



## Equitable Mathematics Teaching for Diverse Learners: Connecting Preservice Teachers' Beliefs and Practices

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### Abstract

This study investigates the beliefs and practices of preservice teachers (PSTs) concerning equitable mathematics instruction for diverse learners. Through a comprehensive analysis of lesson plans and reflective essays, we identify key themes that emerge in PSTs' approaches to teaching mathematics. The findings indicate that PSTs employ various approaches to foster inclusive learning environments that address their students' diverse academic, cultural, and learning style needs. Key strategies highlighted include differentiation, student engagement, and the implementation of culturally relevant pedagogy. Additionally, the research underscores the importance of aligning PSTs' beliefs with their instructional practices to enhance equity in mathematics education. The study also identifies areas for improvement within teacher education programs, suggesting that enhanced training in equity-focused teaching strategies is essential for preparing PSTs to address the challenges posed by learner diversity effectively. Ultimately, this research contributes to the ongoing discourse on equitable teaching practices and offers valuable insights for educators and policymakers aiming to promote inclusivity in mathematics classrooms.

**Keywords:** preservice teacher education, mathematics education, equitable teaching

### Introduction

The pursuit of equity in education has become a fundamental goal to ensure that all students, regardless of their background or circumstances, have access to appropriate mathematics instruction (NCTM, 2014). The National Council of Teachers of Mathematics (2024) and the Council for Exceptional Children (2024), in their joint statement on teaching mathematics to students, state that teachers need to treat students with disabilities as valuable owners of and contributors to the mathematics being learned. Equitable mathematics teaching practices play a crucial role in creating an inclusive learning environment where every student can thrive and succeed. It is widely recognized that preservice teachers (PSTs) play a significant role in shaping the educational experiences of future generations (O'Keeffe et al., 2019). While there is substantial research on equitable and culturally responsive teaching in general, there remains a gap in specific research focusing on mathematics education (Averill et al., 2009; Register et al., 2022).

Understanding that teachers' practices are influenced by their beliefs, it is essential to explore the instructional approaches that preservice teachers (PSTs) perceive as effective and utilize to promote equity. This understanding is crucial for fostering inclusive learning environments and addressing disparities in mathematics education (Paige et al., 2024). Teacher education programs face the challenge of enhancing the knowledge, skills, and dispositions of PSTs to create classrooms that are both academically appropriate and emotionally supportive (Aronson & Laughter, 2016). It is not easy, but

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teacher educators need to examine the curriculum that is being represented. Even in mathematics, the questions of who is represented in the curriculum and how knowledge is constructed should be addressed (Salem & Tillis, 2021). Schools in the United States often base their curriculum on racial and cultural distinctions built from colonial times (Dei & Kempf, 2006; Willinsky, 1998). It is imperative for teacher educators to assess instructional approaches and advocate for a pedagogy that values the professional and ethical considerations of all aspects that students bring to the classroom (Paige et al., 2024; Register et al., 2022).

This study investigates PSTs' perspectives and implementation of equitable mathematics teaching. The research questions guiding this investigation are as follows:

- 1) How do preservice teachers perceive the effectiveness of equitable mathematics teaching strategies in meeting the diverse needs of students?
- 2) How do preservice teachers address the diverse learning needs of students in the mathematics classroom?
- 3) What are the similarities and differences between preservice teachers' perceptions of equitable mathematics teaching strategies and their actual implementation to address the diverse learning needs of students in the mathematics classroom?

These research questions explore the alignment between PSTs' perceptions of effective equitable mathematics teaching strategies and their practical implementation to cater to the diverse learning needs of students. The study seeks to provide insights that can inform teacher education programs and empower teachers to create inclusive and supportive spaces for all students in the mathematics classroom. By exploring the perspectives, strategies, and experiences of PSTs, this research contributes to the ongoing discourse on equitable mathematics teaching practices.

### **Theoretical Framework and Literature Review**

To investigate PSTs' perspectives and implementation of equitable mathematical teaching approaches, the study drew upon theories that provide insights into individual belief systems as well as practical pedagogical strategies.

#### **Teachers' beliefs about teaching**

Teachers' beliefs about teaching play a crucial role in shaping their instructional decisions, classroom practices, and interactions with students. These belief systems are influenced by personal experiences, education, culture, and the broader social context in which teachers operate. Research emphasizes the significant impact of teachers' beliefs on educational outcomes, particularly in the field of mathematics education (Abdulrahim & Orosco, 2020; Berlin, Youngs, & Cohen, 2021; Hongying, 2013). Teachers who perceive mathematics as a dynamic and problem-solving field are more likely to adopt student-centered and inquiry-based instructional approaches, leading to a deeper understanding of mathematical principles among students. In contrast, teachers who view mathematics as a fixed set of rules may prioritize memorization, which limits students' opportunities for exploration and meaningful discussions.

Moreover, teachers' epistemological beliefs influence their perspectives on the essence of knowledge and the learning process (Katharina & Hans-Stefan, 2019). These beliefs shape teachers' perceptions of the equitability of mathematical concepts. When teachers believe that all students have the potential to understand mathematics with appropriate guidance, they are more inclined to employ teaching strategies that promote fairness and equality. Self-efficacy, or teachers' belief in their ability to teach mathematics effectively, is another critical aspect of belief systems theory (Berlin et al., 2021). A strong sense of self-efficacy empowers teachers to implement innovative teaching methods, adapt instruction to meet diverse student needs, and persevere in the face of challenges (Bandura, 1997; Webb & LoFaro, 2020).

Teachers' beliefs also act as a filter through which instructional decisions are made, influencing the nature of mathematics instruction and the adoption of equitable practices (Philipp, 2007). Understanding and addressing teachers' beliefs is essential for preparing them to deliver high-quality mathematics instruction to a diverse student population. By exploring PSTs' mathematical belief systems, this study aims to comprehend how these beliefs shape their instructional approaches and perceptions of equity in the mathematics classroom. Examining PSTs' beliefs about mathematics, their confidence in teaching the subject, and their views on students' ability to learn mathematics provides valuable insights into how these beliefs impact efforts to create inclusive and supportive learning environments. Recognizing the interplay between teachers' belief systems and their teaching practices is crucial for promoting equitable mathematics education and addressing disparities in the classroom (Abdulrahim & Orosco, 2020; Berlin et al., 2021).

