstate Teacher Assessment and Support Consortium, 2013), which outline the scope of what PSTs should leave their teacher preparation programs knowing and doing to be considered “well prepared” professional educators. These standards focus on the domains of knowledge of learners, content, instructional practice, and professional responsibility at a broad level, however research has consistently shown that teachers need pedagogical knowledge that is specific to the discipline in addition to generalized pedagogical knowledge (Schulman, 1986). Within the discipline of mathematics, for example, Ball et al. (2008) identified six domains of knowledge for mathematics teaching: common content knowledge, horizon content knowledge, specialized content knowledge, knowledge of content and students, knowledge of content and teaching, and knowledge of content and the curriculum. The Association of Mathematics Teacher Educators *Standards for Preparing Teachers of Mathematics* (2017)

document reinforces these domains and further explicates that effective mathematics teachers must also take the social contexts of teaching and learning into account as advocates for equitable access to high quality mathematics instruction for all learners. This conceptualization of disciplinary knowledge for teaching illustrates the complex layers of understanding that teachers must be equipped with to grapple with problems of practice in the mathematics classroom.

In addition to the complex skillset that goes into developing effective mathematics teachers, the challenge of preparing highly qualified elementary teachers has been compounded by the change in focus from more traditional models of mathematics instruction that focus on procedural fluency and toward a more balanced approach that includes active learning and building a conceptual foundation. K-12 mathematics content standards have shifted over the past several decades to mirror this call, so that students are tasked with developing both conceptual understanding and facility with processes and practices (National Council of Teachers of Mathematics [NCTM], 2000; National Governors Association for Best Practices and Council of Chief State School Officers, 2010; National Research Council, 2001). In response to changes in mathematics standards, NCTM (2014) identified eight core practices for mathematics teaching to support the attainment of these learning goals:

- Establish mathematics goals to focus learning,
- Implement tasks that promote reasoning and problem solving,
- Use and connect mathematical representations,
- Facilitate meaningful mathematical discourse,
- Pose purposeful questions,
- Build procedural fluency from conceptual understanding,
- Build on students' thinking,
- Support productive struggle in learning mathematics, and
- Elicit and use evidence of student thinking.

Through the effective implementation of these teaching practices, mathematics educators are expected to foster a deep mathematical understanding and positive math identity in children. However, these teaching practices are often at odds with how many people experienced mathematics instruction as students, which can create cognitive dissonance as PSTs engage in pedagogical coursework (Geijsel & Meijers, 2005; Swars & Chestnutt, 2016). Thus, PSTs are often tasked with imagining a classroom environment and teaching structure that is unfamiliar, making it more challenging to reconcile their past learning with future teaching practices. Many elementary PSTs enter their teacher preparation programs carrying negative experiences and images of themselves as mathematics learners (e.g., Kaasila et al., 2012; Lutovac & Kaasila, 2014), which can further complicate their development as future mathematics teachers. PSTs must believe that they have both the content and pedagogical knowledge necessary to successfully teach mathematics (Van Zoest & Bohl, 2005), which often requires that they disrupt past narratives about their mathematical abilities. As a result, mathematics teacher educators are tasked with helping PSTs to reflect on and come to terms with their past experiences to renegotiate their beliefs about their ability to become confident, competent math teachers. PBTE cycles offer a promising approach to help them learn both the envision and to enact high-leverage mathematics teaching practices in a supportive environment.

### **Professional Noticing**

The core mathematics teaching practices advocated for by current research and national organizations rely on a teacher's ability to facilitate learning that positions the student as not only actively engaged during instruction, but also at the center of how a lesson is designed and enacted. Over the past two decades, a number of mathematics teacher researchers and teacher educators have utilized the framing of "professional noticing" as a form of professional development to help both pre- and in-service teachers hone their ability to engage in student centered mathematics instruction. Professional noticing is an intentional habit of mind through which teachers *attend to* students' mathematical ideas, *interpret* what those ideas reveal about mathematical understanding, and *decide* how to respond instructionally – both in the moment and across lessons (e.g., Jacobs et al., 2010; Sherin et al., 2011). For PSTs, cultivating this skill can facilitate a shift from early, self and task focused concerns toward sustained attention on learners and learning (Fuller, 1969; Fuller & Brown, 1975), supported by Schön's notions of reflecting *in* action (adjusting as teaching unfolds) and *on* action (planning future moves from past evidence) (Schön, 1983). Framed as a stance of inquiry (Cochran Smith & Lytle, 2009), noticing asks teachers to reprioritize what they look for in classroom interactions and to interpret rather than merely evaluate events (e.g., van Es & Sherin, 2008, 2021). Because high-leverage mathematics teaching practices center students as sources of knowledge, professional noticing offers a mechanism that links instructional moves to students' reasoning (van Es et al., 2017a, 2017b). In short, helping PSTs develop professional noticing equips them to enact responsive, ambitious mathematics instruction that broadens participation and advances understanding. This can be particularly challenging for PSTs to engage in, especially when they are not provided with scaffolded and contextualized opportunities to teach mathematics to children. Thus, using PBTE cycles embedded in methods courses that engage PSTs in intentionally designed approximations of practice can help to foster growth in their ability to attend and respond to student thinking "in the moment."

### **Mathematical Approximations of Teaching Practice**

Number talks are a structured, short teaching routine in which students mentally solve a mathematics problem and then share their strategies and reasoning while the classroom teacher facilitates a discussion around understanding, comparing, and connecting strategies and reasoning (Humphreys & Parker, 2015; Parrish, 2014). This routine can help students to build number sense and procedural fluency in ways that promote flexibility, strategic competence, and efficiency, while also fostering a classroom community that uplifts students' mathematical reasoning as a key component of learning (Duffy, 2017; Stewarts, 2016; Yackel & Cobb, 1996). In the context of teacher preparation, number talks as a form of approximation can help PSTs learn to attend to the mathematical reasoning of others, which can help to develop their ability to not only notice, but also to interpret and respond to students' mathematical ideas in the moment. Additionally, it can provide them with an opportunity to investigate ways to effectively incorporate a number of high-leverage mathematics teaching practices in a low-stakes setting (Woods, 2021). Fuson and Leinwand (2023) argue, however, that number talks are often relegated to lesson openers rather than integrated into core mathematics instruction as a lever for engaging students and helping them learn to communicate their mathematical thinking. In the context of teacher preparation, number talks have the potential to inform the ways in which PSTs learn to plan and implement lessons that incorporate high-leverage mathematics teaching practices on a larger scale.

Microteaches are short, coached approximations of teaching in which a PST teaches a lesson with peers role-playing as elementary students and where the instructor can pause (“time-out”), offer targeted feedback, and prompt an immediate re-try. Microteaches offer an alternative to traditional practica in providing PSTs with authentic opportunities to improve their knowledge and teaching practices, which can be particularly promising when discipline-specific practicums are not available (Lampert et al., 2013). As a rehearsal structure, microteaches preserve the core interactional demands of high-leverage mathematics teaching practices while lowering the risk and cognitive load for PSTs (Allen & Ryan, 1969; Patel & Mohasina, 2011). They allow multiple PSTs the opportunity to teach in a single class session, while receiving targeted feedback from both peers and the instructor. This timely feedback can support PST’s self-efficacy development (d’Alessio, 2018; Fernandez & Robinson, 2006; Jakopovic et al., 2021; Lemke et al., 2022; Sadiq, 2011) by allowing them to envision and experience the realities of integrating high-leverage teaching practices in their instruction (Oluwatoyin & Ademiluyi, 2022).

While PBTE cycles, number talks, and microteaches are each well-established practices in mathematics teacher education, less attention has been paid to how these practices can be intentionally sequenced across a methods course in support of PST development. This paper seeks to further investigate such a design.

### **Using Progressive Teaching Rehearsals to Build Preservice Teacher Capacity**

#### **Context**

This PBTE process was implemented in an elementary mathematics methods course in a teacher preparation program at a midsized, urban university in the Midwest. The course met twice weekly for 75 minutes with approximately 25 to 30 PSTs enrolled in each section of the course. PSTs in this program have not had a content specific mathematics practicum prior to enrolling in their methods course, so coached PBTE cycles were integrated inside coursework to provide approximations of teaching for PSTs to apply their learning about high-leverage, core teaching practices. PSTs began the semester by reading sections of *Principles to Actions: Ensuring Mathematical Success for All* (NCTM, 2014) to build background knowledge about high-leverage core mathematics teaching practices before engaging in course activities where they observed, planned, and implemented the practices with opportunities for peer and instructor feedback. The following sections unpack the structure and resources utilized to facilitate the PBTE cycles around the eight mathematics teaching practices.

