Using Practice-Based Teaching Experiences to Leverage Teacher Candidate Effectiveness

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Abstract: Concerns about the lack of connection between university-based teacher education courses and clinical experiences have long been shared. Practice-based teacher education has been offered as one way to connect these two aspects of teacher education closer together. However, descriptions about how to implement practice-based teacher education in ways that support student learning in clinical experiences is lacking. In response to this area of need, this article describes how two mathematics teacher educators implemented practice-based teacher education in their mathematics methods courses. One course took place in a university setting with a clinical component while the other took place during a mediated field experience, in which the course and clinical practice experiences took place in an elementary school. Implications and considerations for future school-university partner work are shared.

KEYWORDS: Practice Based Teacher Education, Elementary Mathematics Teacher Education, Mediated Field Experience, University and School Partnerships

NAPDS NINE ESSENTIALS ADDRESSED:
Essential 2: Clinical Preparation, A PDS embraces the preparation of educators through clinical practice.

Essential 8: Boundary-Spanning Roles, A PDS creates space for, advocates for, and supports college/university and P–12 faculty to operate in well-defined, boundary-spanning roles that transcend institutional settings

Introduction

"You could ask, 'How many vertices does the shape have?'" one of my students shared. "Oh, you can also ask them about the number of sides!" another student contributed. The teacher candidates were identifying different questions they could ask that would elicit and deepen their third-grade students' thinking about shapes. As we wrapped up the discussion, I asked my teacher candidates if they were ready to work with their third-grade math buddies – I was met with a very enthusiastic "Yes!"

The opening story exemplifies the enthusiasm that many teacher candidates (TCs) have about their field experiences and provides a small glimpse into the essential intentional preparation needed for TCs to support student learning during these clinical practice experiences. Research has shown that field experiences, a substantial portion of teacher education programs, provide important opportunities for teacher learning (Zeichner, 2010). Yet, one of the major challenges facing teacher education is the lack of coordination between the clinical and course work experiences (Campbell & Dunleavy, 2016; Zeichner & Bier, 2015). Such a lack of connection between these two aspects of teacher preparation programs lessens the potential growth for TCs and the impact TCs can have on student learning during their field experiences.

Concerns about a lack of connection between the field placements and university courses have been ongoing in teacher preparation programs (Wasburn-Moses, Kopp, & Hettersimer, 2012; Zeichner, 2010). A contributing factor to the disconnect between the clinical and coursework is that teacher education typically takes place in two distinct contexts, the university and in a school, with TCs responsible for navigating between the two settings (Britzman, 2003). Additionally, the classroom teacher in the clinic placement may be unfamiliar with the teaching methods taught in the university course and/or with methods for educating TCs (Zeichner, 2010). As a result, TCs may not receive the support in their clinic placement for translating or recognizing the practices learned in their coursework, such as the practices shared within mathematics methods course.

Further, teacher education courses have emphasized learning about teaching rather than centering the practice of teaching (Hurlbut & Krutka, 2020). As a result, TCs may only learn how to implement specific teaching practices if they happen to experience them in their field placement or complete a related assignment. TCs' development of the skills critical for effective teaching is then left up to chance (Forzani, 2014). Because classrooms and teaching styles vary widely, there is much variance in what TCs experience in their field placement.

Practice-based teaching has been advanced as one way to address the gap between university courses and field experiences and importantly bring the work of teaching to the center (Ball & Cohen, 1999). A practice-based approach to teacher education focuses on designing and implementing rich learning opportunities for TCs in university-based methods courses and field experiences (Ball & Forzani, 2009; Janssen et al., 2015). The intention of this approach is to more closely link the experiences within the university classroom and the clinic placement. Importantly, practice-based teacher education (PBTE) focuses on TCs acquiring the skills necessary to teach students in ways that support their learning (Peercy & Troyan, 2017) However; there is limited work that describes how teacher educators have engaged with practice-based pedagogies (Kazemi et al., 2016).

One risk that researchers have identified with practice-based teacher education is that an emphasis on core teaching practices can peripheralize equity and justice (Philip et al., 2019).

Recognizing this risk, we sought to ensure that our focus on practice-based teaching contributed rather than detracted from promoting equitable teaching practices in schools. Additionally, all of the PBTE work at our university is set in the context of equity-based teaching practices. The focus on equity aligns well to the National Council of Teachers of Mathematics' Principle of Access and Equity (NCTM, 2014), which contends that students need access to high-quality mathematics experiences aligned to grade-level Standards, qualified teachers, and supports that will contribute to all students' mathematics achievement and success. Gutierrez (2009) has argued that equity-based mathematics teaching includes experiences that develop learners' identity as learners and doers of mathematics, instances where learners have power to make sense of mathematics, access to high-quality teaching, and supports are put in place that leads to all students' mathematics achievement.

