Examining the Influence of Practice-Based Teacher Education Approaches on Primary Grades Teacher Candidates' Development of Inclusive and Equity-Based Mathematics Teaching

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ABSTRACT

This article proposes the construct of Inclusive and Equity-Based Mathematics Teaching (IEBMT), a synthesis of theory and research for effective mathematics teaching for all students. There is a critical need for educator preparation programs to intentionally design course activities and clinical practice experiences to provide teacher candidates (TCs) with ample, worthwhile experiences to develop the knowledge and skills required to be an effective teacher for all students. The study examines how practice-based teacher education (PBTE) approaches in two elementary education mathematics pedagogy courses influenced TCs enactment of IEBMT. The inductive analysis of teacher candidates' projects and reflections indicated that they were adequately prepared to support learners who had knowledge of the counting sequence and were able to accurately count a set of 5 objects. However, teacher candidates reported and demonstrated in their project a desire and a need for further opportunities to develop classroom-based skills at observing or listening to primary grade learners and quickly making effective instructional decisions about future activities and questions based on what they notice. The article concludes with implications for both course activities and clinical practice experiences for teacher candidates to support their capacity to teach mathematics effectively.

KEYWORDS

Early childhood education, elementary education, mathematics education, problem solving

Introduction

Framing Inclusive, Equity-Based Mathematics Teaching (IEBMT)

There is compelling evidence that early childhood learners (Pre-Kindergarten through Grade 2) vary in their mathematics achievement based on multiple factors, such as their previous opportunities to learn, access to effective teachers teachers and research-

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-based learning experiences, as well as ethnic and racial backgrounds (Domingo-Martos et al., 2022; Musu-Gillette et al., 2017). This article includes inclusive and equity-based mathematics teaching (IEBMT), a synthesis of empirically- and theoretically-based constructs designed to support learning for all students (Table 1). IEBMT includes two primary pillars: 1) Access to grade-level aligned, research-based experiences and 2) Opportunities for the exploration of problems embedded in meaningful contexts. Within each of those pillars, there are two aspects, for a total of four aspects.

Access to Grade Level-Aligned, Research-Based Practices

Aligned to grade-level content. All learners deserve access to grade-level aligned, research-based practices (Musu-Gillette, et al., 2017; Unbound Ed, 2021a). For those learners whose data suggests that they need learning experiences on concepts from previous grade levels, learning activities should serve as access points to grade level content, and be clearly evident to grade level concepts (Unbound Ed, 2021b). Historically, studies have found that students whose data suggests that they lack foundational concepts often do not receive opportunities to engage in grade-level activities (Liljedahl, 2020; Unbound Ed, 2021a).

Therefore, early childhood teachers and TCs must be equipped with the knowledge and skills related to knowing characteristics of grade-level aligned and developmentally appropriate activities. Further, teachers and TCs need to know how to modify activities so that they align to grade-level concepts and provide access to all learners (Bostic et al., 2021; CAST, 2024; National Association for the Education of Young Children [NAEYC], 2020).

Access to research-based practices. Additionally, early childhood TCs must be given opportunities to learn what supports are research-based and how to use them in a way that supports learners' development (NAEYC, 2020; Zhang & Cutler,

Table 1

Aspects of Inclusive, Equity-Based Mathematics Teaching

Pillar	Aspect	Description
Access to grade-level aligned, research- based experiences	Alignment to grade level content	Learners should engage in activities aligned to current grade-level Standards (Gutiérrez, 2009; NCTM, 2014; Unbound Ed, 2021a). Concepts prior to grade-level Standards should be connected to grade-level concepts (Tomlinson, 2017; Unbound Ed, 2021b)
	Access to research-based experiences	Learners will engage in activities that are aligned to research-based teaching practices proven to increase student learning and achievement (Cioè-Peña, 2017; Gutiérrez, 2012).
Opportunities for the exploration of problems embedded in meaningful contexts	Exploring problems	When appropriate, learners will explore problems and select the strategies that they will use to solve problems (Buchheister et al., 2019; NCTM, 2014). Gutiérrez (2009) describes this as Power.
	Meaningful mathematics contexts	Learners engage in activities that are contextualized in real-life situations that are meaningful to learners and build upon their cultural and academic assets (Buchheister et al., 2019; Chao et al., 2015; Domingo-Martos et al., 2022).

2024). Part of the process of preparing TCs to enact IEBMT with young learners in mathematics is ensuring that they are prepared to incorporate hands-on, concrete learning experiences with manipulatives to support children's understanding of mathematics concepts (NAEYC, 2020). Piaget (1952) posited that young learners must first experience mathematics using concrete objects before learning mathematics with pictures and abstract symbols. Early childhood teacher education programs need to ensure that TCs know how to use manipulatives, when to use them, and when to help students transition to pictures and abstract symbols (Zhang & Cutler, 2020). This includes ensuring that TCs are aware of various levels and progressions of learning mathematics concepts including the use of concrete manipulatives, pictorial representations, and the use of abstract symbols.