#### **Teaching Rehearsals Stage One: Number Talks**

##### ***Developmental Considerations in Stage One***

In the context of this teacher preparation program, PSTs have had prior experience with the gradual release of instruction (Pearson & Gallagher, 1983), however leading a discussion that is both driven by student ideas while also moving toward a mathematics learning goal is typically a novel experience at this stage of their learning. This can make it challenging for PSTs to facilitate, rather than narrate and direct, the conversation. Although they have seen the talk moves in action, implementing them in practice can feel both awkward and unintuitive to many as they attempt their first number talk. Additionally, PSTs are often at a stage where they have not had adequate exposure to students’ thinking to accurately anticipate student errors and misconceptions, as well as novel approaches to solving problems, which can make it challenging

to address them and pivot in the moment while teaching. Combined, these factors can make it challenging for PSTs to engage in their first number talk, making the design of the activity and the role of the teacher educator pivotal in supporting these early attempts at teaching through facilitation rather than directed instruction. One of the end-of-course goals is for PSTs to feel adequately prepared to lead a whole group inquiry-based lesson, where they are able to integrate the eight core teaching practices in real time. Number talks provide an initial steppingstone to help PSTs “get their feet wet” in a short, structured routine as a way to explore these practices in a low stress environment.

### ***Structure of the Cycle***

For the first two weeks of the semester, the instructor engaged PSTs from the learner’s perspective in daily number talks (Parrish, 2014, 2016) that ranged in concepts spanning grades K-6 to help them learn the purpose and structure of the routine as a way to help students develop mathematical strategies. The instructor’s focus for this form of representation was on modeling how to facilitate the teaching practices of eliciting evidence of student thinking and engaging students in mathematical discourse, as well as effective ways to manage the instructional routine in the classroom. The instructor frequently used “time-outs” (Lampert et al., 2013), shifting from leading the number talk as if the PSTs were students to decomposing the in the moment decisions she made during the routine that encouraged participation, explicated students’ strategies for peers, and guided the discussion toward a particular mathematical goal. PSTs participated in four number talks during this time.

In week three of the semester, PSTs are formally introduced to “math talk moves” through a series of course activities. First, PSTs complete readings from the text *Talk Moves: A Teacher’s Guide for Using Classroom Discussions in Math, K-6* (Chapin et al., 2022), which identifies a number of effective strategies teachers can use to facilitate student discourse around mathematical concepts, strategies, and processes. These moves include revoicing/repeating thinking, adding on to another’s ideas, pressing for reasoning, agreeing/disagreeing, turn and talks, and wait time. The goal of these moves is to increase equitable participation during mathematical discussions and help students learn to unpack their own thinking as well as attend to and engage with the thinking of their peers. After learning about the talk moves, PSTs then watch video excerpts of number talks and utilize annotated transcripts to identify evidence of places where the teacher utilized talk moves (see Appendix A), noting both their interpretation of the purpose and resulting action of each move on the facilitation of the discussion. Unlike their initial experiences with number talks, this second use of representation allows PSTs to step outside the role of active participant to decompose the routine and was intended to help develop their noticing (e.g., Jacobs et al., 2010; van Es & Sherin, 2010, 2021) of both specific moves the teacher made and its impact on student learning. PSTs then engage in small and whole group in-class discussions after this activity to share insights, clarify questions, and reflect on considerations as to how they might integrate this teaching structure into their own practice.

After engaging in the decomposition process, PSTs are then asked to collaboratively plan and execute a number talk as a form of microteach with a small group of peers. PSTs are broken into small groups, typically of 4 to 5 participants each, who are then assigned the same number talk to engage in co-planning with support from the instructor. They are provided with a planning sheet (Appendix B) to guide the conversation toward the five teaching practices outlined in *5 Practices for Orchestrating Productive Mathematics Discussion* (Smith & Stein, 2018). The authors outline these practices as a way to effectively plan for engaging students in discussion of high-quality, open ended math tasks, and include:

- Setting a clear mathematical goal (Practice 0),
- Identifying a high-quality, open ended math task (Practice 1),
- Anticipating students' mathematical thinking and strategies (Practice 2),
- Planning for and monitoring student strategies during instruction (Practice 3),
- Selecting and sequencing student strategies for whole group discussion (Practice 4), and
- Connecting representations to the mathematical goal of the lesson (Practice 5).

Once PSTs are assigned their number talk problem, they brainstorm all of the ways they anticipate students might solve (including both viable strategies as well as potential errors and misconceptions). Then, they discuss possible hints/nudges or questions they could pose to support student thinking and any challenges that arise with solving the problem. Since they are learning about talk moves, they are then tasked with identifying a talk move or two that they plan to integrate into their number talk. Finally, the PSTs consider the anticipated sequence of strategies they might highlight as well as a question they can pose to help students make mathematical connections at the close of the number talk. PSTs then engage in a jigsaw activity (Aronson, 1978) and they move into mixed small groups where each person has a distinct number talk so that they have the opportunity to practice leading the routine with their peers acting as students. These mixed groups are given directions to help them self-facilitate, and all groups are presenting simultaneously to maximize use of class time. During this approximation of teaching, the instructor supports by interjecting potential strategies (participating as a student), as well as by engaging in time-outs where feedback is provided before the PST leading the number talk resumes and retries facilitation. After the mixed groups complete their number talks, they return to their original small group to debrief, discussing what went well, what surprised or challenged them, and what their adjusted goals are for their next teaching opportunity.

### *Anticipating Preservice Teacher Needs in Stage One*

As novices to both the facilitation role and the number talk routine, PSTs tend to face several challenges as they navigate leading their first number talk in their small groups. Much like anticipating the needs of students when designing a number talk or inquiry lesson, planning for these challenges in advance can help teacher educators to effectively scaffold the experience for PSTs. These challenges tend to fall into two categories— how to effectively facilitate and how to effectively act as a student.

In terms of facilitation, PSTs often fall back on what they know, which is teaching by telling. Although they have experienced number talks both as student participants and outside observers, stepping into the role of teacher is new. This is where the instructor can integrate “time-outs” as a way to help the facilitator process how to step back and more effectively bring student thinking to the forefront of the conversation, as the following vignette illustrates.

[During the number talk  $4 + 8 + 6$ ]

PST Facilitator: So the first strategy you could use would be to add the 4 and the 6 first, which makes 10...

Instructor: I'm going to call a quick time out here. I'm wondering what might happen if you asked your students to share what they were thinking. Do you think one of them might have used

this strategy? Maybe start by asking someone to share what they did to solve and keep this in your back pocket in case they are stuck.

PST Facilitator: Would someone like to share what they were thinking?

Student One: I was thinking that breaking apart the 4 into 2 and 2 would make it 2 plus 8 is 10 and 2 more. Then I could add the other 2 and 6 to get 8 and last the 10 and 8 to make 18.

PST Facilitator: Okay, so what I think you said is...

[After the number talk]

Instructor: So how did that go?

PST Facilitator: It was hard not to just show them what to do at first.

Instructor: What did you learn about their thinking by asking them a question first?

PST Facilitator: They had more ways of thinking about the problem than I realized. I wouldn't have known that if I hadn't let them share first.

Pausing mid-number talk allowed the PST facilitating to reframe her teaching to focus more on asking guiding questions that allowed students to explain their thinking, rather than her modeling a process while students passively watched. Circling back after the number talk allowed her a further opportunity to reflect on what shifted about her noticing of student thinking as a result of the modification.

A second challenge that PSTs often face is from the perspective of the student during the number talk. Particularly when number talks are still somewhat new, PSTs may find themselves struggling to solve using more than one strategy. When the teaching rehearsal takes place in a small group setting, this can lead to a lack of variety of student solutions being presented for the facilitator to engage with. Instructors can address this in a number of ways. First, they could interject in a number talk as an extra student, to offer a novel strategy the group could consider and discuss. For example, a number talk that PSTs often have only one strategy for solving at the start of the semester is the problem  $12 + 58$ . Many consider finding common denominators, either by mentally picturing the two fractions (e.g., I saw a pizza with half or four-eighths slices and another with five-eighths slices and added to get nine-eighths slices, or one and one-eighth) or using the procedure to solve. When this happens, an interjection could be appropriate to both provide the facilitator with additional directions to take the discussion and a new strategy that students could apply in a follow up problem.

PST Facilitator: Does anyone have another strategy they want to share?

[No response]

Instructor: Can I share another strategy?

PST Facilitator: Sure. What were you thinking?

Instructor: Well, I know that five-eighths is just like half and one more eighth.

PST Facilitator: Okay, so five-eighths is half...?

Instructor: So, five eighths, if I break it apart, is like four-eighths and one more eighth. And I know four-eighths is the same as a half.

PST Facilitator: Okay, so you have four-eighths plus one-eighth [writes on board]

Instructor: Yeah. So if I have that half, plus the other half, I know half plus half is one whole. And then I have that extra one-eighth. So I get one and one-eighth.