### **Equitable teaching practice for diverse learners**

Culturally responsive pedagogy is essential for preparing PSTs to recognize and utilize the cultural backgrounds and knowledge that students bring into the classroom (Lee & Herner-Patnode, 2024; Gay, 2010a; Ladson-Billings, 1995). This approach supports the development of practices that respect and incorporate students' cultural references in all aspects of learning. Culturally responsive mathematics teaching (CRMT) includes embedding cultural responsiveness into the curriculum to build an equitable classroom environment that fosters a community of learners (Norwich & Nash, 2011). CRMT has its origins in Ladson-Billings' (1995) framework, which emphasizes infusing students' backgrounds and community experiences into the everyday learning process. This process involves leveraging students' strengths and focusing on teaching strategies that target these strengths, thereby creating a learning environment that welcomes a diversity of voices (Moscardini, 2014). CRMT should be integrated into teacher education programs so that prospective teachers can practice incorporating these principles into their lessons. This practice helps cultivate a mindset focused on addressing students' needs first. Student needs encompass various dimensions, including academic needs (diverse learning styles and abilities), cultural needs (recognizing and valuing students' backgrounds), and emotional needs (supporting students' social and emotional well-being). By utilizing this information, teachers can approach mathematical concepts in the most inclusive way possible (Aguirre & Zavala, 2013; Thomas, 2013). When mathematics is presented as relevant to students' lives, they are more likely to engage with the subject (Abdulrahim & Orosco, 2020). Increased student engagement leads to improved academic outcomes and enhanced self-efficacy, enabling students to use mathematical language effectively and appreciate the significance of mathematical concepts in daily life. This, in turn, advances the overarching objective of fostering an optimal inclusive learning environment (Gay, 2010b; Villegas et al., 2018).

A social justice framework also equips PSTs with the ability to critically examine the social, economic, and political conditions that affect education, and to seek equity and justice through their teaching practices. Social justice education encourages teachers to use mathematics to analyze and address issues of injustice, empowering students to become socially conscious problem-solvers. In mathematics education, social justice involves exploring concepts of equity and fairness within the community in a way that empowers students and gives voice to historically marginalized communities (Jong, Hodges, & Zhou, 2023; Martin, 2016). Based on Gutiérrez's (2009) exploration of dimensions, considerations should include access (the resources available to students), power (how students can use mathematics to improve the world), achievement (assessment outcomes), and identity (connecting to students' cultural backgrounds). Students who are given opportunities to explore relevant issues can develop confidence in their mathematical abilities (Gutiérrez, 2013). Historically minoritized students have not consistently seen their life experiences and communities reflected in the school curriculum. An equity-centered education means that teachers carefully select academic content that connects to students' lived experiences (Cochran-Smith et al., 2016). As teachers strive to empower students to

challenge biases in mathematics, they can nurture students' advocacy skills and build an equitable learning environment (Nieto, 2010). By establishing this environment, students can push back against stereotypical tracking practices and underrepresentation in STEM fields, dismantle systems that perpetuate inequities, and encourage access to the mathematics curriculum (Gutiérrez, 2013; Nieto, 2010). When implemented faithfully, social justice in mathematics can foster a more inclusive and equitable learning environment.

### **Methodology**

The study employed a qualitative approach to provide a comprehensive understanding of the phenomenon being studied. This method was chosen because it allows for an in-depth exploration of the complex and multifaceted nature of PSTs' beliefs and practices regarding equitable mathematics teaching. Qualitative research is particularly effective in capturing the nuances of participants' experiences and perspectives, which are essential for understanding how PSTs implement equitable teaching strategies in diverse classroom settings (Yin, 2014).

The research design consisted of reflective essays and lesson plan analyses. This combination of data collection methods enabled the researchers to gather rich, descriptive data that highlight the intricacies of PSTs' approaches to fostering inclusive learning environments. Reflective essays, lesson plan analyses, and reflections on lesson plans offered insights into the participants' thought processes and instructional practices.

The research was conducted in accordance with the protocols established by the Institutional Review Board for the Safeguarding of Human Participants.

### **Participants and contexts**

The study was conducted at a small institution located in the Midwest region of the United States. The participants in this study were all PSTs enrolled in the Reflective Seminar course, which is the final semester of a four-year education program. This course serves as a culminating experience and is taken concurrently with an internship (student teaching). The university courses provided PSTs with opportunities to engage in various activities, including video analysis, reviewing and discussing research, developing mathematics stations, and analyzing students' mathematical understanding. These activities aimed to broaden their knowledge base, explore theoretical and practical approaches, and refine their beliefs and attitudes toward teaching diverse learners.

The data analyzed and presented in this study focused on 12 PSTs who concentrated on their mathematics lessons for a reflective teaching assessment. The participant group consisted of nine females and three males. Notably, one participant identified as Black, while the other 11 identified as Caucasian. It is important to acknowledge that the selection of participants was based on their enrollment in the Reflective Seminar course, which may limit the diversity of perspectives represented in our findings. This homogeneity in the participant group could affect the generalizability of the results, as the majority of participants share similar backgrounds. Future research should consider a broader range of participants to capture a more diverse array of experiences and perspectives in the context of equitable mathematics education.

### **Data collection**

Figure 1 summarizes the data sources and the data collection process. The data collection involved three phases. First, PSTs selected their lesson plans and highlighted instances that described class and individual needs, discussed accommodations and modifications for diverse learners, and employed engaging, research-based instructional techniques. Following the examination of their lesson plans, PSTs wrote reflections on the skills they acquired for equitably teaching diverse learners, using examples from their lessons. They also identified areas they believed they still needed to master and

outlined their plans for achieving mastery in the future. In their reflections, they addressed students' needs, specific engagement strategies used, differentiation skills applied, and plans to better meet the needs of all learners in their classrooms.

To ensure the reliability and validity of the data analysis process, the researchers employed a combined inductive and deductive approach, as outlined by Creswell (2013) and Miles et al. (2014). This involved developing codebooks through a systematic process to identify key themes and patterns across the data sources. Additionally, multiple researchers were involved in the coding process to enhance inter-rater reliability, and regular discussions were held to reach consensus on the interpretations of the data.

Finally, the PSTs composed a conclusive reflective essay at the end of the program, discussing what they had learned about teaching diverse learners equitably. The reflective essay enabled the researchers to gain valuable insights into the PSTs' understanding of equitable teaching and their approaches to implementing it.