Opportunities for Exploring Problems Embedded in Meaningful Contexts

The second pillar of IEBMT focuses on providing learners with opportunities to explore problems, when appropriate, that are embedded in meaningful contexts.

Student exploration of problems. Syntheses of research indicate that students benefit by having meaningful experiences to explore mathematics concepts and develop a solid understanding of content before learning specific procedures (NCTM, 2014; Sinha & Kapur, 2021). The process of providing learners with opportunities to explore and the autonomy to choose strategies does not mean that learners have free reign while the teacher sits back. Rather, students use mathematics tools (e.g., manipulatives, paper/pencil for drawings or symbolic work) and explore problems while the teacher scaffolds and guides them with specific questions and feedback (Buchheister et al., 2019; NCTM, 2014). In her influential work on equity-based mathematics practices Gutiérrez (2009, 2012) referred to this idea as giving students Power, and recommended that teachers give learners opportunities to explore and the freedom to select which strategies they want to use to solve problems that are relevant to them. Syntheses of research find benefit in allowing students to engage in productive struggle (failure) prior to discussions of specific strategies of solving problems (NCTM, 2014; Sinha & Kapur, 2021).

Activities in meaningful contexts. Additionally, these activities must be relevant to learners and embedded in meaningful contexts that learners can relate to (Unbound Ed, 2021a, 2021b). Constructs, such as culturally responsive teaching, are grounded in evidence that students are more likely to persist and engage in challenging activities when they are grounded in relevant contexts related to their cultural assets and interests (Paris & Alim, 2017). Similar to the other aspects of IEBMT, teachers and TCs need opportunities to develop knowledge about their students' cultural assets and interests of their students (Domingo-Martos et al., 2022).

Context of Educator Preparation Programs

There have been long-running recommendations to intentionally align the course work within educator preparation programs, teacher candidates' (TCs) clinical practice experiences, and the actual work done daily by teachers (American Association for Colleges of Teacher Education [AACTE], 2016; Putman & Polly, 2021; Zeichner, 2021). Historically, research has documented discrepancies between what TCs experience during education courses, specifically those focused on pedagogies, and their experiences with clinical practice in school settings (Zeichner, 2021). Additionally, recommendations in the past decade have explicitly asked for educator preparation programs to intentionally prioritize the design and implementation of clinical practice experiences that are intended to provide TCs with worthwhile, intensive but supported opportunities to plan instructional activities, teach them, and then reflect on their experiences (AACTE, 2016; National Association for Professional Development Schools, 2022).

This study frames early childhood education broadly to encompass education for learners from Birth through Grade 3 with a specific focus on learners in Grades Kindergarten through Grade 3. In teacher education this involves clinical practice experiences occurring in multiple settings including early childhood education centers, community centers, as well as formal schools which often start in the United States in Pre-Kindergarten or Kindergarten.

When considering the preparation of early

childhood educators, scholars speak to the essential nature of intentionally aligning course activities with clinical practice experiences is critical (Burns et al., 2016; Zeichner, 2021; Putman & Polly, 2021). Historically, university-based course instructors include research- and theory-based approaches to teaching that do not align to what TCs are observing in PK-12 school settings (AACTE, 2016). Additionally, the clinical practice activities that TCs engage in in classrooms do not include the depth needed to adequately prepare them for full-time student teaching internships as well as having their own classroom (AACTE, 2016).

Early childhood TCs who hope to work with primary grade learners need ample experiences working with and learning about children in clinical practice settings in classrooms (Matengu et. al., 2020). These clinical practice activities should include both informal time in classrooms observing and interacting with children as well as more formal opportunities to co-lead or lead instructional activities and reflect on their experiences.

Practice-Based Teacher Education

Practice-based teacher education (PBTE) is a construct used to describe four phases to prepare TCs to learn about and enact research-based pedagogies (Grossman et al., 2009). Table 2 describes the four phases of PBTE: Learn, Practice, Enact, and Reflect (McDonald et al., 2013). McDonald and colleagues wrote in their introductory article about the learning cycle (p. 382),

> This cycle intends to offer guided assistance to candidates to learn particular practices by introducing them to the practices as they come to life in meaningful units of instruction, preparing them to actually enact those practices, requiring them to enact the practices with real students in real classrooms, and then returning to their enactment through analysis. Depending on the goals and purposes of the teacher educator, it is possible to start this learning cycle in any of its four quadrants.

Table 2

Phases of Practice-based Teacher Education

Phase	Description
Learn	Learn research-based pedagogies by participating as learners in an example lesson, watching videos, and/or other experiences.
Prepare	Prepare to enact the research-based pedagogies with young learners. This may include selecting activities, writing lesson plans, and rehearsing/practicing teaching with peers (aka other TCs) and receiving feedback on their rehearsal.
Enact	Enact research-based pedagogies with students in a school setting. This experience may include the collection of artifacts from the enactment such as student work samples, audio recordings, video recordings, or observation notes from an observer.
Reflect	Reflect on the enactment based on TCs' experiences, student data, or recordings of the enactment.