PST Facilitator: Maybe if I draw this as a picture...[draws two circles]. So here is half of a pizza, and the other pizza has half and one more eighth. So you combined the two halves, and had one more eighth leftover. Is that right?

Instructor: That's right. I might suggest a turn and talk to make sure the rest of the group understands too.

In this instance, the instructor stepped in to offer an alternative approach to solving, however this task could also be given to the PSTs acting as students in each group through the use of task cards. Although the PSTs may not be able to anticipate additional strategies on their own, the instructor could provide them with preplanned strategies, particularly for math tasks that may be more challenging to generate multiple approaches for in the moment. Both options can provide an additional layer of support for the PST facilitator by ensuring there are multiple and varied strategies they can highlight to help their students to unpack, compare/contrast, and add to their toolbox through the use of number talks. These scaffolds can help to ensure that PSTs experience success in their initial attempts at leading a student-centered discussion, as well as build their capacity in terms of noticing and anticipating noticing of student thinking.

## **Teaching Rehearsals Stage Two: Co-Planning Lesson with a Microteach**

### ***Developmental Considerations in Stage Two***

As part of their teacher preparation program, PSTs utilize a prefabricated lesson plan format that aligns with the InTASC standards and helps them to process through the salient elements of a whole group lesson. Up until this point in their program, PSTs have only experienced lesson planning through the lens of direct modeling, or the gradual release of instruction (Pearson & Gallagher, 1983), as a structured way to transition from teacher led modeling toward student centered practice. Inquiry-based and active learning approaches (e.g., Baroody & Coslick, 1998; Bruner, 1961; Polya, 1945, 2014), on the other hand, typically start with posing an open ended, high-quality math task and having students pose questions, create and test hypotheses, and critically evaluate solution strategies, while the teacher acts as a facilitator or guide, in a similar approach to conducting a number talk. This instructional approach has been shown to support the development of problem-solving skills in students (e.g., Divrik et al., 2020; Linn et al., 2000; Merritt et al., 2017), along with increased self-efficacy and interest in the content (Riegle-Crumb et al., 2019) and offers an approach for promoting productive struggle in the classroom. As novice practitioners, the instructional activities for this course are designed as *guided inquiry* lessons (Cobb & McClain, 2005), where the teacher

provides more structure and direction through targeted questioning and scaffolding, as an opportunity for PSTs to take what they learn from the deconstruction, implementation, and reflection on number talks and apply it to a more complex math task and learning goal. Thus, in this second stage of teacher rehearsals, PSTs are now familiar with the process of taking a high-quality math task, anticipating student strategies and misconceptions, and guiding a discussion. What is novel at this stage is embedding this process within a full lesson where students engage with new and developing mathematical concepts, requiring the teacher to plan an anticipatory set that activates students' background knowledge as well as scaffolded follow-up practice to support the learning goal after the inquiry phase. This stage connects their learning about the core mathematics teaching practices directly back to the programmatic structures for lesson planning and the related InTASC standards PSTs are expected to demonstrate mastery of by program completion.

### ***Structure of the Cycle***

In week four of the semester, PSTs continue discussing high-quality math tasks and how to design instruction around the eight high-leverage mathematics teaching practices through a second collaborative planning opportunity. To provide multiple representations of teaching prior to having PSTs write their own plans, they first complete a course reading on productive struggle (NCTM, 2014), or the process of having students engage in challenging mathematics tasks to help them develop a deeper understanding of concepts and build resilience and critical thinking skills. In the reading, the authors share a vignette about two classroom teachers who co-plan a guided inquiry lesson and then go back to their respective classrooms to enact the lesson. In the vignette, one of the teachers addresses student struggle by “rescuing” or jumping in to model a strategy, while the second teacher poses questions and offers suggestions to help her students navigate through their struggles and toward viable strategies. The PSTs reflect on the aspects of the teaching moves in the vignette that helped or hindered productive struggle, discussing the challenges they anticipate facing as new teachers who are learning to implement inquiry for the first time. The instructor then engages the class in a demonstration lesson that incorporates “time-outs” for discussion and where the PSTs can see in real time how to integrate the five practices planning that they did with peers for the number talk into a full-length lesson plan. The demonstration includes modeling of how a teacher can take a task from a traditional mathematics textbook and adjust it for both cultural relevance and opportunities for students to have multiple access points for solving (Smith & Stein, 1998; Stein et al., 2009), as well as approaches to selecting and sequencing student strategies to identify a target approach for further investigation by the class. PSTs also engage in an activity where they are given the opportunity to decompose a pair of sample lesson plans to determine the aspects of a written plan that encapsulate a guided inquiry approach versus a gradual release of instruction model. In pairs, PSTs annotate both lesson scripts, identifying teaching moves and design elements that provide evidence of the type of instructional model being employed in each plan.

After PSTs have multiple opportunities to experience representations of guided inquiry, they then work collaboratively in their small groups to co-plan an inquiry lesson. Groups identify a lesson from a mathematics textbook that they would like to design into an inquiry plan – providing justification for their decision prior to engaging in the design process. PSTs are presented with a modified version of the prefabricated lesson plan template that the teacher preparation program uses, that, much like the number talk planning sheet, provides prompts and scaffolding to guide PSTs through the five practices planning process together (Appendix C). PSTs are given both real time support as well as written feedback on their plans by the instructor.

The final phase in this iteration of PBTE cycle is for the PSTs to enact their written plan in a small group microteach. Each PST is given 15 minutes to present their lesson to a group of peers and a university faculty member (either the instructor of record, instructional coaches, or other teacher educators from the department – if this is not an option, PSTs record their microteaches for instructor review). After teaching, each PST receives immediate verbal and written feedback, both from their peers as well as an instructor, which is facilitated by prompts such as:

- What did you notice in the lesson? About teaching moves? Student learning and engagement?
- What wonders or questions do you have?
- What is something that the teacher did well? Try to tie your feedback to the InTASC standards and eight mathematics teaching practices—be as specific as possible!
- What sticky points came up during the lesson? How might the small group help to brainstorm/problem solve what teachers can do in these situations?

At the end of the microteach activity, PSTs are given time to individually reflect on their lesson and the feedback they received before setting forward-facing goals for their next teaching opportunity.

Note: The structure of the microteach as described here came out of previous work by the author and colleagues that explored integrated approaches to teaching approximations in disciplinary methods courses (Lemke et al., 2022).

### ***Anticipating Preservice Teacher Needs in Stage Two***

Unlike the first stage of the PBTE arc, PSTs are no longer given the open-ended math task they will utilize to facilitate the student discussions. In planning for the first microteach, they must consider how to utilize content provided by standards-based curriculum (i.e. textbooks) to engage students in guided inquiry – identifying which math task to use or modify, determining what questions to pose to elicit evidence of student thinking, and anticipating how they can steer the direction of the lesson using this information. This presents a new layer of complexity for PSTs as novice teachers when it comes to planning an inquiry-based lesson, therefore it is important to note several considerations. As this was their first attempt at writing a guided inquiry lesson plan, PSTs were offered several scaffolds to support this process. First, they were allowed the chance to collaborate with peers in writing their plans during class, which also afforded opportunities for the instructor to check in during the early stages of planning to ensure PSTs had identified a viable task to support an inquiry lesson. In end of course reflections where PSTs considered the most impactful aspects of their teaching experiences, they often referred back to these supports as a central part of their learning and success. As one expressed, “Talking about the math with my peers allowed us to be able to come up with ideas together and build off each other's thoughts. Sometimes it is hard to anticipate what students might do on my own, so this was really helpful in planning.” PSTs were able to draw upon their experiences as learners, ideas from course content and activities, as well as interactions with students in practica and other settings to bring a range of ideas to the table during these planning sessions.

Although they had seen number talks and other examples of inquiry tasks in class, determining whether a task was open-ended enough to allow multiple entry points and pathways for solving was a new process for PSTs to navigate. The role of the instructor during this planning stage is critical in setting PSTs up for success in the final design and implementation of their first microteach lesson. Through both the intentional

design of the lesson plan template as well as monitoring questions during the in-class planning stage, the instructor can help PSTs to consider questions like:

- What features of this math task might make it a good one for inquiry? What are you noticing/thinking?
- Are there multiple pathways for students to solve this problem? If you changed the wording, could you increase these opportunities? What might that sound like?
- Is this task better suited for gradual release, where you want them to know and practice one specific strategy or process for solving problems? How can you tell?
- Is there a target strategy or mathematical idea you want students to leave this lesson knowing? What questions might you pose or nudges might you provide as students work to guide them toward this?