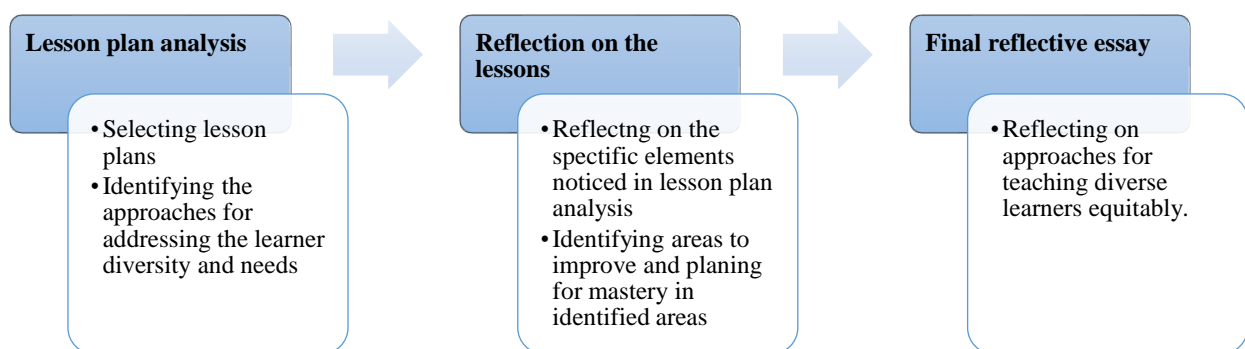


Figure 1. Data Sources and Data Collection Process

**Data analysis**

Three data sources—lesson plans, reflections on the lessons, and the final reflective essay—were analyzed to identify themes and patterns in PSTs' perceptions and approaches to addressing diverse learner needs. A content analysis was conducted to categorize and interpret the data systematically. To identify significant patterns and key themes, a combined inductive and deductive approach was employed (Creswell, 2013; Miles et al., 2014). The codebooks (Tables 1 & 2) were developed through a systematic process that involved identifying key themes, concepts, and patterns within the three data sources.

Table 1.  
Perceived Practice Data Coding Categories and Evidence Analysis

Codes	Evidence found in Data Sources
Reflective Practices	Reflective Practice; Reflection on Personal Beliefs; Reflective Approach; Continuous Improvement and Reflective Practices
Differentiation and Individualization	Significance of Differentiation; Differentiated Instruction; Differentiation for All Students; Scaffolding Instruction; Individualized Instruction and Support Strategies; Intervention Strategies; Catering to Individual Needs; Accommodation of Different Learning Styles and Disabilities; Personalized Strategies and Accommodations

Cultural Responsiveness and Inclusivity	Cultural Diversity and Inclusivity; Cultural Responsiveness and Responsive Teaching; Inclusive Environments; Student-Centered Education; Building Relationships and Cultural Representation; Understanding Diverse Backgrounds; Overcoming Implicit Biases; Addressing Implicit Bias and Cultural Differences; Combatting Barriers and Stereotypes
Equity and Student Success	Belief in Equitable Teaching for Student Success; Value of Equitable Teaching Strategies; Promotion of Equity; Equity as Essential; Support for Students of All Backgrounds and Abilities; Comprehensive Support for Diverse Needs
Teaching Strategies and Techniques	Adapting Teaching Strategies; Incorporation of Various Learning Modalities; Integration of Real-Life Examples; Utilization of Manipulatives; Teaching in Diverse Ways; Incorporation of Multiple Learning Styles; Promotion of Critical Thinking and Collaboration; Use of Multi-Modalities; Evidence-Based Instruction Techniques
Inclusive Environments	Inclusive Environment; Creating a Safe and Welcoming Environment; Inclusive and Supportive Learning Environment; Equal Opportunities for Learning; Inclusive Classroom Practices
Relationship Building and Engagement	Proactive Approach; Valuing Diverse Perspectives; Student-Centered Approach; Building Meaningful Relationships; Active Learning and Engagement; Engagement and Varied Instructional Approaches

The development of the codebooks involved several steps: data familiarization (reading through the data to gain an understanding of the content and identify recurring themes), initial code generation (creating initial codes based on the identified themes and patterns), refinement of codes (reviewing the initial codes to capture the essence of the data accurately), and the development of the final codebook (a finalized set of codes, along with their definitions and examples). The coding categories encompass various aspects, including reflective practices, differentiation, cultural responsiveness, teaching techniques, engagement, equity, and classroom management.

Table 2.

*Implemented Practices Data Coding Categories and Evidence*

<b>Codes</b>	<b>Evidence found in Data Sources</b>
Professional Development and Reflection	Reflecting on teaching practices; Reflective Practice
Differentiation and Individualization	Individualized Instruction (Individualized Instruction; Individualized Support; Intervention; Providing visual supports for students with Individualized Education Programs (IEPs) or 504 Plans); Differentiated Instruction (Differentiated Instruction; Differentiated Centers; Differentiated Activities);
Teaching strategies and Techniques	Advanced Learning Opportunities (Incorporation of critical thinking; Advanced Learning Opportunities); Real-world connection; Zone of Proximal Development and Scaffolding (Implementing Zone of Proximal Development and Scaffolding; Scaffolding Instruction)
Collaborative Learning	Grouping Students (Grouping Students Based on Abilities; Group Support; Group Instruction); Small Group Instruction (Utilizing Small Group Instruction; Utilizing small group centers); Collaborative activity
Assessment and Feedback	Observation and Assessment (Observation and Assessment; Ongoing Assessment); Formative and Summative Assessments (Using Formative Assessments; Formative and Summative Assessments); Data-Driven Instruction (Data-Driven Instruction; Using Data for Decision-Making)
Engagement and Motivation	Hands-On and Engaging Activities (Hands-On and Engaging Activities; Interactive Activities; Active Learning); Incentives and Motivation

	(Incorporating Incentives; Incorporating incentives for motivation); Engagement Strategies (Engaging student voice; Engagement Strategies)
Equity and Inclusion	Supportive Classroom Environment (Creating a Supportive Classroom Environment; Creating a Supportive Learning Environment); Multi-Modalities (Multi-Modalities; Use of manipulatives and visuals; Incorporating Multiple Learning Modalities); Practical Accommodations; Visual Supports (Providing visual supports for students with Individualized Education Programs (IEPs) or 504 Plans)
Culturally Responsiveness	Culturally Responsiveness (Culturally Responsive Teaching; Addressing Implicit Biases; Promoting Cultural Diversity; Creating Culturally Responsive Environments);
Behavior and Classroom Management	Behavior Management (Implementing behavior management strategies); Classroom Management (Classroom Management Strategies; Classroom Management Techniques)

## Results

This section provides a comprehensive overview of the themes related to PSTs' perceptions and implementation of equitable mathematics teaching strategies for addressing diverse student needs.