The purpose of this manuscript is to share how two elementary mathematics teacher educators integrated PBTE approaches set in the context of equity-based teaching practices to develop the mathematics pedagogies of TCs. The PBTE approach used by both mathematics teacher educators included rehearsals as well as strategically designed clinical practice activities, in partnership schools. First, we will present a background of PBTE and rehearsals. Then we will share two vignettes. The first describes how a mathematics teacher educator integrated PBTE pedagogies within a university-based mathematics methods course with intentionally-designed clinicals in partner schools. The second vignette describes how PBTE was infused within a mediated field experience (MFE). A MFE is an approach to teacher education that provides TCs with opportunities to engage with the instructional practices learned in teacher education courses in a real classroom with the support of a mathematics teacher educator (Pinter, 2021). The two vignettes of the teacher educators implementing PBTE will be used to highlight the ways that practice-based teacher education can support TCs in learning and improving their methods for teaching mathematics and importantly, how the TCs applied the methods to support student learning during clinical practice experiences in partner schools.

Synthesis of Related Literature

Overview of Practice-based Teacher Education

Over the past decade, there has been growing momentum for restructuring teacher education programs to focus on the practice of teaching (Ball & Forzani, 2009; McDonald et al., 2014). While the turn to PBTE is not new (Zeichner, 2012), some argue the current emphasis on core practices within practice-based teaching is a unique emphasis (Forzani, 2014). In recent work focused on PBTE, it is "less concerned with where teachers' training takes place and more with what teachers are helped to learn and how they learn it" (2014, p. 358). The emphasis on what and how TCs are learning can help to refocus teacher preparation on teaching the practices necessary to support student learning.

A model that describes the elements of PBTE is described in Table 1. Researchers at the University of Washington (Teacher Education by Design, 2014) as part of the Teacher Education by Design project conceptualized PBTE with the learning cycle that includes four stages: Introduce, Prepare, Enact, and Analyze. Each of these cycles was included in both the university-based and mediated field experience course sections described in this article.

Table 1
Learning Cycle of Practice-based Teacher Education (Adapted from TEDD, 2014)

Stage of the Learning Cycle	Description of the Stage
Introduce	Teacher educator introduces a teaching practice through modeling, analysis of video, or decomposing specific aspects of the teaching practice.
Prepare	TCs plan an instructional activity and get feedback on it. This includes the activity as well as questions they would pose. TCs rehearse (practice) teaching the lesson to a small group or whole group of colleagues. TCs receive feedback on specific aspects of their rehearsal.
Enact	TCs teach the instructional activity to students. TCs collect student work and/or other artifacts when possible.
Analyze	TCs reflect on their enactment using specific prompts focused on the instructional practice. TCs use student work and/or other artifacts to support their analysis of their enactment. The focus can be on their teaching and/or students' learning.

Eliciting and Interpreting Student Thinking

The core practices for PBTE were identified as commonly used teaching practices critical to student learning that cut across content areas and grade levels (TeachingWorks, 2020). One of the core practices is eliciting and interpreting student thinking (Gotwals & Birmingham, 2016; TeachingWorks, 2020; Shaughnessy & Borest, 2018a). While eliciting and interpreting student thinking is a practice used across content areas, this practice has been defined specifically for mathematics (TeachingWorks, 2020). The National Council of Teachers of Mathematics (NCTM; 2014) notes that "effective teaching mathematics uses evidence of student thinking to assess progress toward mathematical understanding" (p. 53). Such that teachers elicit student thinking beyond whether an answer is correct or not correct (Crespo, 2000) and respond to student ideas in ways that probe and further their conceptual understanding of mathematics (NCTM, 2014).

The process of eliciting and interpreting student thinking is important to the formative assessment process (Shaughnessy & Boerst, 2018b; Wiliam, 2007). Formative assessment is the process of gathering and analyzing information about student understanding related to a specific learning goal and then using this information to decide how to best move student learning forward (Black & Wiliam, 2009). Such a process is important for increasing student learning (Black & Wiliam, 2003). Teachers who effectively engage in the formative assessment process elicit and interpret students' thinking to assess student understanding, make-in-the moment instructional decisions, and also use this information to plan subsequent lessons (NCTM, 2014).

Since eliciting and interpreting student thinking happens in the moment and is responsive to student's mathematical thinking, it is a complex practice for TCs to develop (Colonnese et al., 2022; Shaughnessy & Boerst, 2018b). Research has shown that TCs who have increased

opportunities to learn and apply content specific teaching practices are more effective (Lustick & Sykes, 2006). Further, previous studies found that TC's skills related to eliciting and interpreting student thinking were possible to develop while teaching lessons in small groups instead of to a whole classroom of children (Polly, 2021). TCs also often desire and benefit from coaching and additional in-classroom support to help them pose tasks and questions that allow opportunities for them to elicit their students' thinking (Reinke et al., 2022). Thus, it is important for teacher educators to provide multiple opportunities for TCs to practice this teaching method and to draw connections between their university and school-based field placements.