This last question is similar to the one PSTs wrestle with during stage one of the PBTE arc in terms of determining a goal for the lesson – when presenting an open-ended task for students, how do teachers pair such a flexible structure for problem solving with a strategic, focused mathematical goal? At this stage in their learning, PSTs are often navigating their ability to solicit ideas from students, thus it is important to remind them to design discussion facilitation questions that will steer the students toward the target learning goal. Again, peer and instructor support was a scaffold that multiple PSTs noted as benefitting their growth as they learned how to plan for the variable nature of guided inquiry during stage two. At the end of the course, one sharer reflected, “I really valued getting to break [inquiry planning] down more and practice doing this with my peers. It helped to increase my comfort level in teaching an inquiry lesson instead of just using gradual release.” In addition to planning, PSTs also noted that immediate feedback also helped to support their growth.

Although PSTs still grappled with the novelty of planning and teaching using inquiry-based approaches during stage two, reflections they completed directly after the microteach illustrated their growing understanding of the role of student engagement and a desire to strategically elicit evidence of their students’ thinking during instruction. At times, their reflections focused more on student engagement as a tool for keeping children focused and “on task” during instruction, as when one PST shared the feedback, she had received from her peers after the microteach. “They mentioned when I have them count to use clapping or snapping to help keep [students] involved.” Another made a similar remark, explaining that his peers suggested he “...have sentence starters for potential students that would help them use the vocabulary words to explain.”

PSTs also demonstrated an increased awareness in their role of eliciting student thinking during instruction, however. As part of their post-microteach reflections, they were asked to set one goal for their teaching practice as they moved into the next portion of the course, and a number talked about building in additional opportunities to increase student discourse in their lessons.

One goal that I have for my next lesson is to slow down throughout the lesson and ask more questions to make sure students are really thinking.

One thing I want to grow is my ability to have meaningful conversations with students. I want to get better at using the way students respond and answer to engage in a deeper understanding.

Overtime, I want to grow my ability to ask questions that get students to be curious and want to search for the answer.

Such quotes help to illustrate growth PSTs began to make from stage one to stage two of the teaching rehearsal arc. Not only were they better able to design and enact lessons intended to be student-centered, they also had begun to identify specific ways they could go about doing this and noting it as a key part of effective teaching for deeper mathematical understanding.

### **Teaching Rehearsal Stage Three: Individual Planning and Microteach**

#### ***Developmental Considerations in Stage Three***

In the final third of the semester, PSTs graduate from co-planned experiences to solo planning, following a similar approach to the previous rehearsal stages. This stage is designed to consolidate learning from the first two stages, continue to press PSTs to engage in the five practices, and facilitate additional opportunities for them to enact high-leverage teaching practices in a lower risk environment while also attending to professional noticing. In addition to having more experience facilitating student centered discussions and integrating student strategies into the core of instruction, PSTs have also engaged in a number of activities across the course where they explored mathematics learning trajectories/progressions (e.g., Clements & Sarama, 2004; Daro et al., 2011), or the developmental pathways along with children's mathematical understanding evolves along a given concept. This involved analyzing student work, particularly work samples that included both intermediary strategies as well as misconceptions, as a way to help PSTs learn to anticipate student strategies and to plan for instruction with these progressions in mind. As a result, PSTs enter the final portion of the course with additional knowledge and experience that can support their ability to anticipate and plan prior to instruction so they can more effectively monitor and notice student thinking and strategies during the lesson.

#### ***Structure of the Cycle***

For this final approximation of teaching, PSTs select a grade appropriate task (typically adapted from a textbook task) and align it to a clear mathematical goal before designing their written plan using the guided inquiry lesson plan template (Appendix C). Similar to the setup of the Stage 2 microteach, PSTs are placed in small groups with 15 minutes to enact their written plan. In addition to planning from beginning to end on their own, another difference to the structure of Stage 3 is that PSTs focus not only on integrating talk moves, but also strategies for equitable participation across the class (e.g., think-pair-share, non-verbal responses, or other thinking routines). In order to help the PST leading the lesson focus on their development of professional noticing, peer and instructor support is designed as a facilitated discussion that is targeted on students' mathematical thinking. The small group discusses questions such as: Which strategies and connections surfaced during the lesson? Whose ideas were taken up? Whose ideas were not? What strategies can support all voices being heard? After the discussion, PSTs are given another opportunity to reflect in writing on their learning about teaching, answering the following prompts:

1. What is something you learned about students' thinking and strategies after reflecting on your lesson?

2. What is a goal or suggestion about guided inquiry and mathematics teaching that you will carry forward into your next teaching opportunity?
3. What is a participation move that you might integrate into your lessons to broaden student engagement? How will it help to promote equitable participation?
4. How might you collect evidence of students' mathematical thinking during instruction to help you make instructional decisions?

PSTs are encouraged to take these goals forward into future practicum and clinical practice as an opportunity to continue to deepen their understanding and implementation of high-leverage mathematics teaching practices.

### *Anticipating Preservice Teacher Needs in Stage Three*

Much like the gradual release of instruction, the third stage of teaching rehearsals is intended to nudge PSTs toward independence in both designing and enacting mathematics lessons that are student-centered and can promote deep mathematical understanding for children. As demonstrated by some of the reflections PSTs engaged at the end of stage two, in stage three the focus moved from task design and implementation and toward the integration of teaching moves that increased meaningful engagement during instruction. Although PSTs are provided less structured support from peers or the instructor in planning their final microteach, they are now equipped with tools such as the learning progressions to help them anticipate students' mathematical thinking, allowing them to refine the questions and nudges they design, along with the target strategies or representations that are the focal points of their lessons. As novice teachers, PSTs' content knowledge is often still a work in progress and so continuing to provide them with tools they can draw upon to support this development while planning remains an important scaffold in this final stage of the teaching rehearsal arc. The main difference is, in lieu of having support from peers and the instructor during the planning stages, PSTs are now learning to incorporate tools that they would have available to them at any time.

As PSTs reflected on their own growth from stage two to stage three of the rehearsal arc near the end of the course, many acknowledged that learning to teach mathematics, whether using guided inquiry or gradual release models for instruction, was still a "work in progress." They consistently noted the value they found engaging in the number talks and microteaches as ways to gain experience and confidence in their ability to do so, however. In their final reflection, a PST shared,

The first inquiry-based lesson plan that we wrote for the class was my first experience with writing an inquiry-based lesson plan. The lesson plan wasn't my best work, and I could recognize that when I was writing it, as I felt lost and a bit out of my element...The feedback I received on that first draft helped me grow a lot as an educator. For the second microteach, I went back to the drawing board and added intentional math problems paired with scripting explain why students would do what they're doing and how this makes sense. I think ultimately this process helped strengthen my skills and taught me what a good math lesson needs, looks like, and sounds like.

Similarly, another PST expressed how beginning with the approximations and rehearsals of number talks helped them to make a connection to effectively plan whole group mathematics lessons as the semester went on, saying,

The number talks helped me because we had many opportunities to practice them with our peers and facilitating a number talk in a small group environment helped me to be more comfortable during my microteach lessons. Throughout the lessons I taught I made sure that I had effective questions that I asked students to help them explain and to think critically about the concepts we were working on. These questions also helped the students to make mathematical connections.

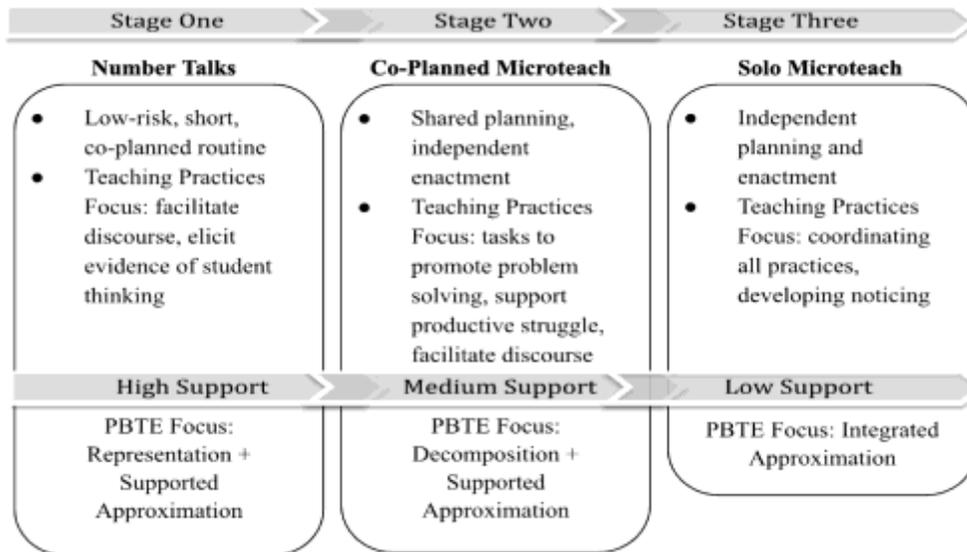
Such reflections illustrate the importance of providing multiple rounds of practice that integrate consistent feedback and opportunities for reflection. These experiences support PSTs in transferring the complexities of teaching through inquiry and in developing the ability to decompose and recompose the practices needed to implement this type of mathematics instruction effectively.