### PSTs' perceptions of effective equitable mathematics teaching

PSTs demonstrated a commitment to promoting inclusivity and equitable teaching in the mathematics classroom by utilizing a variety of strategies and methods that prioritize the diverse needs and backgrounds of each student. Figure 2 illustrates the PSTs' stated strengths in the areas of Reflective Practices, Differentiation and Individualization, Cultural Responsiveness and Inclusivity, Equity and Student Success, Teaching Strategies and Techniques, Inclusive Environments, and Relationship Building and Engagement. As shown in Figure 2, the PSTs indicated varying degrees of emphasis on these essential aspects of effective teaching. Table 3 is a collection of PSTs' perceptions of equitable mathematics instructional strategies derived from the data.

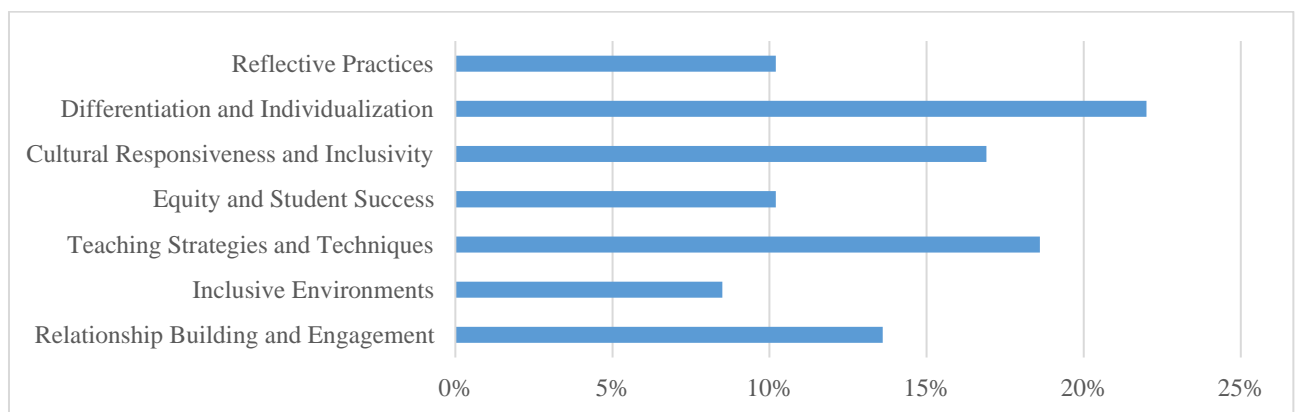


Figure 2. PSTs' Perception of Effective Equitable Mathematics Teaching Strategies

*Reflective Practices* (10.2%) involve PSTs engaging in reflection to challenge their teaching practices, beliefs, and biases. These practices help teachers assess their effectiveness, make improvements, and enhance their ability to meet the diverse needs of students. The PSTs who identified this area as a strength valued reflective practices and continuous improvement as crucial elements of their teaching approach. By reflecting on their teaching methods and outcomes, they aimed to enhance their effectiveness in meeting student needs as seen Kevin's final essay in Table 3.

*Differentiation and Individualization* (22.0%) entail customizing instruction to address the unique learning needs of individual students. Individualization involves providing tailored learning experiences that cater to students' strengths, weaknesses, and interests. PSTs underscored the importance of scaffolding instruction, offering personalized accommodations, and providing support specific to each student. Additional support noted by PSTs included adapting instructional materials, providing extra resources, allowing additional time for assignments, and utilizing assistive technologies to support students with diverse needs. For example, in her final essay, Casey emphasized how she learned to make accommodations to ensure that all students have the opportunity to demonstrate their understanding, regardless of their individual challenges (see Table 3).

Table 3.

*PSTs' Perceptions of Equitable Mathematics Teaching*

<b>Strategies</b>	<b>PSTs' Perceptions</b>
Reflective Practices	I have learned that reflective practice is a cycle that needs to be repeated. In this practice you learn to teach, self-assess the effect your teaching has had on learning, consider new ways of teaching which can improve the quality of learning, trying these ideas in practice, and repeating the process. (Kevin, Final Essay)
Differentiation and Individualization	Striving to have equitably in the classroom means that every student has the resources and support they need and this could mean differentiating to meet the students' learning styles. (Casey, Final Essay)
Cultural Responsiveness and Inclusivity	With identifying what characteristics make up a culturally responsive teacher, it's also important to identify some of the misconceptions that are brought when looking at and understanding culturally responsive teaching. Educators might think that they are a culturally responsive teacher, but they aren't which is ultimately hurting the students. Culturally responsive teaching is not just about building relationships or some other things, but it really is about improving the academic achievement of students. ... Culturally responsive teaching should start with addressing implicit bias. (Ava, Final Essay)
Equity and Student Success	It is also very important that we diversify our curriculum. Teachers need to expose students to a spectrum of multicultural and female experts, writers, and artists. Adding these into your curriculum will help those students feel a sense of connection and comfortability. Another thing that I learned was to hold every student to high expectations. It is reported that students of color report being held at a lower standard and expectations. So, making sure to hold all students to the same expectations it decreases the stereotypes within your classroom. (Emma, Final Essay)
Teaching Strategies and Techniques	To start my lesson I incorporated a video about subtraction which my students were able to sing and dance to. This allowed for my students with musical, visual, and movement learning styles to connect with the material. (Grace, Reflection on Lesson Plan)
Creating Inclusive Environments	Teaching diverse learners equability has a huge impact on our students. When we build a classroom community that promotes and accepts diversity, we allow students to feel comfortable and ok with being themselves. (Grace, Final Reflective Essay)
Fostering Relationship Building and Engagement	Getting to know your students on a deeper level is also very important. Every morning, I greet my students with "Good morning (students name)" I then proceed to ask them how their evening was. Students always love to tell me what they did the night prior. (Olivia, Final Essay)

*Cultural Responsiveness and Inclusivity* (16.9%) focus on recognizing and valuing students' diverse cultural backgrounds, experiences, and perspectives in the classroom. This includes creating a



welcoming and supportive environment where all students feel respected and included, regardless of their cultural backgrounds. PSTs who identified this as an area of focus prioritized cultural responsiveness and inclusivity in their teaching practices. They worked to create a supportive environment by building relationships, understanding diverse backgrounds, and overcoming implicit biases to ensure that all students feel seen. The importance of addressing implicit bias in culturally inclusive teaching was highlighted in Ava's final reflection, where she emphasized the significance of recognizing and addressing any biases that may be present in teaching practices to foster a more inclusive and equitable learning environment for all students (See Ava's final essay in Table 3).