"The learning cycle is rooted in theory that posits that learning is situated within meaningful learning experiences and refined through empirical studies on teacher candidates' learning."

The learning cycle is rooted in theory that posits that learning is situated within meaningful learning experiences (see Rogoff, 1997; Wenger, 1998) and refined through empirical studies on teacher candidates' learning (Grossman, 2013; Kazemi et al., 2009; Windschitl et al., 2012). While the learning cycle has four distinct phases, based on TCs background, teacher educators may begin the cycle with any phase.

In the **Learn** phase TCs are introduced to specific research-based pedagogies through various means including, but not limited to, an instructional activity where the teacher education models the pedagogies as TCs take on the role of learners, conducting live observations of a teacher enacting this practice, watching a video of a teacher implementing the pedagogy with students, or analyzing written vignettes from teachers or researchers about classroom-based enactments of the pedagogies. The priority in this phase is that TCs gain a deeper understanding of what the practice looks like with learners in actual schools.

Typically, the **Prepare** phase also occurs during a course meeting when TCs practice using the research-based pedagogies with peers in what is often called rehearsals. During this phase, the course instructor and peers give feedback to help refine the use of the pedagogy before TCs enact it with children in classrooms.

The **Enact** phase occurs in a classroom when TCs teach an instructional activity and use the research-based pedagogies with students. Lastly, the **Reflect** phase includes TCs analyzing student work, recordings, or thinking about their experiences during the enactment phase.

Research on PBTE approaches have indicated that this process, especially the Practice phase with Rehearsal activities have positively influenced TCs' perceptions of feeling prepared to enact research-based pedagogies (Colonnese et al., 2022; Shaughnessy & Boerst, 2018; Shaughnessy et al., 2019). Additionally, the PBTE phases contributed to TCs posing more questions about elementary school students' mathematical thinking and ideas instead of just asking more basic questions about the answer that they received (Polly, 2021).

In light of the context of educator preparation programs and the need to support early childhood educator preparation programs in preparing TCs to be more inclusive of primary grades learners, PBTE has a lot of potential that needs to continue to be explored as a possible approach to support TCs enactment of research-based pedagogies. To that end, this paper explores the following broad question: How do course activities in early childhood mathematics pedagogy courses influence TCs' performance during Practice and Enactment activities?

Methods

Context

This study examined data sources from two elementary education mathematics pedagogy courses focused on teaching primary grades learners (Kindergarten through Grade 2) taught by the author at a large university in the southeastern United States. Course A is a traditional face-to-face course taken by undergraduate students who are earning their undergraduate degree in Elementary Education and their initial teaching license in Grades Kindergarten through Grade 6. Course A required TCs to attend face-to-face courses for 3 hours each week for a 16-week semester. The course also included clinical practice activities in which TCs enacted a number sense activity (aka a number talk) and three lessons focused on word problems.

Meanwhile, Course B was an online course with both synchronous and asynchronous coursework taken by post-baccalaureate students during a 10-week summer session. Each of the TCs in Course B had a degree in a non-education related field and were earning their initial teaching license in Grades Kindergarten through Grade 6. During this section TCs completed 8 asynchronous modules and participated in 3 synchronous sessions, two of which involved practice and rehearsal activities. Enactment and reflection were not required in this course since the course occurred in the summer.

Due to the differences in the course formats, the purpose of this study is to examine each course separately in light of the research question: How do practice-based teacher education (PBTE) course activities in early childhood mathematics pedagogy courses influence TCs' enactment of Inclusive and Equity-based Mathematics Teaching (IEBMT)? Both courses were included since PBTE approaches have not been studied thoroughly in both face-to-face and online, bichronous settings (Polly, 2021; Shaughnessy et al., 2021).

Description of Course Activities

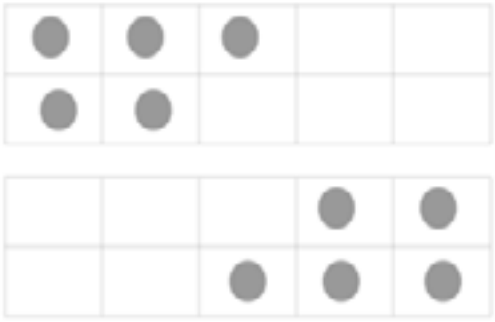
Number Sense Activity

Course A. In Course A TCs participated in number sense activities (aka number talks) as learners three times during the first two weeks of the semester. Each of these activities focused on having TCs look at and talk about pictures of dots that were arranged differently based on the research-based activity of subitizing (Clements, 1999; Figure 1). The goal of the activity was to think about different ways to count the total number of dots. While there are various ways to arrange manipulatives inside of a ten frame the purpose of these arrangements was to promote conceptual subitizing (Clements, 1999) so that TCs could clearly see two distinct groups with a constant total amount. In the activity all the pictures had a total of 10 dots with varying dots in each of the ten frames. In Figure 1 when asked about what they notice, TCs may state ideas such as:

- "I see 5 on the top and 5 on the bottom and I know that 5 plus 5 is 10."
- "I see that the bottom dots can be moved up to fill the empty boxes so that all 10 boxes on top are full to make a total of 10."
- "I went from left to right and counted by 2s. I landed on 10 which is the total."