## Discussion

### *Intentionality in Practice Based Teacher Education Cycles*

In teacher preparation programs that do not include content-specific practica, bringing in approximations of practice into coursework can create scaffolded, repeated opportunities for PSTs to plan, enact, and receive feedback on high-leverage mathematics teaching practices in supportive environments. Many mathematics teacher preparation courses strive to integrate NCTM's mathematics teaching practices, PBTE cycles of representation-decomposition-approximation, and utilize number talks and microteaches to provide space for PSTs to apply course learning in real time while receiving peer and instructor feedback. One of the challenges of learning to teach is the many layers of complexity that PSTs are navigating simultaneously as they take on the task of facilitating instructional opportunities for the first time. Particularly when content specific pedagogies, such as mathematics and science, require PSTs to learn teaching methods that vary from the traditional approaches they are developing through other coursework (i.e. guided inquiry versus gradual release of instruction), this can be a daunting task. As illustrated in the developmental considerations for PSTs in stage one of the teaching rehearsal arc, PSTs struggle with issues such as reverting to teaching-by-telling, anticipating strategies and misconceptions, and treating lesson planning as a series of tasks to complete rather than a conceptual planning support. If PBTE cycles are implemented as repeated activities rather than as a developmental trajectory to intentionally help PSTs learn to navigate the cognitive load of teaching, this can lead to design flaws in methods courses.

Through intentional staging of these cycles, however, PSTs can gradually increase their capacity to integrate core teaching practices and professional noticing in their teaching practice. The design conjecture presented in this paper articulates a developmental design for three-stage arc of teaching rehearsals – beginning with a low-risk number talk, progressing through co-planned microteaches, and culminating in a solo microteach – that draws upon existing structures in PBTE to support PSTs' ability to wrestle with the facets of planning and teaching in manageable ways. Figure 2 illustrates how a three-stage teaching rehearsal arc can help to shift the responsibility, planning complexity, and cognitive load to PSTs gradually across iterative cycles of planning and teaching—features that are often implicit without being directly articulated in PBTE design.

**Figure 2***Three-Stage Teaching Rehearsal Arc*

This process supports PSTs as they learn how to coordinate the five practices, talk moves, and professional noticing, all of which support a shift from teacher performance to students' mathematical thinking in the classroom (Grossman et al., 2009; Jacobs et al., 2010; Lampert et al., 2013; Smith & Stein, 2018). Within each stage of this arc, representations such as course readings, modeled number talks, and video observations make the work visible. Decomposition tools, such as a planner for using the five practices and integrating talk moves, help PSTs to name specific facets of the work before engaging in coached approximations where they facilitate in the moment consolidation of these teaching moves. Incorporating time-outs and timely/immediate feedback can help to further catalyze in the moment adjustments by PSTs as they attempt to integrate high-leverage mathematics teaching practices real time and doing so in the context of a microteach helps to alleviate concerns such as classroom management and interruptions. The integration of a multi-stage arc across the span of the methods course allows PSTs to increase their capacity for facilitating inquiry lessons by slicing learning into manageable tasks that gradually increase the cognitive demand of the planning and facilitation.

In stage one, number talks can function as an accessible rehearsal space for PSTs to practice *eliciting and interpreting* student strategies, publicly recording ideas, and pressing for reasoning before taking on a full guided inquiry lesson. This narrows the focus to student discourse, eliciting thinking, and practice facilitating discussion in a small group setting while requiring reduced demands in terms of planning. In stage two PSTs begin to broaden their planning focus to include identifying/using high-quality math tasks that promote problem solving, and planning questions and nudges they can use during the lesson to guide student thinking. At this stage, the planning load increases in that PSTs must now create a whole group lesson plan but are still given supports in terms of co-planning and peer/instructor feedback at both the planning and enactment stages of the microteach. In the final stage, PSTs take on the role of coordinating the planning and facilitation of the guided inquiry lesson on their own, with the goal of positioning them to make in-the-moment instructional decisions that are supported by intentional planning. As the cognitive

load shifts toward independent planning in later stages, PSTs use the five practices to anticipate strategies, monitor during enactment, and select/sequence/connect ideas to meet their target mathematical goal (Smith & Stein, 2018). In stages one and two, the time-out + immediate feedback routine offers an opportunity for PSTs to focus on *one* high-leverage teaching practice, rehearse a slim slice of teaching moments later, and then reflect on ways to improve future iterations of the teaching move in practice (Lampert et al., 2013). This allows them to navigate the complexities of NCTM's eight core teaching practices in manageable chunks before having to consider them within the context of a fully developed whole group lesson. Despite their prevalence, number talks are often seen as a structure that can be implemented for a lesson warm up, rather than as a scaffold for building teacher capacity to engage in inquiry-based teaching and effective integration of all eight core teaching practices. By maintaining an intentionally parallel design between the number talks and the microteaches, teacher educators can transition PSTs from one type of rehearsal to the next with minimal friction, gradually building their capacity to navigate multiple facets of teaching all at once.

### ***Design Tensions in Staged Teaching Rehearsals***

Microteaches bring with them several tensions and tradeoffs. In terms of authenticity, this approximation of practice affords PSTs with the opportunity to practice using high-leverage practices, develop their noticing of students' mathematical thinking, and to take advantage of in the moment feedback and support. When this takes place after repeated exposure to representations of the teaching practice paired with decomposition activities where PSTs can identify the individual facets of teaching moves that lead to successful implementation (or not), microteaches provide PSTs with a safe space to explore these practices in practice. Microteaches offer a controlled, structured setting that can help to eliminate potential distractions as novice teachers attempt to unpack content for learners. Further, when PSTs are presented with clear and distinct connections between what they are learning about planning and enacting number talks as a micro-routine to planning and leading a "full lesson" microteach, they are better equipped to transfer learning from prior experiences.

Previous studies (Jakopovic et al., 2021, 2024; Lemke et al., 2022) have found that, despite the benefits of microteaches, they can also present several challenges. For example, it may be hard for peers who are also novice PSTs to anticipate and engage in lessons in the same way that an elementary student would, including offering possible misconceptions that a teacher might come across in a real classroom setting. Another drawback of this approach is the very lack of messiness that comes with instructing children versus adults. To help mitigate this, instructors can seed plausible strategies and common misconceptions as a way to enhance the authenticity of the experience for the PST during their lesson implementation, in addition to incorporating strategies such as "time-outs" to help PSTs wrestle with these issues in the moment. Further, providing PSTs with exposure to learning progressions and multiple and varied exposure to analyzing student work samples, they can help to increase PSTs' capacity for anticipating and addressing student thinking and potential misconceptions – both as the teacher facilitator of the microteach as well as from the role of the student in the simulation. Additionally, some PSTs may feel uncomfortable teaching a group of adults in a simulation setting versus working with children, which could negatively impact their confidence and lesson delivery. Despite this apprehension by some participants, microteaches have been shown to increase PST self-efficacy and competence in implementing high-leverage teaching practices (Arsal, 2014; Iliasova et al., 2025; Jakopovic et al., 2021; Lemke et al., 2022). The use of iterative PBTE cycles across a three-stage teaching rehearsal arc can help to normalize this process for adult learners, alleviating some of

the pressure of teaching to adults that allows PSTs to lean into one another as support when they facilitate lessons.

Finally, coaching capacity matters, as the type and quality of feedback is dependent on the instructor. Particularly when having peers or other faculty/teachers provide feedback on the microteaches, it is important to provide a clear set of look-fors and tools to ensure consistent and quality support. In the case of the elementary methods class shared in this paper, it is important to note that the eight high-leverage mathematics teaching practices promoted by NCTM (2014) are ambitious in nature. Thus, helping PSTs learn to prioritize one to two practices at a time, such as eliciting evidence of student thinking and facilitating discourse, can help to bring depth of learning to a subset of the practices. Providing clear expectations for PSTs, peers, and instructors can help to ensure a single coaching focus for the teaching rehearsal and subsequent discussions.

The iterative design of the three-stage arc affords staggered, iterative opportunities for PSTs to embed slim slices of these practices into their practice, which culminates in the final microteach as an opportunity to apply their synthesized learning in real time. The tensions outlined here underscore the essential nature of intentional staging and facilitation required at each stage of teaching rehearsal arc to ensure PSTs are supported in gaining independence and competence engaging in inquiry-based teaching via PBTE cycles.