*Equity and Student Success* (10.2%) pertains to ensuring fairness, equal opportunities, and academic success for all students. The PSTs who focused on this area strived to address disparities, provide necessary support, and create conditions that enable every student to achieve their full potential. They believed that equitable teaching strategies are essential for promoting student success. PSTs advocated for maintaining high expectations, supporting students of all backgrounds and abilities, and offering comprehensive assistance to address diverse needs, as stated in Emma's final essay in Table 3.

*Teaching Strategies and Techniques* (18.6%) underscore the significance of employing a wide range of instructional strategies to actively engage students, facilitate learning, and address the diverse needs of learners. The PSTs who focused on this area recognized the value of utilizing teaching strategies that incorporate various learning modalities, real-world examples, and engagement techniques to foster critical thinking and accommodate different learning preferences. They also emphasized the use of evidence-based instructional methods to improve student learning outcomes and employed multimodal approaches. An example from Grace's reflection on her lesson plan is shared in Table 3. PSTs highlighted the importance of varying instructional approaches to effectively reach all students and create an inclusive learning environment that promotes equity and collaboration. By recognizing the significance of employing diverse and engaging teaching methods, educators can establish classrooms where every student can thrive.

*Creating Inclusive Environments* (8.5%) involves establishing classroom settings that embrace diversity, promote collaboration, and foster a sense of belonging for all students. PSTs focused on creating safe and welcoming environments that encourage collaboration, respect, and active participation among students. In their pursuit of equitable teaching practices in the mathematics classroom, PSTs concentrated on fostering a positive classroom atmosphere and building strong relationships with students. They prioritized cultivating a culture of excellence, inclusivity, and mutual respect to empower every student to succeed (see an example in Grace's final essay in Table 3). This inclusive approach not only supports students' well-being but also enhances their sense of belonging and engagement in the learning process. When students feel accepted and valued for who they are, they are more likely to thrive academically and socially (Abdulrahim & Orosco, 2020). Therefore, promoting diversity and inclusivity in the classroom is essential for creating a supportive and empowering learning environment for all students.

*Fostering Relationship Building and Engagement* (13.6%) is a crucial aspect of effective teaching. This category emphasizes the importance of establishing connections with students, promoting active participation, and cultivating a supportive learning community to enhance student learning and well-being. PSTs who referenced this category adopted a proactive and student-centered approach by valuing diverse perspectives, building meaningful relationships, and encouraging critical thinking and collaboration through varied instructional methods (see Olivia's final essay in Table 3). By nurturing a positive classroom culture where students feel secure, respected, and appreciated through relationship-building practices, PSTs empower students to develop a growth mindset and engage in a learning environment that values diversity and promotes equity in mathematics education.

### PSTs' implementation of equitable mathematics teaching

Table 4 outlines the aspects of learner diversity observed by PSTs and their corresponding actions in response to these diversities in their lesson plans. This reflects not what they think works, but rather what they implemented in the classroom. PSTs recognized learner needs in three key areas: academic diversity, cultural background diversity, and learning styles. By identifying distinct learner needs and applying strategies to assist students with diverse abilities, backgrounds, and learning styles, PSTs endeavored to establish an inclusive and equitable learning environment.

Table 4.

#### *Noticing of Learner Diversity and Responsive Strategies*

	<b>Noticing of Learner Diversity</b>	<b>Responsive Strategies</b>
	The importance of providing individualized support and accommodations	<ul style="list-style-type: none"> <li>• Differentiate instruction</li> <li>• Tailored interventions</li> <li>• Additional assistance to meet the specific needs</li> </ul>
Academic diversity	Highlighting students' varying readiness levels	<ul style="list-style-type: none"> <li>• Differentiated instruction</li> <li>• Flexible grouping</li> <li>• Varied learning activities to ensure appropriate challenge and support based on individual readiness levels.</li> </ul>
	The importance of challenging and extending learning opportunities for high-achieving students	<ul style="list-style-type: none"> <li>• Enrichment activities</li> <li>• Higher-level thinking tasks</li> <li>• Independent exploration to meet students' needs</li> </ul>
Cultural background diversity	Realization of students came from family structures or communities different than the PSTs	<ul style="list-style-type: none"> <li>• Making a concentrated effort to research student identities</li> <li>• Creating a respectful and inclusive learning environment</li> <li>• Consideration for all students' voices and connections to their everyday life experiences</li> </ul>
Learning styles	The need to accommodate students' learning styles	<ul style="list-style-type: none"> <li>• Providing multimodal instruction</li> <li>• Hands-on activities</li> <li>• Varied instructional approaches to cater to the learning preferences of students.</li> </ul>

The data shown in Figure 3 indicates the relative emphasis placed by PSTs on their teaching practices. PSTs placed a strong emphasis on tailoring instruction to meet the diverse learning needs of students, with a primary focus on differentiation and individualization. The two other categories that were also rated in the top three were engagement and motivation, as well as collaborative learning experiences. The data further indicates PSTs' commitment to developing effective teaching methods, providing assessment and feedback, promoting equity and inclusion, fostering cultural responsiveness, and maintaining positive behavior and classroom management practices. Overall, PSTs aimed to create inclusive and supportive learning environments where all students feel valued, respected, and supported in their educational journey. Table 5 is a collection of PSTs' implementation of equitable mathematics instructional strategies derived from the data.