During the discussion after the activity, TCs spent time talking about their experiences as learners and the benefits of the number sense activities. Part of the discussion during the course focused on the specific questions that the instructor (the author) asked during the activity with a focus on how those questions elicited students' thinking about the mathematical concepts embedded within the activity.

FIGURE 1
Screen shot of image from number sense activity



During the fourth class meeting TCs came to class with a number sense activity prepared and questions planned. The TCs spent time practicing their number sense activity in small groups of 5 or 6 people. After each round of practice each TC who practiced received feedback from their peers.

Course B. Since Course B was an online course with asynchronous modules and a few synchronous sessions, TCs experienced two examples of a number sense activity during the first synchronous session and then watched a video example of a number sense activity during a subsequent online module. In the second synchronous session the TCs practiced their number sense activity with colleagues. Similar to Course A, after each round of practice each TC received peer feedback.

Problem Solving Lessons

Course A. In the undergraduate face-to-face course TCs spent two class periods in the Learn phase where they analyzed and solved different types of word problems. During this time the instructor modeled how to teach a word problem using an inquiry-based approach that involved the teacher posing the word problem, asking a series of questions about the problem, and then allowing students to solve the problem.

During the course meetings the instructor (the author) provided examples of ways to support primary grades students. For example, consider the word problem: There are 4 dogs in the park. Then 3 more dogs show up. These scaffolds that were shown to TCs included asking questions about the problem to guide students through the problem-solving process and providing them with a number path and hands-on counters to help students who need help keeping track of the numbers in the problems (Figure 2).

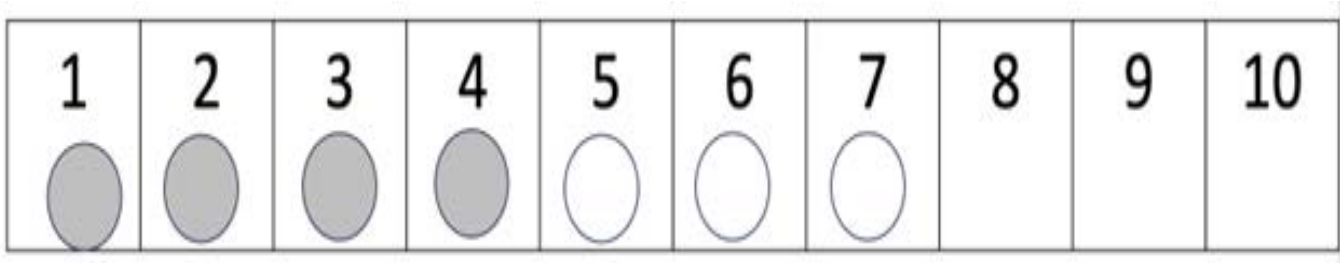
The instructor walked through the process with TCs in the following way:

- *Instructor:* I want us to think about this situation. *There are 4 dogs in the park. Then 3 more dogs show up.*
- *Instructor:* How many dogs are in the park?
- *TCs:* There are 4.
- *Instructor:* How can we use our counters to show that?
- *TCs cover the numbers 1, 2, 3 and 4 on the number path.*
- *Instructor:* What is the action in our problem?
- *TC:* 3 more dogs showed up.
- *Instructor:* Use your counters to show the 3 dogs that showed up.
- *TCs put counters that are a different color on the numbers 5, 6, and 7.*
- *Instructor:* The question we are going to answer is "how many dogs are now in the park? What is the answer?
- *TC*: The answer is 7.
- *Instructor:* How do you know?
- *TC:* I have 4 counters and 3 counters. That is a total of 7.

TCs then spent time during a class meeting creating word problems to use in each of their three lessons. The template that was given to students required five word problems per lesson. TCs were required to create an opening word problem and then four follow up word problems. TCs were asked to create two of the four follow-up problems to be easier than the opening problem, meaning the numbers were smaller OR there would be more guidance from the TC while teaching young learners. Additionally, two of the follow-up problems were expected to be more challenging than the opening problem with larger numbers and possibly focusing on the use of pictures instead of hands-on manipulatives and less teacher guidance. After students created word problems, they had a class session where they practiced teaching one of their word problems using the process that was detailed above. Similar to the number sense activities, peers provided feedback.

Course B. Course B, the 10-week online bichronous course, was markedly different from Course A regarding the Learn phase of the problem-solving process. TCs examined different types of word problems in the first two asynchronous modules and received feedback about their word problems from the author via an assignment that they submitted. In the second module TCs wrote their five word problems for each lesson. These word problems were similar to Course A with one opening problems and four follow-up problems, two that were easier and two that were harder compared to the opening problem. In the course's second synchronous session, which occurred during Week 4 of the course, TCs practiced teaching one

FIGURE 2
Picture of Number Path and Counters



of their word problems using the same process described in Course A. TCs attended Zoom sessions in groups of four to six where each TC taught their peers as if they were young learners. After each rehearsal peers gave glows and wonderings. Glows were positive things from the rehearsal and rehearsals included things that peers had questions about. Most peers gave glows and there were few wonderings. The author, as the course instructor, also gave glows. All suggestions for their tasks or teaching were communicated privately by the author after the practice rehearsal teaching.