### **Implications for Discipline-Focused Methods Courses in Teacher Preparation Programs**

Utilizing a cyclical, progressive arc of PBTE cycles to support PST development of disciplinary pedagogical skills in methods courses can have multiple implications for teacher preparation programs. For methods instructors, this sort of approach that uses a three-stage arc (participate/observe, co-plan + microteach, solo plan + microteach) can help to scaffold PSTs toward independent use of high-leverage pedagogical practices. Selecting a teaching routine that highlights the discipline's core high-leverage teaching practices or core thinking can make multiple coached attempts possible in a class. Ensuring that the PBTE cycle is followed – showing a model or representation of the practice, allowing PSTs to name the teaching moves through a shared lens, and enacting the teaching rehearsal with feedback – can maximize PST learning over compact periods of time. By keeping feedback and coaching support targeted on specific aspects of planning and instructional delivery at each stage (e.g., facilitating class discussions using effective teaching strategies), instructors can help ensure the enactment of these practices are both learnable and sustainable for novice teachers. Offering PSTs planning tools to help them decompose and plan for rehearsal, as well as providing targeted discussion prompts for peer and coached feedback, can help keep a tight focus on these elements specific to the discipline. Finally, closing each rehearsal stage with time for reflection and goal setting can help PSTs develop a plan for transferring learning to future opportunities for implementation. This approach situates PBTE cycles as a designed learning trajectory, rather than isolated teaching opportunities (see Figure 2).

Although this paper situates the teaching rehearsal three-stage arc within the context of elementary mathematics, this approach could be applied in other content areas as well. For example, given the rise of more scripted curricula in literacy, it is vital for methods instructors to help PSTs learn to navigate the complexities of integrating effective teaching practices into more rigid structures. The structure of the three-arc teaching rehearsals presented here could offer a possible outline methods instructors could use to map onto the strategies and teaching practices of other disciplinary content areas in support of PST growth.

At a broader scale, teacher preparation programs can integrate this teaching rehearsal arc as a core programmatic component versus a “one off” approach used unevenly across methods courses. By facilitating iterative and increasingly scaled opportunities for microteaches, teacher preparation programs can make the professional noticing approach of attend-interpret-decide an explicit habit that is developed by all PSTs. Not only can this provide program coherence across methods courses, it can also help to promote equity in providing students access to ambitious, high-leverage teaching practices. Embedding teaching rehearsals across multiple methods courses can help PSTs see teaching practice as something that is both learnable and transferrable across content areas and can reduce the variability of clinical experiences across disciplines. Additionally, if intentionally paired with practicum experiences, microteaches and other forms of teaching rehearsal can lead to more transfer by bridging peer role play to enactment with actual students in the classroom. Taken together, PBTE cycles should exist not only as stand-alone course innovations, but as part of a systematic design for teacher preparation programs to ensure that all PSTs leave the program with coherent opportunities to practice and receive feedback on ambitious and equitable pedagogical practices, ensuring greater consistency as they transition into the profession as highly prepared educators.

This work suggests that, while PBTE tools such as microteaches and high-leverage teaching practices may be common in methods courses, their impact on PST development depends on how these opportunities are designed and sequenced. Specific to the discipline of mathematics, learning to facilitate guided inquiry mathematics lessons is complex, requiring PSTs to coordinate their content knowledge, understanding of students, and integration of effective teaching practices in real time. The three-stage teaching rehearsal arc presented here illustrates the importance of gradually releasing the complexities of this work to PSTs through repeated, scaffolded activities that help them to refine their practice. This model highlights how teacher educators can incorporate PBTE cycles in intentional ways that support PSTs in developing the confidence and capacity to enact equitable teaching practices in the field.

### References

- Allen, D., & Ryan, K. (1968). *Micro Teaching*. Addison Wesley.
- Aronson, E. (1978). *The jigsaw classroom*. Sage.
- Arsal, Z. (2014). Microteaching and pre-service teachers' sense of self-efficacy in teaching. *European Journal of Teacher Education*, 37(4), 453–464. <http://dx.doi.org/10.1080/02619768.2014.912627>
- Association for Advancing Quality in Educator Preparation. (2025). *Standards and guide*. <https://aaqep.org/standard-3>
- Association of Mathematics Teacher Educators. (2017). *Standards for preparing teachers of mathematics*. [amte.net/standards](http://amte.net/standards)
- Jakopovic, P., Lemke, J., Reding, T., & McGlamery, S. (2021). Adapting to COVID-19: Exploring the relationship between integrating microteaches during field experiences and pre-service teachers' self-efficacy. *Journal of Curriculum, Teaching, Learning, and Leadership in Education*, 6(1), 64–80. <https://doi.org/10.32873/uno.dc.ctlle.06.01.1090>

- Lemke, J., Karpf, A., Jakopovic, P., & McGlamery, S. (2022). Field experience reimaged: Integrating microteaches to foster preservice teachers' self-efficacy. *Delta Kappa Gamma Bulletin*, 88(5), 25–34. <https://digitalcommons.unomaha.edu/tedfacpub/151>
- Jakopovic, P., Lemke, J., Karpf, A., & Stamatis, K. (2024). Reflecting on practice: Using video to promote preservice teacher development of professional noticing and ambitious pedagogy. *The Teacher Educator*, 59(1), 140–174. <https://doi.org/10.1080/08878730.2023.2270948>
- Ball, D., Thames, M., & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, 59(5). <https://doi.org/10.1177/0022487108324554>
- Baroody, A. J., & Coslick, R. T. (1998). *Fostering children's mathematical power: An investigative approach to K-8 mathematics instruction*. Routledge.
- Brown, T., & McNamara, O. (2011). *Becoming a mathematics teacher: Identity and identifications*. Springer. <https://doi.org/10.1007/978-94-007-0554-8>
- Bruner, J. S. (1961). The act of discovery. *Harvard Educational Review*, 31(1), 21–32.
- Chapin, S., O'Connor, C., & Anderson, N. C. (2022). *Talk Moves: A teacher's guide for using classroom discussions in math, K-6* (3rd ed.). Math Solutions.
- Clements, D., & Sarama, J. (2004). Learning trajectories in mathematics education. *Mathematical Thinking and Learning*, 6(2), 81–89. [https://doi.org/10.1207/s15327833mtl0602\\_1](https://doi.org/10.1207/s15327833mtl0602_1)
- Cobb, P., & McClain, K. (2005). Guiding inquiry-based math learning. In K. Sawyer (Ed.), *The Cambridge handbook of the learning sciences* (pp. 171–186). Cambridge University Press. <https://doi.org/10.1017/CBO9780511816833.012>
- Cochran-Smith, M., & Lytle, S. L. (2009). *Inquiry as stance: Practitioner research for the next generation*. Teachers College Press.
- Core Practice Consortium. (2025). *Core practice*. <https://www.corepracticeconsortium.org/core-practice>
- Interstate Teacher Assessment and Support Consortium. (2013). *InTASC Model Core Teaching Standards and Learning Progressions for Teachers 1.0: A Resource for Ongoing Teacher Development*. Council of Chief State School Officers. <https://learning.ccsso.org/intasc-model-core-teaching-standards-and-learning-progressions-for-teachers>
- Daro, P., Mosher, F. A., Corcoran, T., Barrett, J., Battista, M., Clements, D., Confrey, J., Daro, V., Maloney, A., Nagakura, W., Petit, M., & Sarama, J. (2011). *Learning trajectories in mathematics: A foundation for standards, curriculum, assessment, and instruction*. Consortium for Policy Research in Education. <https://files.eric.ed.gov/fulltext/ED519792.pdf>
- d'Alessio, M. (2018). The effect of microteaching on science teaching self-efficacy beliefs in preservice elementary teachers. *Journal of Science Teacher Education*, 29(6), 441–467. <https://doi.org/10.1080/1046560X.2018.1456883>
- Divrik, R., Pilten, P., & Mentis Tas, A. (2020). Effect of inquiry-based learning method supported by metacognitive strategies on fourth-grade students' problem-solving and problem-posing skills: A