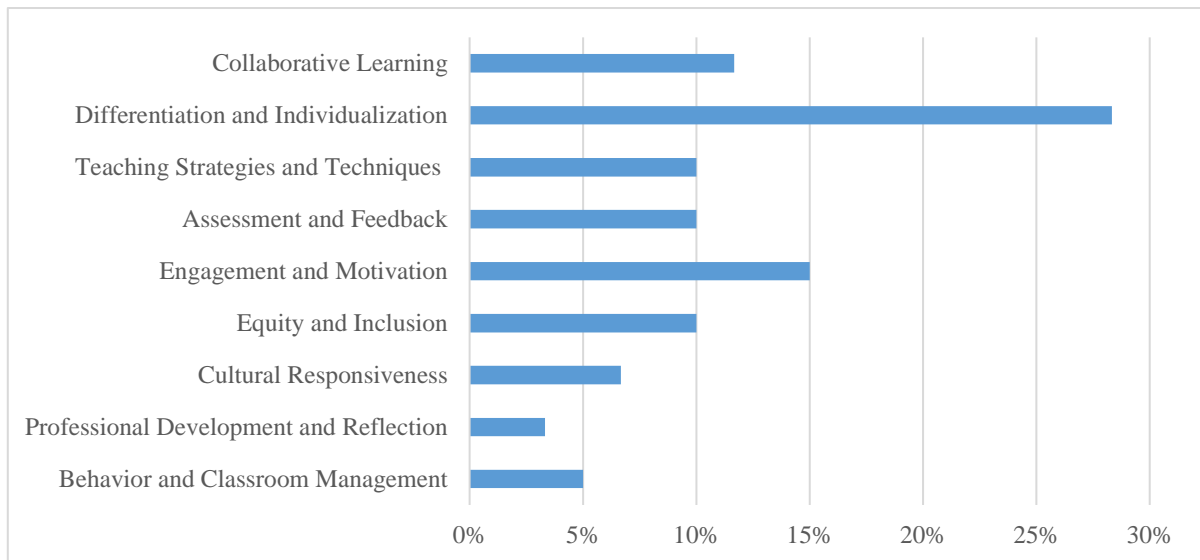


Figure 3. PSTs' Implemented Equitable Mathematics Teaching Approaches

Table 5

PSTs' Implementation of Equitable Mathematics Teaching

Strategies	PSTs' Implementation
Collaborative Learning	Students will be able to work in a group setting asking questions that they need assistance with. After the lesson we can join in a group and look over our answers together and use discussion questions to guide this group. (Kevin, 5 <sup>th</sup> grade, Long division)
Differentiation and Individualization	These learning tasks are appropriate for my students because it builds off their prior knowledge. We have been talking about addition and counting on. Also, my students are being split into groups based off their needs from the assessment that was given to them on Friday. Each of my groups based off this assessment will have different support levels or activities to meet their needs. This is scaffolding or changing the level of support to meet the ability of the child. (Hannah, 1 <sup>st</sup> grade, Doubles) (Individual) students will receive a higher level of thinking. Students can be introduced to larger two-digit numbers that they need to solve for each of the centers. ... (Advanced) students can receive an advanced list of questions that have larger two-digit numbers to solve. Students will solve the problems as a group or on their own (Ava, 2 <sup>nd</sup> grade, Addition regrouping through math centers).
Teaching Strategies and Techniques	First, I will review how to simplify $\frac{3}{6}$ using the greatest common factor ladder method. I will put this on the board and do step by step reviewing with the students. I will include real world connections in this step by talking about baking. I will say "If a recipe calls for $\frac{3}{6}$ cup and you do not have that size measuring cup you can simplify that down to $\frac{1}{2}$ cup." (Kevin, 5 <sup>th</sup> grade, Simplest form). I will connect my lesson to the real world by comparing how the numbers interact with each other is kind of like how a real family can interact with each other. A mother and father will interact in a different way than a mother and son would. Just like when you switch the numbers around in a fact family, you will get a different number (Fred, 2 <sup>nd</sup> grade, Turn around facts) I will utilize a number line to help me subtract numbers and have them do it alongside me to get more practice with subtraction. I will also do more examples with them using the dienes blocks and have them help me write the number bond and number sentence. We will then draw the pictures together using the dienes blocks. (Diana, 1 <sup>st</sup> grade, 1 and 1 Less).

Assessment and Feedback	For the students who need extra help I will assist them one on one in writing their addition number sentences. (Formative assessment)...For my students that are struggling the incorporation of pictures that go along with the problem will help them to visualize the problem and make it easier to solve. (Summative assessment) (Grace, 1st-grade lesson on subtracting)
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*Collaborative Learning* (11.7%) signifies the recognition of the value of student collaboration and cooperative learning experiences. PSTs employed various methods, including group activities, peer teaching, small group discussions, collaborative projects, peer feedback activities, and collaborative problem-solving tasks. An example, Kevin's 5<sup>th</sup> grade lesson on long division is shared in Table 5. The collaborative learning strategies provided students with opportunities to engage with their peers actively, enhance their collaboration and communication skills, and develop a sense of community, teamwork, and shared responsibility in the classroom. PSTs who had lower or no implementation rates of collaborative learning strategies may have relied less on group activities or cooperative learning approaches. Factors contributing to these lower implementation rates could include a preference for individualized instruction, time constraints, lack of training in collaborative teaching methods, or differing pedagogical beliefs.

*Differentiation and Individualization* (28.33%) received the highest implementation percentage, indicating a strong focus on tailoring instruction to meet the learning needs of students. PSTs prioritized adapting teaching methods and materials to accommodate varying abilities, learning styles, and interests among students. The varying levels of execution of these strategies among PSTs suggest that they approached differentiation and individualization with differing degrees of consistency and effectiveness. PSTs with higher rates of implementation of these strategies were more proactive in adapting their teaching methods to address the unique needs of each student in their classrooms. An example, Hannah's 1<sup>st</sup> grade lesson on doubles is shared in Table 5. By building on students' prior knowledge of addition and counting, the teacher ensures that new learning tasks are connected to what students already know, facilitating a smoother transition and deeper understanding. This practice of adjusting the level of support and activities based on students' abilities is a form of scaffolding, where the teacher provides varying degrees of assistance to meet the needs of each student (Çakmak, 2023).

As seen in Table 5, Ava also tailored her 2<sup>nd</sup> grade lesson on addition regrouping to address the needs of both individual students and a group of advanced learners. This approach promotes personalized learning experiences and helps students progress at their own pace, ultimately enhancing their overall learning outcomes. Conversely, other PSTs have demonstrated lower rates of implementation, indicating potential areas for growth in effectively differentiating instruction and providing individualized support to students.

*Teaching Strategies and Techniques* (10%) highlights the emphasis on developing effective teaching methods and instructional approaches. PSTs invested in enhancing their pedagogical skills and exploring innovative strategies to facilitate student learning. PSTs with higher implementation rates in utilizing these strategies were more proactive in employing a variety of instructional methods to support student learning. They demonstrated a diverse repertoire of pedagogical approaches to cater to the learning needs of their students, incorporating active learning strategies, technology integration, hands-on activities, and cooperative learning structures to enhance student engagement, understanding, and retention of mathematical concepts.