Implementing Practice-Based Teacher Education

Grossman et al. (2009) identified three components necessary for teaching instructional practice: representations, decompositions, and approximations of practice. Representations refer to the different ways the practice is enacted. Decomposition is breaking the practice into parts for both teaching and learning and approximations are opportunities for TCs to engage in practices that are proximal to actual teaching practice. The three components offer an initial framework for designing rich learning experiences to engage TCs in the core practices such as eliciting and interpreting student thinking.

Rehearsals have been advanced as one kind of rich learning experience to engage TCs in the decomposition, approximation, and representation of the core teaching practices (Colonnese et al., 2022; Ghousseini, 2017; Polly et al., 2019). Rehearsals of teaching practice typically take about fifteen minutes and provide TCs with an opportunity to try out the practice with guidance from the course instructor before enacting this practice with students (Lampert et al., 2013). Because the rehearsals occur in the university classroom, the teacher educator can pause at important moments to help TCs realize specific aspects about the practice and discuss instructional decisions (Colonnese et al., 2022; Kazemi et al., 2016). The ability to pause also allows the TC to stop, ask questions, and confer with their peers and the course instructor. The brief discussions provide TCs an opportunity to consider different actions and the consequences of those actions.

In an analysis of rehearsals, Kazemi et al. (2016) shared three insights to leading rehearsals: fostering a culture of making practice public; opportunities for approximations and enactment in the actual classroom of the instructional activities; and the proximity of the rehearsal and enactment with students. Designing rehearsals with these three insights can help to maximize the potential for TC learning and refinement of the instructional practice. Important to leading the rehearsal is the intentionality of the experience including the activities that happen before and after the rehearsal, the instructional activity selected, and the choices made in the moment by the teacher educator.

Our aim is to describe how we used rehearsals, using vignettes, in two different structures of mathematics methods courses to highlight how we supported our TCs in developing their ability to elicit and interpret student thinking. We share these vignettes to provide other teacher educators with examples as to how rehearsals can be implemented with the common purpose of improving TC practice and their potential to support student learning in clinical placements.

Description of Practice-Based Teacher Education Activities

Context for Our Work

The vignettes shared in this article are situated within the first of two mathematics methods courses in a teacher education program that prepares individuals to teach elementary school (Grades Kindergarten through Grade 6). TCs typically take 5 courses during this semester: the mathematics methods course, a literacy course focused on phonics and early literacy skills, a course on diversity and multicultural education, a child development and learning theory course, and a course on instructional planning and assessment. The first mathematics methods course focuses on mathematics content and pedagogies for primary grades. As a college, we elected to focus on three core practices, eliciting and interpreting student thinking, small group work, and whole class discussion. Then within our department we decided the first mathematics course, which is the focus of this article, would focus on eliciting and interpreting student thinking because we saw this as foundational to the other two practices. The vignettes shared in the next section are from two different sections of the first mathematics methods course (Section A and Section B). The teacher educators of the two courses co-designed the course with one other mathematics educator and regularly collaborated and shared instructional activities.

University-Based Mathematics Methods Course

Section A of the mathematics methods course took place at the university with an intentionally-designed clinical practice component in partner schools. Section A had 21 TCs. The TCs met three times a week for fifty minutes for in-person activities. As part of the clinical practice experiences, TCs completed 30 hours of activities that included mathematics and literacy. The mathematics activities are described in Table 2.

Table 2

Clinical Practice Activities in University-based Mathematics Methods Course

Clinical Activity	Description
Observations	Observe 2 mathematics lessons and complete a form in which you describe the mathematics tasks, the actions of the teacher, the grouping of students (whole group, small group, partners).
Assessment of 2 students	Complete 2 number sense assessments with 2 students each. Students should vary in terms of their performance in mathematics class.
Teach a number talk	Teach the number talk (dot images or equations) that you rehearsed during class. Reflect on students' responses and the extent to which you elicited student thinking.
Small Group Problem Solving Lessons (3)	Teach the same small group (3 to 5 students) 3 lessons focused on word problems. You should adjust future lessons based on student performance in your lessons.
Teach a notice/wonder/do OR a 3 Act Task	Use the library of 3 Act Tasks (gfletchy.com) OR use your own picture/video to teach a notice/wonder/do or a 3 Act Task to students.