- mixed methods research. *International Electronic Journal of Elementary Education*, 13(2), 287–308. <https://doi.org/10.26822/iejee.2021.191>
- Duffy, M. (2017). *Can frequent use of number talks increase the comprehension, understanding, and fluency of fractions, decimals, and percentages in alternative high school students?* [Thesis, Hamline University]. HSEL Student Capstone Theses and Dissertations.
- Emerson, J. M., Junor Clarke, P., & Moldavan, A. M. (2018). Bridging pedagogy and practice: From coursework to field experiences in a teacher preparation program. *Georgia Educational Researcher*, 14(2), 24–35. <https://doi.org/10.20429/ger.2018.140203>
- Fuller, F. F. (1969). Concerns of teachers: A developmental conceptualization. *American Educational Research Journal*, 6(2), 207–226. <https://doi.org/10.3102/00028312006002207>
- Fuller, F., & Brown, O. (1975). Becoming a teacher. In K. Ryan (Ed.), *Teacher education: Seventy-fourth yearbook of the national society for the study of education* (Part 2, pp. 25–52). University of Chicago Press.
- Fuson, K., & Leinwand, S. (2023). Building equitable math talk classrooms. *Mathematics Teacher: Learning and Teaching PK-12*, 116(3), 164–173. <https://doi.org/10.5951/MTLT.2022.0285>
- Geijsel, F., & Meijers, F. (2005). Identity learning: The core process of educational change. *Educational Studies*, 31(4), 419–430. <https://doi.org/10.1080/03055690500237488>
- Grossman, P., Compton, C., Igra, D., Ronfeldt, M., Shahan, E., & Williamson, P. W. (2009). Teaching practice: A cross-professional perspective. *Teachers College Record*, 111(9), 2055–2100. <https://doi.org/10.1177/016146810911100905>
- Humphreys, C., & Parker, R. (2015). *Making number talks matter: Developing mathematical practices and deepening understanding, Grades 3-10*. Routledge.
- Iliasova, L., Nekrasova, I., Mena, J., & Estrada-Molina, O. (2025). Microteaching on pre-service teachers' education: Literature review. *Frontiers in Education*, 10. <https://doi.org/10.3389/educ.2025.1562975>
- Ismail, S. (2011). Student teachers' microteaching experiences in a preservice english teacher education program. *Journal of Language Teaching and Research*, 2(5), 1043–1051. <https://doi.org/10.4304/jltr.2.5.1043-1051>
- Jacobs, V. R., Lamb, L. L., & Philipp, R. A. (2010). Professional noticing of children's mathematical thinking. *Journal for Research in Mathematics Education*, 41(2), 169–202. <https://doi.org/10.5951/jresematheduc.41.2.0169>
- Jao, L., Rao, N., Stewart, A. (2020). Bridging the gap between coursework and practica: Secondary mathematics pre-service teachers' perceptions about their teacher education program. In Radakovic, N., Jao, L. (Eds.), *Borders in mathematics pre-service teacher education* (pp. 119–139). Springer. [https://doi.org/10.1007/978-3-030-44292-7\\_6](https://doi.org/10.1007/978-3-030-44292-7_6)
- Kaasila, R., Hannula, M., & Laine, A. (2012). “My personal relationship towards mathematics has necessarily not changed but...” analyzing preservice teachers' mathematical identity talk.

- International Journal of Science and Mathematics Education*, 10, 975–995. <https://doi.org/10.1007/s10763-011-9308-x>
- Kavanagh, S. S., Gotwalt, E. S., & Farrow, J. (2023). Practice-based coaching for project-based teaching: Understanding relationships between coaching practice and teaching practice. *Teaching and Teacher Education*, 132, 104255. <https://doi.org/10.1016/j.tate.2023.104255>
- Kazemi, E., Ghouseini, H., Cunard, A., & Turrou, A. (2016). Getting inside rehearsals: Insights from teacher educators to support work on complex practice. *Journal of Teacher Education*, 67(1), 18–31. <https://doi.org/10.1177/0022487115615191>
- Kelly-Petersen, M., Davis, E.A., Ghouseini, H., Kloser, M., & Monte-Sano, C. (2018). Rehearsals as approximations of practice. In P. Grossman (Ed.), *Teaching core practices in teacher education* (pp. 85–105). Harvard Education Press.
- Lampert, M., Franke, M. L., Kazemi, E., Ghouseini, H., Turrou, A. C., Beasley, H., Cunard, A., & Crowe, K. (2013). Keeping it complex: Using rehearsals to support novice teacher learning of ambitious teaching. *Journal of Teacher Education*, 64(3), 226–243. <https://doi.org/10.1177/0022487112473837>
- Linn, M. C., Kessel, C., Lee, K., Levenson, J., Spitulnik, M., & Slotta, J. D. (2000). *Teaching and learning K-8 mathematics and science through inquiry: Program reviews and recommendations*. Office of Educational Research and Improvement. <https://files.eric.ed.gov/fulltext/ED478918.pdf>
- Lutovac, S., & Kaasila, R. (2014). Pre-service teachers' future-oriented mathematical identity work. *Educational Studies in Mathematics*, 85(1), 129–142. <https://doi.org/10.1007/s10649-013-9500-8>
- Mader-Stewart, A. (2018). The impact of daily number talks on the development of mental math abilities of second graders within a reform-based classroom. [Master's thesis, Lakehead University]. Lakehead Knowledge Commons.
- McDonald, M., Kazemi, E., & Kavanagh, S. S. (2013). Core practices and pedagogies of teacher education: A call for a common language and collective activity. *Journal of Teacher Education*, 64(5), 378–386. <https://doi.org/10.1177/0022487113493807>
- Merritt, J., Yeon Lee, M., Rillero, P., & Kinach, B. M. (2017). Problem-based learning in K-8 mathematics and science education: A literature review. *The Interdisciplinary Journal of Problem-Based Learning*, 11(2). <https://doi.org/10.7771/1541-5015.1674>
- National Council of Teachers of Mathematics (NCTM). (2000). *Principles and standards for school mathematics*.
- National Council of Teachers of Mathematics (NCTM). (2014). *Principles to actions: Ensuring mathematical success for all*.
- National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Mathematics standards*. <https://www.corestandards.org/Math/>
- National Research Council. (2001). *Adding it up: Helping children learn mathematics*. The National Academies Press.

- Oluwatoyin, O. O., & Ademiluyi, F. L. (2022). Assessing the effectiveness of microteaching during teacher preparation in post COVID-19 era. *KWASU International Journal of Education*, 4(1), 97–107. <https://www.kije.com.ng/index.php/KIJE/article/view/11/11>
- Parrish, S. (2014). *Number talks: Whole number computation, grades K–5*. Heinemann.
- Parrish, S. (2022). *Number talks: Whole number computation, grades K–5*. Heinemann.
- Parrish, S., Dominick, A., & Leinwand, S. (2016). *Number talks: Fractions, decimals, and percentages*. Heinemann.
- Parrish, S., Dominick, A., & Leinwand, S. (2022). *Number talks: Fractions, decimals, and percentages*. Heinemann.
- Patel, M. A. I., & Ansari, M. A. (2009). Practice of microteaching as a training technique in teacher education. *EDUTRACKS*, 9(2), 40–44. <https://doi.org/10.5281/zenodo.7488651>
- Pólya, G. (1957). *How to solve it: A new aspect of mathematical method* (2nd ed.). Princeton University Press.
- Riegle-Crumb, C., Morton, K., Nguyen, U., & Dasgupta, N. (2019). Inquiry-based instruction in science and mathematics in middle school classrooms: Examining its association with students' attitudes by gender and race/ethnicity. *AERA Open*, 5(3), 1–17. <https://doi.org/10.1177/2332858419867653>
- Schon, D.A. (1983). *The reflective practitioner: How professionals think in action*. Basic Books.
- Sherin, M., Jacobs, V., & Philipp, R. (2011). *Mathematics teacher noticing. Seeing through teachers' eyes*. Routledge.
- Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, 15(2), 4–14. <https://doi.org/10.3102/0013189X015002004>
- Smith, M. S., & Stein, M. K. (1998). Selecting and creating mathematical tasks: From research to practice. *Mathematics Teaching in the Middle School*, 3(5), 344–350. <https://doi.org/10.5951/MTMS.3.5.0344>
- Smith, M. S., & Stein, M. K. (2018). *5 practices for orchestrating productive mathematics discussions* (2<sup>nd</sup> ed.). National Council of Teachers of Mathematics.
- Stein, M. K., Smith, M. S., Henningsen, M., & Silver, E. A. (2009). *Implementing standards-based mathematics instruction: A casebook for professional development* (2nd ed.). Teachers College Press.
- Swars, S. L., & Chestnutt, C. (2016). Transitioning to the common core state standards for mathematics: A mixed methods study of elementary teachers' experiences and perspectives. *School Science and Mathematics*, 116(4), 212–224. <https://doi.org/10.1111/ssm.12171>
- Teaching Works (n.d.). *High-Leverage Practices*. <https://library.teachingworks.org/curriculum-resources/high-leverage-practices/>