Three examples in Table 5 showcase effective teaching strategies that engage students in math through real-world connections and hands-on activities. Kevin simplified fractions using real-life examples, such as baking, to help students understand the concept more easily. Fred related math to family dynamics, demonstrating how changing numbers affects outcomes. Meanwhile, Diana used

visual aids and hands-on activities to teach subtraction, making the learning experience interactive and engaging.

*Assessment and Feedback* (10%) signifies a commitment to using assessment tools and providing constructive feedback to monitor student progress and guide instructional decisions. PSTs valued ongoing assessment to support student learning and growth. They monitored student learning, assessed understanding, and provided meaningful feedback to facilitate student development. PSTs also demonstrated a commitment to using both formative and summative assessments to gauge student progress, identify areas of strength and growth, and adjust instruction accordingly. They employed a variety of assessment tools and techniques, such as quizzes, tests, observations, exit tickets, and student self-assessments, to gather data on student learning and inform their teaching practices. PST Grace utilized a differentiated assessment for her 1st-grade lesson on subtracting from 4 and 5 for formative and summative assessments, as shown in Table 5. Furthermore, the implementation of feedback practices by these PSTs indicates a focus on providing timely and specific feedback to students to help them understand their strengths and areas for improvement, because effective feedback can motivate students, clarify expectations, and guide them towards achieving learning goals (Hattie & Timperley, 2007; Shute, 2008).

*Engagement and Motivation* (15%) emphasizes the importance of keeping students engaged and motivated in the learning process. PSTs recognized the need to create stimulating and inspiring learning experiences that capture students' interest and enthusiasm. They employed a variety of techniques to promote active participation and enhance overall learning experiences, incorporating hands-on activities, interactive lessons, real-world connections, gamification elements, collaborative projects, and other innovative approaches to make mathematics learning more engaging and relevant for students (see Casey's lesson on Shapes in Table 5). By incorporating these student-centered approaches into their lesson plans, PSTs aimed to create a learner-centered environment that actively engages students, empowers them to make choices, and encourages them to take ownership of their learning. These approaches not only support diverse learners and promote equity but also enhance student motivation and achievement in the classroom.

*Equity and Inclusion* (10%) reflects a commitment to promoting fairness, diversity, and inclusivity in the classroom. PSTs endeavored to create an equitable learning environment where all students feel valued, respected, and supported. Equity and inclusion practices refer to the efforts made by PSTs to establish a learning environment that is fair, inclusive, and supportive of all students, valuing their backgrounds, identities, and abilities. PSTs actively engaged in promoting diversity, equity, and inclusivity in their mathematics classrooms and prioritized creating a classroom culture that celebrated diversity. They incorporated culturally responsive teaching strategies, differentiated instruction, personalized support, and inclusive classroom management techniques to address the needs of their students and foster a sense of belonging for all learners.

Furthermore, the implementation of equity and inclusion practices among these PSTs demonstrates a commitment to fostering a learning environment where every student can thrive academically, socially, and emotionally (see Grace's final reflection in Table 5). By recognizing and addressing systemic barriers, biases, and inequalities, these PSTs have worked to create a more equitable and inclusive educational experience for all students.

*Cultural Responsiveness* (6.67%) underscores the importance of incorporating cultural awareness and responsiveness into teaching practices. PSTs aimed to acknowledge and celebrate students' diverse backgrounds, experiences, and identities in the classroom. Cultural responsiveness refers to the ability of PSTs to recognize, respect, and integrate students' diverse cultural backgrounds, experiences, and perspectives into their teaching. In her lesson, Casey encouraged her students to identify shapes in their reading material and relate them to objects they encounter in their everyday lives (see Casey's reflection in Table 5).

PSTs with higher implementation rates of cultural responsiveness were particularly effective in incorporating culturally relevant and inclusive practices in their mathematics classrooms, prioritizing creating a learning environment that honored and reflected their students' cultural identities and experiences. These PSTs integrated culturally diverse content, perspectives, examples, and instructional approaches that resonated with their students' backgrounds and lived experiences, thereby promoting a sense of belonging and cultural validation in the classroom. As Jacob noted in his final reflection, "To understand students' cultural backgrounds, it is important that I build relationships and get to know my students. Some ways I can get to know students are by sharing stories and learning about their interests." This commitment reflects a dedication to fostering cultural awareness, sensitivity, and inclusivity in the mathematics classroom.

*Professional Development and Reflection* (3.3%) refers to the practices of engaging in ongoing learning, self-assessment, and critical reflection to enhance teaching effectiveness and professional growth. A small number of PSTs implemented professional development and reflection to seek opportunities for improving their teaching practices, expanding their knowledge, and reflecting on their experiences to enhance their effectiveness as educators. They participated in activities such as training sessions, collaborating with colleagues, seeking feedback from mentors, and engaging in self-assessment practices to continuously improve their teaching skills and pedagogical approaches (see Kevin's final reflection in Table 5). These PSTs have demonstrated a growth mindset, a willingness to learn from experiences, and a commitment to ongoing professional growth and development. By engaging in reflective practices, seeking out professional learning opportunities, and actively participating in their own development, these PSTs are embarking on a path of lifelong learning and continuous improvement in their teaching practices.

While *Behavior and Classroom Management* (5%) was the lowest percentage category, it highlights the significance of establishing effective behavior management strategies and maintaining a positive classroom environment conducive to learning. PSTs focused on creating a structured and supportive environment that enabled students to engage effectively in learning activities. PSTs with higher implementation rates of behavior and classroom management strategies were particularly effective in creating a well-managed and orderly classroom setting that supported student learning and engagement. They employed strategies such as setting clear expectations, establishing routines, implementing consistent consequences, fostering positive relationships with students, and proactively addressing behavioral challenges. Additionally, they prioritized creating a safe, respectful, and structured learning environment where students felt supported, motivated, and able to focus on their academic tasks.

### **Comparison between perceived and implemented equitable teaching approaches**

The statistical frequencies (Figure 4) provide insights into the perceived and actual implementation of various equitable teaching practices, revealing several notable implications.