Participants, Data Sources, and Data Analysis

This section describes the participants, data sources, and data analysis included in this study.

Participants

In order to examine the research question with a focus on the early childhood grades this study includes data from TCs who completed course activities related to Kindergarten. While the course included 22 TCs in Course A and 28 students in Course B, focusing only on TCs who had placements in Kindergarten reduced the number of participants to seven TCs in Course A and five TCs in Course B. All TCs in Course A completed clinical practice activities in urban schools where over 85% of the students within the school were experiencing poverty and over 60% of the students identified as Black or Latinx. While TCs in Course B did not complete clinical practice activities during the summer course, each of them had completed clinical practice activities in previous semesters in either urban or rural schools where over 80% of the students within the school were experiencing poverty. The students in the schools where TCs in Course B previously had completed clinical activities included diverse populations of students including those who identified as White, Black, and Latinx.

Data Sources and Data Analysis

In order to examine the research question multiple data sources were examined (see Table 3). The data from each course was examined separately since the courses included different populations (undergraduates and post-baccalaureate teacher candidates) and activities. These data sources came from the two primary course activities that included practice (both courses) and enactment (only Course A).

Table 3

Data Sources Used the Study

	Course A **Undergraduate Face-to-Face Course**	**Course B** **Online Post Baccalaureate Course**
Number Sense Activity	Practice: TC's written reflection	Practice: TC's written reflection
	Enactment: TC's written reflection	*No Enactment Data*
Problem Solving Lessons	Practice: Planning Map of word problems and questions TC's written reflection	Practice: Planning Map of word problems and questions TC's written reflection
	Enactment: TC's written reflection	*No Enactment Data*

In order to examine the research question, data was analyzed using an inductive process using open coding (Bingham, 2023; Bogdan & Biklen, 2006). Bingham (2023) proposed a five-stage process which was used. First, data was organized with all the data sources inserted into google documents. Second, data was sorted into categories based on the course. Third, the author coded data. The codes were informed by the two pillars on inclusive, equity-based mathematics teaching (Table 1). Codes were assigned to excerpts of the data by the author. Examples of codes include TC's actions such as posing word problems, posing questions, supporting students and direct teaching. Examples of codes related to student actions included solving word problems, using manipulatives, and choosing strategies.

Fourth, codes were organized by similar topics to generate themes. The themes were then checked by revisiting the original data excerpts in order to help establish trustworthiness. Lastly, findings were explained. Due to the limited context of the study, Bingham's suggestion of advancing theory was not included. As stated earlier, based on the limited context, this was an exploratory study to better understand the influence of PBTE activities in early childhood teacher education programs, and the study was not designed to advance theory or make generalizations.

Findings

This study was framed around the research question: How do practice-based teacher education (PBTE) course activities in early childhood mathematics pedagogy courses influence TCs' enactment of Inclusive and Equity-based Mathematics Teaching (IEBMT)? The findings are organized by the two pillars of Inclusive and Equity-Based Mathematics Teaching ([IEBMT]; Table 1): 1) access to grade-level aligned research-based experiences and 2) opportunities for exploring problems embedded in meaningful contexts.

Access to Grade-level Aligned Research-based Experiences

Teacher candidates (TCs) in both courses planned learning experiences that were aligned with the Kindergarten grade-level standards. All candidates wrote word problems and number sense activities that provided scaffolds to support primary learners' access to the word problems. Specific themes related to this pillar of IEBMT included progressions of questions in the number sense activity and the use of visuals and manipulatives.

Progression of questions in number sense activity. In terms of the number sense activity, all seven TCs in Course A had planned for a series of questions that progressed from low-level to more higher-level. When the seven teacher candidates did not ask the questions that they had come prepared with; instead, they made up other questions on the spot that were basic and low-level questions. In Course B all five TCs planned for and asked questions that progressed from low-level to higher-level questions.

Examples of the higher-level questions that were asked were similar to those asked during the examples provided by the instructor (the author) during the **Learn** phase, such as: "How is this strategy of finding the total number similar to the strategy we saw earlier?" And "How do you know that your thinking is correct?" Similar to what happened during the Learn phase, TCs in both Course A (face-to-face) and Course B (online) mimicked what they saw the instructor (the author) do and implemented the progression from low-level to higher-level questions with a high degree of fidelity.

One TC from Course A who decided to make up her own questions wrote in her reflection, "I did not feel comfortable asking the harder questions since I was still unsure what a correct answer would look like and how I would respond to my classmates." Despite the activities that this TC went through she still chose not to ask higher-level questions due to her uncertainty about the correct answer and how to respond to answers.