- van Es, E. A., Cashen, M., Barnhart, T., & Auger, A. (2017). Learning to notice mathematics instruction: Using video to develop preservice teachers' vision of ambitious pedagogy. *Cognition and Instruction, 35*(3), 165–187. <https://doi.org/10.1080/07370008.2017.1317125>
- van Es, E. A., Hand, V., & Mercado, J. (2017). Making visible the relationship between teachers' noticing for equity and equitable teaching practice. In E. Schack, M. Fisher, & J. Wilhelm (Eds.), *Teacher noticing: Bridging and broadening perspectives, contexts, and frameworks* (pp. 251–270). Springer.
- van Es, E. A., & Sherin, M. (2008). Mathematics teachers' "learning to notice" in the context of a video club. *Teaching and Teacher Education, 24*(2), 244–276. <https://doi.org/10.1016/j.tate.2006.11.005>
- van Es, E. A., & Sherin, M.G. (2021). Expanding on prior conceptualizations of teacher noticing. *ZDM Mathematics Education, 53*, 17–27. <https://doi.org/10.1007/s11858-020-01211-4>
- van Rooji, E. C. M., Fokkens-Bruinsma, M., & Goedhart, M. (2019). Preparing science undergraduates for a teaching career: Sources of their teacher self-efficacy. *The Teacher Educator, 54*(3), 270–294. <https://doi.org/10.1080/08878730.2019.1606374>
- van Zoest, L. & Bohl, J. (2005). Mathematics teacher identity: A framework for understanding secondary school mathematics teachers' learning through practice. *Teacher Development, 9*(3), 315–345. <https://doi.org/10.1080/13664530500200271>
- Woods, D. (2021). Enacting number talks in a simulated classroom environment: What do preservice teachers notice about students? *International Journal of Technology in Education, 4*(4), 772–795. <https://doi.org/10.46328/ijte.148>
- Yackel, E., & Cobb, P. (1996). Sociomathematical norms, argumentation, and autonomy in mathematics. *Journal for Research in Mathematics Education, 27*(4), 458–477. <https://doi.org/10.2307/749877>

## Appendix A

### Talk Moves Video Reflection Activity Note Taker

#### Math Talk Moves:

Revoicing: the teacher tries to repeat what a student has said, then asks the student to respond and verify whether or not the teacher's revoicing is correct. *"So you're saying..."*

Repeating someone else's reasoning: the teacher asks one student to repeat or rephrase what another student has said, then follows up with the first student. *"Can you repeat what he just said in your own words?"*

Asking students to apply their reasoning to someone else's reasoning (agree/disagree): students make their own reasoning explicit by applying thinking to someone else's contribution. *"Do you agree or disagree and why?"*

Prompting students for further participation (adding on): the teacher asks for further commentary. *"Would someone like to add on?"*

Prompting students to justify their reasoning: the teacher asks students to explain their thinking. *"Can you tell me why you thought that?" "Can you explain how you knew...?"*

Using wait time: the teacher waits at least ten seconds for students to think before calling on someone for an answer. *"Take your time...we'll wait."*

Turn and talk to a partner: students share with an elbow partner to brainstorm/practice sharing an idea before having to share whole group. *"Turn and tell your partner how you thought about solving that."*

**Video Observation.** Record the math talk moves you observe in the table below. Try to notice both what the teacher says and does as well as what students say and do.

<i>What the Teacher Says</i>	<i>Category of Talk Move</i>	<i>How did students respond? Who was engaged? What evidence do you see of students making connections?</i>

**Round Robin Processing.** In your small group, take turns sharing one of the talk moves that you observed, and discuss how you saw it impacting students' mathematical understanding. What did you notice about the teacher's moves and students' ideas? Why do you think the teacher made those choices? What do the student responses suggest about their thinking? If you were leading, what would you do next and why?

**Personal Reflection.** If you were leading this Number Talk, what would you want to try to do similarly? What might you do differently? What challenges do you anticipate you might face in leading a Number Talk? How could you use talk moves to better elicit or connect student thinking in your own teaching?

**Appendix B**  
**Number Talk Planning Sheet**

<p><b>Content Area:</b> Mathematics</p> <p><b>Grade Level:</b></p> <p><b>Standard:</b></p>
<p><b>Materials Needed:</b></p> <p>Students will not need materials</p> <p>White board and markers for the teacher</p>
<p><b>Number Talk Problem:</b></p>
<p><b>Objectives(s)</b></p> <p><i>What do you want students to learn through this activity? What is your mathematical goal?</i></p>
<p><b>Pre-Planning</b></p> <p><i>When you plan for a number talk, it can be helpful to brainstorm all of the possible strategies (right and wrong) that students are likely to come up with so you can anticipate how the conversation might go. What are all the ways students might solve your problem?</i></p> <p><i>Which strategies are you hoping to highlight?</i></p> <p><i>What might you say/do if a mistake or misconception comes up? Are there nudges you can give? Questions you can pose?</i></p>
<p><b>Facilitating the Number Talk</b></p> <p>Tips to get started:</p> <ol style="list-style-type: none"> <li>1. Remind students of your expectations for participating in the number talk</li> <li>2. Present the problem and give students silent think time</li> <li>3. As students about the answer and write possible solutions on the board (don't correct them)</li> <li>4. Consider how you will launch the discussion. You might either start with a turn and talk OR call on students to share their strategies. Use talk moves to help others understand the thinking of peers (what's the same? What's different?)</li> </ol> <p><i>Which talk move(s) will you focus on in this number talk?</i></p> <p><i>Which target strategy/connection do you want to end with? What do you want students to understand?</i></p> <p><i>What questions or prompts might you pose to help students get there?</i></p>
<p><b>Closure</b></p> <p><i>How will you have students help summarize their learning? What is the big take away/connection you want them to be able to articulate?</i></p>

## Appendix C

### Guided Inquiry Lesson Plan Template

<p><b>Content Area:</b> Mathematics</p> <p><b>Grade Level:</b></p> <p><b>Math Standards:</b></p> <p><b>Rationale (Why is this important?):</b></p>
<p><b>Materials Needed:</b></p>
<p><b>Objective(s):</b>  <i>What will your students be able to do by the end of the lesson? What is your mathematical goal?</i></p>
<p><b>Vocabulary</b>  <i>(What terms need to be introduced to help the students develop understanding of the topic discussed?)</i></p>
<p><b>Anticipatory Set</b>  <i>(How will you focus students' attention on the material? How will you build on prior knowledge and set a purpose for learning) Describe this in detail and be sure to state the learning objective. You're A.S. <b>could</b> include one of the following:</i></p> <ul style="list-style-type: none"> <li>*Number talk related to the concept</li> <li>*Daily Number Sense routine related to the concept</li> <li>*Read Aloud/Contextualized Problem/Open Ended Question to hook students' interest and activate prior knowledge</li> <li>*Other</li> </ul>
<p><b>Beginning of Lesson: Guided Inquiry</b>  <i>(How will you structure the task so that students can successfully engage in productive struggle? What supports will you provide? How will you check for understanding while students work?)</i></p> <p>Preparing for Inquiry:</p> <ol style="list-style-type: none"> <li>1. Identify a math task to launch the investigation. What tools, manipulatives, or resources will you provide to groups?</li> <li>2. How will students work on the problem – will you provide think time before having them work in pairs, for example? What directions and expectations will you provide?</li> </ol> <p>Guiding the Inquiry</p> <ol style="list-style-type: none"> <li>1. What strategies and ideas do you anticipate students may come up with? Which ones do you hope to focus on?</li> <li>2. Is there anywhere you think they might get stuck? If they do, what nudges might you offer or questions might you pose?</li> </ol> <p>Facilitating Discussion:</p> <ol style="list-style-type: none"> <li>1. Which strategies will you highlight and in what order? How might you display/model these representations for the class?</li> <li>2. What questions might you pose to help students make sense of peers' work? To help them see the mathematical connection or goal?</li> <li>3. Is there a specific strategy or representation you would like students to try out on follow up math tasks? If so, how would you unpack it for learners with another example? What would you say and do?</li> </ol>
<p><b>Middle of Lesson: Supporting Targeted Practice</b>  <i>(How will students apply the new skill/strategy in small groups or in a partner setting while receiving immediate feedback? What practice opportunities will be provided for students to explore the content?)</i></p> <ol style="list-style-type: none"> <li>1. What additional problems will you have students solve?</li> <li>2. What structures will you put in place to support learning? (e.g., continue working in pairs/groups, teacher supported practice)</li> <li>3. What additional questions or nudges might you have prepared to increase students' facility with the target strategy or representation?</li> </ol>

**End of the Lesson: Transferring Learning**

*(How will the students apply new skill/strategy independently?)*

1. If students are ready for independent practice, what will they work on? If they are not, what will you do (Pull a small group, continue intentional paired practice, etc.)?
2. Which problems might you use for more practice? *(Share an example or two of the problems to show alignment to the objective)* Will you do an exit ticket to see where individuals are in their understanding?

**Assessment Statement:**

*(How will you know that your students have met the learning objective?)*

1. What formative assessment techniques will you use to determine how well students met the mathematical goal of the lesson?

**Closure:**

*(How will you end this lesson and prepare students for the next lesson?)*

1. Consider how you might engage the class in a brief math talk/closing conversation to circle back to the learning goal. What is the big take away you want them to share with one another?