Mediated Field Experience

Section B of the mathematics methods course was part of a MFE. The MFE took place at a local elementary school to strategically connect the university-based instruction with the expertise of the school-based educators (Zeichner, 2010). The 23 TCs met twice a week for an hour and fifteen minutes. The course instructor engaged the TCs in learning and practicing mathematics methods for forty-five minutes and then the TCs spent thirty minutes working with second- or third-grade students. The TCs started the semester working one-on-one with a student and then transitioned to teaching a small group. The classroom teachers and the course instructor selected this structure because the TCs were at the initial stages of learning methods for teaching mathematics. As a result, one student would allow the TCs to try out methods for eliciting student thinking and find out what worked for their particular student without also managing a small group. The teachers and course instructor also felt this was an important opportunity for the TCs to develop positive relationships with the students and for the students to receive one-on-one instruction. The mathematics activities are described in Table 3.

Table 3
Clinical Practice Activities in the MFE Course

Clinical Practice Activity	Description
One-on-one tutoring	Work with an assigned math buddy to support mathematics learning. Responsible for eliciting and interpreting student thinking. TCs complete a weekly log to record their observations.
Observation	Observe the course instructor teach a whole class lesson. Participate in a class discussion to identify the tasks, questions used to elicit student thinking, and analyze why instructional decisions were made during the lesson.
Assessment of 1 student	TCs complete two one-on-one assessments with one student. The first assessment focuses on fact fluency and the second assessment on problem-solving. TCs reflect on their ability to elicit student thinking. TCs interpret and analyze the information gathered through the assessment.
Small Group Problem Solving Lessons (6)	TCs collaboratively analyze their assessment results. TCs then made groups of 2-3 students, using their assessment data and knowledge of the student, to plan six lessons to teach. The TCs were each responsible for being the lead teacher for three of the lessons and serving as an observer focused on what students are doing for the other three of the lessons. TCs adjusted lessons based on student needs.
Mathematics Game	TCs develop a mathematics game based on the concepts and skills they have identified as areas that their students need extra support. TCs will identify the big mathematical idea and questions to ask students as they play the game to elicit mathematical understanding.

Table 4 provides an overview of one of the PBTE learning cycles that occurred during Section A and B of the mathematics methods course. There were several PBTE cycles that the TCs engaged in throughout both mathematics methods courses. We decided to describe the number talk in Section A and the one-on-one interview in Section B because they each represented two different kinds of instructional tasks that can be used during a PBTE learning cycles. Our intent was to demonstrate the different ways that the instructional tasks offered TCs opportunities to rehearse, practice, and receive feedback on eliciting and interpreting student thinking.

Based on the current research and our initiatives in our educational preparation program we decided to examine TCs experiences. We framed this examination around the broad research question: What did TCs report about their experiences during PBTE learning cycles and clinical experiences teaching mathematics to elementary school students? In the rest of this article, we briefly describe the methods of examining TCs experiences as well as vignettes based on the data collected during the experiences.

Methods

Since the current research states that there is potential and benefit to both field mediated course experiences and intensive, intentionally-designed clinical practice activities the goal of this article is to not directly compare the two approaches. Additionally, our goal with this paper is to provide a description of what TCs did and their experiences. Therefore, in the following section we share a vignette from Section A that further describes the word problem learning cycles as well as a vignette from Section B that describes the one-on-one interview. We selected these vignettes to demonstrate the different ways that TCs can be engaged in the PBTE learning cycles. In each vignette we share the stages of the learning cycle and take-aways from our TCs.

Since the authors were also the course instructors, the data sources for these vignettes came from course instructor's instructional materials housed in the university's Learning Management System as well as course assignments that TCs completed. The primary assignment that was used was TCs reflection about their clinical field experiences.

Table 4
Description of the Learning Cycle in these Vignettes (Adapted from TEDD, 2014)

Stage of the Learning Cycle	Course Section A (university-based)	Course Section B (MFE)
Cycle 1	**Number Talks**	**One-on-One Interview**
Introduce	● Number talks were modeled and facilitated by the course instructor four times. ● The decomposition of eliciting and interpreting student thinking (TeachingWorks, 2020).	● Strategies for eliciting and interpreting student thinking were modeled and discussion about them facilitated by the course instructor during the prior five weeks. ● TCs engaged in readings focused on strategies for solving addition, subtraction, and multiplication facts.
Prepare	● TCs planned number talks and collaborated to brainstorm questions that they would ask. ● TCs rehearsed them using simultaneous rehearsals during class.	● TCs prepare for one-on-one interviews in a simulated interaction with peers. ● TCs plan using the support of a planning tool
Enact	● TCs taught number talks to students in their clinical experience. Nearly all TCs did this in a small group setting, but a few opted to facilitate a whole class number talk.	● TCs conduct a one-on-one interview with a student focused on eliciting the students' thinking about how to solve addition, subtraction, and/or multiplication facts. ● TCs listened carefully, recorded student thinking, and responded to student ideas.
Analyze	● TCs shared during class meetings how the experience went. ● TCs reflected on questions that they asked to elicit thinking and the extent to which students' responses influenced either follow-up questions or the modification of the next part of the number talk.	● TCs shared in the following class meeting about the questions they asked to elicit student thinking and how that influenced their follow-up questions. ● TCs collaboratively interpreted the information gathered from the assessment and discussed next steps for the students.