A TC from Course B wrote, "Even though the synchronous time before we practiced was brief, it helped to see an example on video and also be part of one that [the instructor] led. These activities definitely helped me feel prepared to practice my own activity."

Only TCs in Course A enacted this activity with primary grade learners. In their reflection, six of the seven TCs reported a positive experience from

teaching the activity to a small group of primary grade learners. One TC who had a positive experience wrote, "The questions that I had planned for worked very well and my students were able to do the activity and share their thinking."

The TC who did not report a positive experience was one of the TCs who abandoned her planned questions during the **Practice** phase. She wrote in her reflection, "When I was teaching my students the activity was too easy, so I had to make up more problems and questions on the spot." This reflection speaks to the idea that her planned activity did not align well to students' strengths and needs.

In summary, TCs in both courses were able to practice the number sense activity in ways that aligned with the instructor had intended. TCs in Course A enacted the activity with students and had a positive experience, except for one individual who reported that her students were bored and she had to plan her activity on the spot since the original activity was too easy.

Use of manipulatives and visuals. All the TCs across both courses planned for and used manipulatives such as counters or cubes during each of the lessons. This was consistent and evident during each TCs **Practice** activity. During the reflection of the practice TCs wrote questions though about when they should have their students use manipulatives compared to drawing a picture about the math problem. One TC wrote, "I always make them use counters or can I give them the option of counters or a picture?" Another TC wrote, "I know my students will always want counters but some may not need them. How do I take them away and have them draw pictures?"

All TCs were aligned with the desired pedagogies by using manipulatives such as counters or cubes along with Number Paths (Figure 2). TCs reported confusion and uncertainty knowing when they should encourage students to transition from manipulatives to pictures in ways that are positive and non-threatening. Following the **Practice** this was discussed in a class session for Course A, and through an email to TCs in Course B. The instructor gave ideas about how they may encourage students to create a representation with manipulatives and then draw a picture of the concrete objects, or when ready begin their work by trying to first draw a picture to solve the problem.

When the TCs in Course A enacted their lesson, they reported that their students found the use of counters to be very helpful and some primary grade learners demonstrated misconceptions when they had to draw pictures instead of manipulatives. One TC wrote, "If my students have counters they get them all correct. If they have to draw a picture then 3 of my 5 students will need help just getting started." This TC had firsthand evidence that the transition from manipulatives to pictures was hard and needed more support in the future.

In summary, TCs demonstrated some degree of fidelity to the desired pedagogies by planning for and using manipulatives such as counters and cubes in their **Practice** activity. TCs, though, reported a lot of uncertainty across both courses on how to help students transition from manipulatives to pictures.

Opportunities to Explore Problems Embedded in Meaningful Contexts

Opportunities to explore problems. The analysis of data related to the problem-solving lessons indicated that all 12 TCs across both courses had planned to allow students to explore word problems with TCs scaffolding by providing manipulatives and questions to support students. This matched both the face-to-face course session for Course A and the asynchronous modules in Course B. The planning and preparation of their lessons included scaffolds for learners since it went systematically step by step using questions to guide students.

However, four of the seven TCs during the Practice phase of Course A; two TCs taught directly how to solve a problem with direct teaching and did not ask any questions, and two TCs taught posed the word problem and provided no questions or guidance to support students. In all these four instances, the practice either provided too much scaffolding with direct teaching or not enough scaffolding by simply giving the word problem. In their reflection of the practice, one TC who practiced in a direct instruction method that did not match the desired pedagogies wrote, "As soon as I got into my practice I know I needed to teach every step of the problem since my students will need to be given all

the information like that when I teach it." This TC had a predetermined notion of her students that they needed direct instruction instead of inquiry-based instruction and she decided to practice using that approach.

During the enactment with primary grades' learners, TCs from Course A all used a step-by-step inquiry-based approach. The debrief of the Practice activity provided TCs with more examples and clarification about what the lessons should look like, which led to a higher degree of fidelity during the enactment with students. In her reflection, one of the TCs who taught with direct instruction during practice but inquiry-based during enactment said, "I still was skeptical during my lesson with kids until I saw how my Kindergarteners had their own ideas and strategies on how to solve the problem. They had enough of a foundation to be successful and share their ideas with me and their classmates."

In terms of Course B, during a synchronous session, two of the five TCs practiced their word problem with classmates in a step-by-step approach that provided scaffolds and an inquiry-based approach where the teacher taught by asking a lot of questions. There were three TCs who directly taught each step and did not use an inquiry-based approach. These TCs who directly taught how to solve word problems included comments in their reflection about how their schools have completed clinical practice experiences in teaching mathematics this way with direct instruction about specific strategies instead of inquiry-based approaches. One TC who taught her practice lesson in a direct instruction manner wrote, "This is what my school does. They teach step by step while students listen and watch and then they will eventually get to practice."

Data analysis indicated that the number sense routines included plans for and evidence during the practice activities of students having Power and being able to determine which strategy they want to use to count the total number of dots. Additionally, the number sense activities all included alignment to grade level content since subitizing and the questions posed aligned to the state mathematics standards. Identity was not explicit since number sense activities are non-contextualized problems, but the scaffolds provided by the TCs were designed to empower primary grade learners that they are capable of being successful in mathematics.