Vignettes from Both Course Sections

Vignette from University-based Mathematics Methods Course

It was week 8 of the course and there were three 50-minute class meetings left until the TCs were going to begin teaching their problem-solving small group lessons in our partner schools. Intentionally, the course instructor had focused on three goals for the week to focus on maximizing the likelihood that TCs would positively impact students' learning when they taught their lessons: (1) revisiting aspects of equity-based teaching, (2) Providing opportunities to interpret student thinking and make decisions about future tasks, and (3) rehearsing the lesson with a focus on eliciting and interpreting student thinking.

Revisiting Aspects of Equity-based Teaching

Gutiérrez' framework for equity (Gutiérrez, 2009) is front and center in this section of the course. From the first meeting, we unpack the dimensions of access and power as priority aspects, and also address the other dimensions achievement and identity. From a problem-solving perspective during weeks 5 through 7 we spent time discussing how commercial curricula often do not give students access to high quality learning opportunities and that we need to be intentional on how we introduce and teach word problems in a way that gives students agency and power to make sense of the mathematics in their own way.

During Week 8 we evaluated problems from a commercial curriculum and discussed ways to modify the problems to increase access and power. We also spent time reading an article and discussing ways that we can pose questions to students who are starting problems, working on problems, or have finished a problem, in order to elicit their thinking and start to interpret students' understanding and performance (Jacobs & Ambrose, 2008).

Providing Opportunities to Interpret Student Thinking

During Weeks 6 and 7 TCs spent time writing or modifying word problems from the course instructor's problem-solving website. For each lesson they worked with other TCs during class to discuss ways to increase access or increase rigor of tasks word problems on student thinking and/or their work on the first word problem in a lesson. TCs observed and practiced strategies such as adjusting the size of the numbers in the problems, providing access to more hands-on manipulatives or encouraging students to solve a problem using both manipulatives and paper-pencil strategies, and modifying the complexity of language in the word problems.

The focus on eliciting and interpreting student thinking had been central in the course all semester. Previously in clinical practice experiences TCs spent time observing the extent to which their clinical educators elicited student thinking and modified problems or how they taught based on students' thinking and/or performance. Further, during course activities TCs looked at student work and discussed what subsequent problems and teaching strategies should be used. While this work had been done before, TCs had not been in a position where they needed to do this immediately in the moment of teaching until the rehearsal in Week 8.

Rehearsing the Lessons with a Focus on Eliciting and Interpreting

In Week 8 when TCs were rehearsing lesson plans, this was the second formal rehearsal where everyone in the class was rehearsing, but it was the third time where candidates had

rehearsed posing and teaching word problems using a launch-explore-discuss format. In each of the previous times, I, as the course instructor, had posed a word problem using a fish bowl format where a half-dozen TCs were at my small group table role playing elementary school students and the rest of the class was around us. During these fish bowl rehearsals, I would pause and ask everyone to talk to each other about what teacher moves I had just done and why. I also would ask them what I should likely do next. After those conversations I would "tag out" and "tag in" a TC to take over my small group. We would continue this for two-word problems which would last approximately 10 to 15 minutes.

In Week 8, though, TCs were simultaneously rehearsing so that all TCs were able to practice during the 50-minute class period. TCs came with one of the word problems that they had written along with questions to ask. At each table were counters, base ten (place value) blocks, and paper if they were needed. This rehearsal was different from previous ones where one TC at each table role playing as a student would make an error or demonstrate a misconception related to doing the wrong operation or incorrectly counting. Through the fish bowl modeling and rehearsals previously TCs had seen, practiced, and talked about ways to support students through their misconceptions. During Week 8 all TCs had the opportunity to practice this work with one of the word problems that they were posing to their students.

Take-Aways from Clinical Practice Experiences

In their project reflections, TCs mentioned a few common take-aways from the number talk enactment as they prepare to think about their enactment of their number talks with elementary school students.

First, students made comments about the strengths of their students. One TC, who worked with Kindergarteners mentioned, "I was so impressed that my group, which has misconceptions during whole class lessons, really did well making sense of the visuals and making connections to addition." Other comments focused on the strengths of students being able to explain what they were seeing, talk about both visuals and equations, and "make connections between the different pictures."

Thinking about future experiences, TCs reported the need to plan for a wider range of difficulty. Some TCs that reported that the number talk activity was too easy for students and it did not last long at all since it was not challenging. A TC who worked with second grade students commented,

> I had 3 pictures of dots to focus on addition. They finished so quickly. I had to come up with questions on the spot where they compared the pictures. I am glad that we had at least talked about that in class.

Others reported that the number talk activity was too challenging and they had to help their students a lot or modify the activity in the middle of teaching. One candidate who worked with first grade learners wrote, "Even though I used the questions that we had practiced they just stared at me and I had to ask questions multiple times and provide a lot of help."

Additionally, TCs mentioned the benefit of rehearsing and practicing the number talk. No one reported that they were nervous or uncomfortable teaching their number talk, but a few mentioned the uncertainty of not knowing how to respond to students' answers and thinking. This take-away supports the idea and need for more explicit course activities about the possible

range of student responses and possible responses that will increase the likelihood of student learning.

Vignette from a Field Mediated Mathematics Methods Course

Prior to the start of the MFE Mathematics Methods course the course instructor collaborated with the second- and third-grade teachers to identify the concepts of fluency with addition/subtraction and multiplication/division facts as two areas where a majority of their students needed extra support. We also identified second and third graders who could benefit from one-on-one instruction and paired them with a TC to be their math buddy. To help the TCs understand where to begin instruction with their math buddy, they first administered a one-on-one assessment to help them identify the facts that the TCs should focus on during their small group instruction. Importantly, the assessment provided the TCs an opportunity to apply the skills needed to elicit and interpret student thinking.

The two weeks prior to the one-on-one assessment, the course instructor structured the course activities around three goals to introduce and prepare the TCs. The goals included: (1) develop a positive relationship and recognize student strengths; (2) build an understanding of fact fluency and grade level expectations; (3) rehearse the interview using strategies for eliciting and interpreting student thinking. The goals were identified to maximize the effectiveness the TCs would have when assessing their students and in interpreting their student's thinking. During Week 6 of the course, the TCs administered the one-on-one assessment and then interpreted the results.

Prepare the TCs for the Assessment

To build rapport prior to the assessment, the TCs worked one-on-one for two weeks with their assigned second- or third- grade math buddy. During this time the TCs supported their math buddy with their regularly planned mathematics activities. The emphasis during the first few weeks of the experience was to build a positive relationship with the student and understand how the student learned best. The TCs recorded insights they learned about the student in a weekly log. TCs were also encouraged to reach out to the classroom teachers who worked with their assigned student to learn more about the strategies that were most successful for helping the student learn. One TC recognized during the first two weeks of working with her student, that her student was more successful when he knew a strategy to solve and had ownership in the activity. She used this insight during her one-on-one assessment. Instead of asking the student the facts, she provided all of the facts and had the student choose which ones to work on first. After having the opportunity to select several facts and successfully solving them, the student readily worked through the more challenging facts they had yet to answer with their TC.

In addition to building a positive relationship with the students, it was also important for the TCs to develop a strong understanding of computational fluency. The TCs understanding of computational fluency would help inform the kinds of questions they could ask their students and to interpret their students' thinking. In the two weeks prior to the assessment, the TCs read two articles, "Developing Computational Fluency with Whole Numbers" (Russell, 2000) and "Enriching Addition and Fact Mastery Through Games" (Bay-Williams & Russell, 2014). The first article provided the TCs with a background on what it meant to fluently compute and the second article was to help TCs understand the phases of learning basic facts. Next, the TCs

unpacked grade-level standards and created short videos explaining different strategies for solving the basic facts and why they might use that particular strategy.

Rehearsing and Enacting the Assessment with a Focus on Eliciting and Interpreting

To support the TCs with eliciting student thinking during the assessment, the TCs were introduced to the talk moves (Chapin, O'Connor, & Anderson, 2013). The talk moves were shared with the TCs to support them in facilitating a productive discussion. The TCs were also given instructions to ask their math buddy questions such as: "How did you figure that out?". The TCs were provided with the facts for the assessment and were responsible for modifying the order and which facts they asked their math buddy depending on how their students responded.

The TCs simultaneously rehearsed the fact fluency assessment with one of their peers. The TCs worked in groups of three to rehearse the assessment. This was the first formal rehearsal for the TCs. One peer was tasked with being the "student", the other the "teacher", and the third peer was asked to observe the interaction and then offer feedback. After about ten minutes, the peers switched roles. The "student" solved the facts they were given using strategies that they had read about and seen their math buddy using. The "teacher" asked the "student" how they solved and asked follow-up questions as needed. While the TCs were rehearsing, the course instructor monitored the groups, listened to the ways the TCs were eliciting student thinking, and provided coached feedback. After the TCs rehearsed, the course instructor shared several aspects she noticed related to eliciting and interpreting student thinking.