In regards to the idea of Power, one TC from Course A wrote in her reflection after the enactment, "It was transformative to hear my students' ideas during the number talk. They had such creative, correct ways to find the answer." One TC from Course B wrote in her reflection after the practice, "It makes me nervous to ask questions about what my students are thinking because I do not know what they will say, but I know that it is good for them and I want to keep doing that even if it is a bit nerve wracking."

In terms of the problem-solving lessons, all of the TCs across both courses provided word problems that were embedded in real-life situations which were intended to be relevant to learners, which helps to develop their identity. As stated above, not all TCs demonstrated during the Practice pedagogies that give students power since some TCs taught using direct instruction the exact steps about how to solve a word problem. Additionally, when TCs (and teachers) teach using direct instruction where students are not actively doing mathematics for a time that has potential to negatively impact their identity since they may feel not capable of doing mathematics without the teacher first demonstrating each step.

Problems embedded in a meaningful context. Additionally, each of the TCs were able to write word problems that included contexts that were meaningful to their students. In the lesson plans for the problem-solving lessons TCs provided a written rationale about how their word problems were embedded in a meaningful context. Examples from teachers' rationales included references to students' cultural backgrounds or businesses near their school. One TC in Course A wrote: "Many of my students speak Spanish at home so I decided to make word problems about Spanish food." A TC wrote in Course B, "There is a park down the street from my school and so I wrote word problems about the park since students are always talking about the park."

In summary, there was evidence that TCs were able to write word problems in a meaningful context when they embedded the problems in students' cultures or community assets such as parks or stores. In terms of allowing students to explore problems,

data only came from Course A since Course B TCs did not enact lessons in Kindergarten classrooms. For TCs in course A, some TCs had preconceived notions that their primary grade learners needed direct instruction of specific strategies instead of opportunities to explore, so they practiced that. Fortunately, for the TCs in Course A, the debrief after the practice activity provided clarity which led to all TCs teaching word problems in an inquiry-based approach during the Enact phase.

Discussion and Implications

The purpose of this inductive, exploratory qualitative study was to examine the broad research question, How do practice-based teacher education (PBTE) course activities in early childhood mathematics pedagogy courses influence TCs' enactment of Inclusive and Equity-Based Mathematics Teaching (IEBMT)? Data from TCs reflections and instructor's notes were used as primary data sources. In this section, I connect the findings to current research and provide possible implications for future work. This section focuses specifically on the potential of practice-based teacher education (PBTE) and the consideration of inclusive, equity-based teaching in early childhood educator preparation programs.

Potential of Practice-based Teacher Education (PBTE)

In this paper, the data analysis led to findings that the process of Practice-based Teacher Education (PBTE) and its four phases led to direct alignment between desired research-based pedagogies associated with IEBMT. Specifically, evidence of these practices were more clearly evident in TCs plans and their practice teaching during each course related to the number sense activities and number talks. TCs used activities that were aligned to state mathematics standards and a series of questions that progressed from lower-level to higher-level which matched what TCs had experienced when they were learning about these activities. In the case of number sense activities, the course activities and PBTE processes of **Learn and Practice** led to TCs using the desired pedagogies across both Course A (face-to-face) and Course B (online). This finding supported previous studies (Colonnese & Polly, 2022; Shaughnessy et al., 2021) in that there was documented evidence that the PBTE framework was linked with evidence of TCs learning as noted on both TC reflections on clinical documents (Colonnese & Polly, 2022) as well as performance-based tasks that embody the daily work of teaching mathematics (Shaughnessy et al., 2021).

"TCs in both courses wrote word problems that were embedded in meaningful contexts relevant to their students"

In this study, the PBTE process was associated with TCs posing word problems that had embedded research-based scaffolds, such as number paths and manipulatives. Additionally, TCs in both courses wrote word problems that were embedded in meaningful contexts relevant to their students. However, there was evidence of a lack of alignment for some TCs in each course between the desired approach to teach these problem-solving lessons using an inquiry-based approach focused on asking students questions, and a direct instruction approach that some TCs used during their practice teaching. This direct instruction approach to teaching how to solve word problems was evident in both Course A and Course B. This complexity about the lack of alignment between course concepts and the actual enacted pedagogies that TCs observe in clinical classrooms affirms the critical need to better align pedagogies in clinical placements and the research-based practices taught in teacher education courses (AACTE, 2016; Zeichner, 2021).

However, the alignment between course activities and clinicals appeared to be influenced by the specific course. Since Course A included the **Enact** phase with primary grade learners and Course B did not, all TCs in Course A received feedback and developed more clarity about how to teach using an inquiry-based approach and used that approach with students in classrooms. In the case of TCs in Course B since it was a summer course without

clinical practice experiences and an **Enact** phase there is no evidence about how the TCs would teach word problems to students. This finding contributes to the literature since it provides empirical data that while PBTE has potential as a process to support TCs adoption and use of research-based pedagogies, there is a need for the instructor to be attentive to TCs performance during **Practice** and look for ways to support pedagogical shifts between the **Practice** and **Enact** phases.

Recent work has started to look at the influence of mediated field experiences (MFEs) where the course instructor is in the clinical practice setting with TCs to provide ongoing support and coaching during enactment (Colonnese & Polly, 2022; Gesel et al., 2023). Future research is needed to examine which models of supporting both **Practice and Enactment** are best, especially in the cases of online teacher education courses and programs. Additionally, the research base still needs studies that examine the influence of approaches like PBTE on the enactment of research-based practices as well as student learning outcomes. In order for these types of approaches to be more widespread in educator preparation programs these topics need to be empirically investigated to associate these efforts to teacher candidate learning and, when possible, PK-12 student learning.

Preparing TCs to Enact (IEBMT) in Early Childhood Settings

As stated earlier, inclusive, equity-based teaching practices were framed in two ways in this study- 1) providing access and support to grade level content, and 2) integrating equity-based mathematics pedagogies that are relevant to primary grade learners.

Providing access to grade-level aligned, research-based experiences

The data analysis indicated that TCs in both courses were able to successfully create number sense activities and word problem lessons that aligned to grade level content, and TCs were also able to think about how to provide access to manipulatives such as counters and cubes as a support to do the mathematics. As indicated in the findings, though, is that TCs asked questions and reported a lack of clarity on how to help students transition from manipulatives to pictures; more specifically, when students show that they may not need the supports of the manipulatives anymore they were uncertain on how to remove them in a non-threatening way. In some cases, TCs reported not knowing when they should think about and consider removing the manipulatives from students, instead strongly encouraging the use of pictures. This finding supports a seminal mathematics education study that found that teachers tended to focus on isolated aspects of mathematics teaching such as manipulative use, but in a superficial way where hands-on manipulatives were used but teachers did not demonstrate efforts to help learners make connections between the manipulatives and the actual mathematics concepts (Cohen, 1990). Additionally, there is a need for educator preparation programs to ensure that ample experiences are included to support TCs enactment of IEBMT.

Future research studies need to examine ways that educator preparation programs can provide both course and clinical practice experiences related to providing support and scaffolds for learners. This includes the process of preparing TCs to recognize in the moment of teaching or afterwards while examining student work information or data that scaffolds may no longer be needed or need to be modified. Additionally, research is needed about how to best support TCs use of transitions of scaffolds as they move from more intensive to less intensive supports. In the case of this study, TCs in Course A planned and enacted three problem solving lessons to small groups of students where manipulatives were used in nearly each case. In the teacher education program that Course A is part of, previous studies found that having TCs enact lessons and instructional activities to small groups of students makes these clinical practice activities easier to enact compared to requiring whole group teaching experiences (Polly, 2021; Colonnese & Polly, 2022; Putman & Polly, 2022). Part of the reason that small group activities appear to be a better context for TCs to enact inclusive, equity-based practices is that clinical educators who host TCs are more apt to give TCs control of a small group of students compared to a whole group of students. One equity-based,inclusion practice that was com-

-plex in this study was TCs decision to use manipulatives or encourage young learners to represent their word problem with pictures on paper. In some cases, in Course A, TCs required manipulative use but reported that in some cases, in retrospect, they likely should have encouraged pictures instead of manipulative use. As scholars continue to think about inclusion and meeting students' academic needs, one-size-fits all approaches do not work, and teacher education programs have a responsibility to develop TCs who are flexible and responsive to data when deciding how to best support young learners.

Opportunities for Exploration while Solving Problems in Meaningful Contexts

The second aspect of inclusive, equity-based teaching focuses on providing learners with opportunities for exploration while solving problems in meaningful contexts. The findings from this study provide evidence that TCs were able to successfully create (both courses) and enact (only Course A) word problems in contexts that were embedded in relevant and meaningful contexts to primary grade learners. However, in their reflections, some TCs shared that although they planned to engage learners in activities that provided student exploration and inquiry-based approaches, they were afraid it would be too challenging, and instead opted to use direct instruction pedagogies in their practice activities, which did not align to what the TCs had learned and used in the PBTE activities in the course. This dissonance between planning (intended practices) and how TCs taught (enacted practices) occurred only in Course A because TCs enacted their lessons. Meanwhile, in Course B, this potential disconnect was not as clearly evident since enactment was not required with early childhood learners.

This potential disconnect between PBTE and other course-based activities dealt with providing early childhood learners with opportunities to explore problems and use their choice of strategies while solving problems. In order for IEBMT to come to fruition in early childhood settings, TCs need course activities that encompass PBTE approaches and also include scaffolded enactments with young learners. In the case of Course A possible revisions could include video or audio recordings of enactments with a time for TC reflection, instructor feedback or additional rehearsals in between enactments. The ideas of mediated field experiences (Colonnese & Polly, 2022; Gesel et al., 2023) may provide promise in the efforts of supporting TCs enactment of pedagogies aligned with IEBMT.

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