After the TCs rehearsed the fact fluency assessment, we went to the second and third grade classrooms and the TCs administered their assessment. The course instructor and the classroom teachers were able to observe the TCs engaging their students in the assessment. We provided in-the-moment feedback to help support the TCs in eliciting student thinking. The TCs recorded the strategies the student used to solve and made any additional notes on the record sheet.

Analyzing Student Thinking

During the following class, the TCs met in small groups of their peers to collectively analyze and interpret the information on their record sheets. The goal of each group was to identify a mathematics fact that they would select for their math buddies if they were to lead a number talk. The purpose of having the TCs think about the fact they would select was to help them closely analyze which facts their student answered correctly or incorrectly and what strategies their students used. One group of TCs chose the equation 5 x 7 for their number talk because many of the students that they interviewed had struggled with the five facts and the group knew that counting by fives was important for solving other facts. One of the TCs in this group mentioned that her student knew this fact but recognized that the student did not yet see the relationship between 5 x 7 and 7 x 5. The class was then able to discuss why it would be helpful for the number talk to have 7 x 5 as the follow-up equation.

The TCs were then involved in a second rehearsal focused on leading a number talk using the fact they identified. The purpose of this rehearsal was to help the TCs work through some of the challenges they encountered when eliciting their student's thinking during the assessment. The TCs worked with their peers to identify several strategies their students would use to solve the equation. TCs also had to anticipate at least one developing idea or misconception. Two of

the groups were then selected to rehearse in front of the class. One of the group members was the teacher and the other members of the group acted as the students using the strategies they had discussed. The TCs not in the presenting groups were able to participate, observe, and/or ask questions.

Throughout the rehearsal, the TCs were very engaged. Notably, when the developing idea was shared, we paused for several minutes to discuss how to help a student work through a developing idea. The TCs had questions such as, "How could you encourage the student to try another strategy?" and ideas about how to respond like, "You could ask someone who solved in a different way to share". The rehearsal of the number talk differed from the rehearsal of the one-on-one assessment because the TCs were able to use the recent experiences they had with their students to help them think about how students might respond and interact and also encouraged them to ask authentic questions that reflected their own experiences. As we concluded the rehearsal, the TCs noted that they felt more prepared to work with their students in small groups.

Take-Aways from Clinical Practice Experiences

The TCs shared how much they enjoyed administering the one-on-one assessment. For example, one TC shared that this helped them learn a lot about their second-grade math buddy and their thought process. Further, the TC explained that it gave them a strong idea about the content needed to be addressed to help develop their student's mathematical understanding. Another TC shared that they wanted to continue working with their third-grade math buddy one-on-one so that they would be able to provide lessons specific to their students' needs. They also shared, based on the assessment results, that they needed to regularly incorporate fact fluency games because that was something their students shared that they enjoyed and helped them to want to participate in the activity.

Several TCs described how they learned a lot about their student's strategies for solving. One TC shared that to multiply their student used a representation to model the multiplication expression. For example, the student represented 4 x 6 by drawing four circles and then drawing six dots in each circle. The student then counted each dot to find a product of 24. While the TC recognized that the student was successful in solving, the TC shared that they wanted their student to use more efficient strategies such as derived facts.

Because I was able to observe several of the TCs administering their assessment, I also had the opportunity to provide in-the-moment coaching such as suggesting follow-up questions for the TCs to ask and reminding TCs to use the talk moves (Chapin, O'Connor, & Anderson, 2013). I specifically reminded the TCs of the talk moves wait time and re-voice to encourage the TCs to give enough time for their student to respond and help the TCs accurately document the information they were gathering.

One difference I noticed between the MFE and a traditional methods course was the rehearsal after the one-on-one interview. The rehearsal was much more closely related to what actually happens in the classroom. The TCs were able to use what they had seen their students doing to accurately portray them during the rehearsal so that we had an opportunity as a class to talk through different ways elicit the student's thinking, interpret the student response and identify different ways to respond.

Implications and Considerations for Future Partnership Work

In the context of School-University Partnerships both of these vignettes bring to light multiple implications and considerations for future partnership work as well as future research. We have focused this section on preparing TCs for clinical practice experiences, the benefit of intentional and purposeful rehearsals, and opportunities for future research.

Preparing TCs for Clinical Practice

One of the key takeaways that we have noticed in the last few years was the need for partnership schools for clinical practice that give TCs freedom to learn by teaching mathematics in ways that align to the practices taught in education courses. Even in classrooms in which clinical educators were using scripted mathematics textbooks that did not support equity-based teaching, the process of teaching lessons to only a small group of students led to opportunities for TCs to enact lessons using the launch-explore-discuss model and gain opportunities to elicit and interpret students' thinking (Polly, 2021; Polly & Holshouser, 2021). Teacher education programs need partner schools with clinical educators that will allow their TCs to enact pedagogies that align with what they are learning in their education courses (Winitzky & Arends, 1991; Polly, 2021).

In addition to partner schools that give TCs freedom to teach in specific ways, there is a need to also structure course activities in ways that get TCs as prepared as possible for what they will experience in their clinical practice. For example, if there is a likelihood that TCs will be working with students who are developing their mathematical thinking and reasoning skills there is a need for preparation to include time to learn about strategies to support that population of students. This preparation includes equipping TCs with content- and concept-specific strategies and common misconceptions so that they can notice them and readily adapt their lesson as needed (Polly, 2021). The strength of strong school-university partnerships is that teacher educators should have a clear idea on the types of environments that TCs will be enacting lessons and can prepare them to be successful (Putman et al., 2021).

Further, identifying the concepts and skills where the students in the clinical setting need extra support can provide a space for TCs to contribute to student learning. In the MFE, the classroom teachers and mathematics teacher educator were able to identify computational fluency as an area where the students needed additional support. The mathematics teacher educator could then create experiences for the TCs that would address computational fluency. In both vignettes, student needs are placed at the center of the partnership. Students should be the primary beneficiaries in the school-university partnership (Walsh & Backe, 2013).

Intentional and Purposeful Rehearsals

While the ideas of practice-based teacher education have been discussed now for over a decade (Ball & Forzani, 2009; Kazemi et al., 2016) there is growing empirical evidence about the need for these experiences to be intentional and purposeful (Colonnese et al., 2022; Shaughnessy & Boerst, 2018). The intentionality and specific purposes of these experiences in methods courses increases the likelihood that TCs will enact specific practices and pedagogies in desired ways and positively influence student learning (Colonnese et al., 2022). During the first vignette in the university-based methods course the course instructor intentionally had TCs rehearse one of the word problems that they would be posing and had the other TCs role play

both correct students and students demonstrating misconceptions. This idea of addressing misconceptions during rehearsal, in past semesters has anecdotally provided TCs with at least an idea of what to do during clinical practice experiences when they are teaching elementary school students and a misconception is brought to light. Meanwhile, in the MFE in the second vignette the course instructor had the TCs engage in a rehearsal after their assessment to help think through some of the challenges the TCs experienced and to prepare them for their first lesson. In past semesters, TCs have anecdotally shared that it is difficult for them to authentically identify what students might say during the lesson. Other mathematics teacher educators have noted similar findings (e.g., Spangler & Thrasher-Hallman, 2014; Kim, 2011). Because the TCs had been able to access various students' thinking first, this enabled them to accurately represent student responses and grapple with different ways to respond.

As teacher educators continue to think through the implementation of aspects of practice-based teacher education, including the stages of the learning cycles, and the use of rehearsals, there is a need to consider what the goal of the rehearsals are. Further, there is a need to consider how to structure the planning of instructional activities and associated preparation before the rehearsals in ways that best support TCs developing of skills and knowledge related to specific instructional practices (Colonnese et al., 2022). In the case of both vignettes there was an intentional decision to focus solely on the high-leverage teaching practice of eliciting and interpreting student thinking. By focusing only on one practice for multiple rounds of the practice-based teacher education learning cycle TCs have multiple opportunities in courses and during clinical practice experiences to hone their ability to enact this.

Opportunities for Future Research

From our current work with PBTE described in this article, we envision several opportunities for future research. First, since we implemented PBTE practices in both a university-based setting and as part of a MFE, it seems worthwhile to understand how the different contexts for teacher education influenced TC development of knowledge and skills related to the emphasized instructional practice of eliciting and interpreting students' thinking. These findings can advance the field related to the structure of teacher education programs and related clinical practice experiences. Further, since MFEs are not always feasible, it is necessary to better understand what aspects from this experience are impactful for TC development so those aspects may be able to be translated to a university-based course.

Subsequent areas of research include identifying the different course activities and their influence on TC's development. The two vignettes provided varied ways to develop TCs skills and knowledge related to eliciting and interpreting student thinking in various ways. Since these assignments all focused on that high-leverage teaching practice (or core practice) it would be helpful to understand how each activity contributes to the overall development of TCs knowledge and skills. Ultimately, the clinical experience of the TCs should benefit the students that they are working with, so it is necessary to create both university- and clinical-based experiences that will maximize the effectiveness of the TCs.

Within that goal the quality of the school-university partnerships is a critical variable. In the case of the MFE the course instructor had worked with the principal and university department leadership to have the course and the clinical practice experience all take place in the elementary school. In the case of the university-based methods course, TCs completed their

clinical practice experiences in partnership schools who were committed to allowing TCs to complete the courses' assignments. Further research should also consider how the clinical educator (i.e., mentor teacher) influences TCs perceptions and development of their knowledge and skills.

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