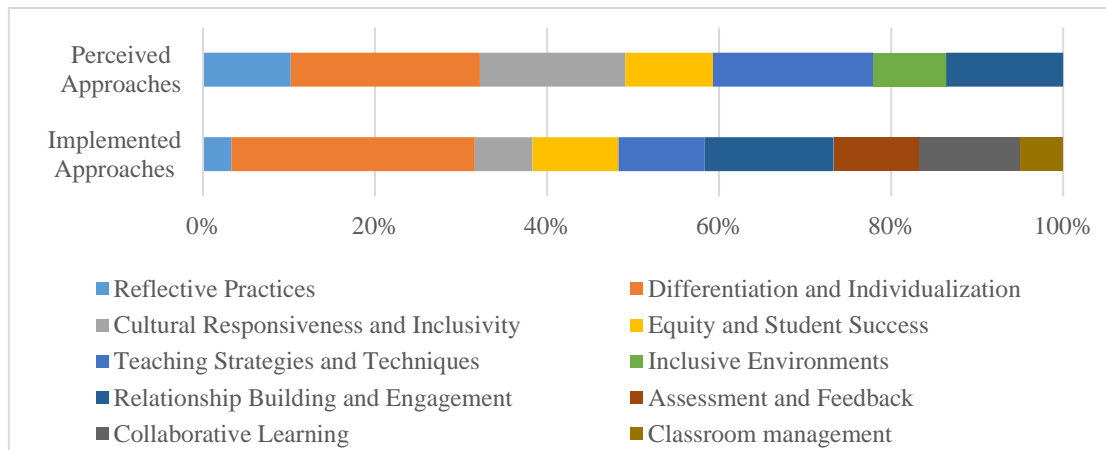


Figure 4. Comparison Between Perceived and Implemented Equitable Teaching Approaches

### ***Enhanced implementation, from perception to practice***

The data indicates a strong emphasis on Differentiation and Individualization, with a perceived importance of 22.0% and a higher implementation rate of 28.3%. This suggests that PSTs are effectively tailoring their instruction to meet the diverse learning needs of students, demonstrating a commitment to personalized learning experiences. The higher implementation rate for differentiation and individualization than perception indicates that PSTs focus on improving individual student outcomes. Additionally, Relationship Building and Engagement also showed a higher implementation rate than perceived importance, suggesting that PSTs recognize the significance of fostering positive teacher-student relationships and promoting student engagement in learning.

There were some areas with no perceived importance. The shift from zero percent to ten percent in implementing assessment and feedback strategies underscores their crucial role in enhancing teaching effectiveness and student learning outcomes. Collaborative Learning, which was initially perceived at 0%, was implemented at a rate of 11.7%, indicating a positive shift towards incorporating collaborative learning experiences once PSTs were actively engaged in the classroom. Similarly, Classroom Management, initially perceived at zero percent, was implemented at a rate of five percent, demonstrating a growing understanding that establishing effective behavior management strategies and maintaining a positive learning environment are conducive to student success. While some of the shifts may not be statistically significant, any increase in practice by a PST could have a meaningful impact on future students when these PSTs facilitate learning.

### ***Diminished implementation, from perception to practice***

The consistent implementation rate for equity and student success aligns with the perceived importance, indicating a commitment to promoting fairness and supporting student achievement. Equity and student success were perceived and implemented at a similar rate of one-tenth, reflecting a consistent focus in this area. However, there is a significant gap between the perceived importance of reflective practices, cultural responsiveness, and inclusivity, and their actual implementation rates. For reflective practices, the perceived importance was approximately one-tenth, while the implementation rate was significantly lower at about three-hundredths. In the area of Cultural Responsiveness and Inclusivity, the perceived importance was slightly less than one-fifth, whereas the implementation rate fell below one-tenth. This highlights a gap between awareness of the importance of cultural responsiveness and the actual integration of culturally inclusive practices in the classroom, suggesting a need to align beliefs with actions to ensure effective teaching practices.

Another area with lower implementation rates compared to perceptions was Teaching Strategies and Techniques, which had a perceived importance of approximately one-fifth but was implemented at

a lower rate of one-tenth. This suggests a potential area for improvement in diversifying instructional approaches to enhance student engagement and learning outcomes. Notably, Inclusive Environments were perceived to be less than one-tenth but were not implemented at all, indicating a lack of practice in creating inclusive classroom settings. This underscores the importance of university class discussions focused on fostering environments that embrace diversity and promote collaboration and respect among students, as well as field placements that exemplify what it means to create an inclusive classroom environment.

While some areas, like assessment and feedback, saw a notable shift towards implementation, others, such as inclusive environments, had no implementation. This highlights the need for a balanced approach to address all aspects of effective teaching. Overall, the findings emphasize the necessity for continuous reflection, alignment of beliefs with actions, and a comprehensive approach to teaching practices, where university instructors connect theory to practice to demonstrate to PSTs how to create inclusive, engaging, and effective learning environments for all students.

## **Discussion**

### **Alignment of beliefs and practices**

The study emphasizes the critical need to align PSTs' beliefs in equity and inclusivity with their teaching practices. When these beliefs are effectively reflected in their instructional strategies, it fosters a positive and diverse learning environment in mathematics education. This alignment not only enhances the overall classroom atmosphere but also positively impacts student experiences, as supported by the research of Cochran-Smith & Lytle (2009) and Darling-Hammond (2017). PSTs can implement this alignment in their lesson planning by incorporating culturally relevant materials and engaging students in discussions about their own experiences with mathematics.

### **Importance of reflective practices**

Reflective practices are crucial for preservice teachers (PSTs) as they engage in self-assessment and reflection to enhance their understanding of equitable teaching approaches. By critically evaluating their teaching methods, PSTs can identify areas for improvement and tailor their instructional techniques to meet the diverse needs of students effectively. This reflective process fosters continuous growth and improvement in teaching practices, as highlighted by the works of Lee and Herner-Patnode (2005) and Zeichner & Liston (2014). To engage in reflective practices, PSTs can maintain a teaching journal or participate in peer observation sessions. These strategies can provide PSTs with concrete feedback and insights into their teaching effectiveness.

The researchers recognize the value of employing a specific strategy to encourage the reflective process. The Gibbs' (1988) reflective cycle will be more explicitly utilized in future semesters. The plan is to provide a more structured approach to the reflective process, where PSTs will be given questions based on the cycle to guide their reflective practice (Nurlatifah, Purnawarman, & Sukyadi, 2023). The Gibbs cycle includes the following components:

- **Description:** PSTs describe what they are reflecting on without drawing any conclusions.
- **Feelings:** PSTs discuss their feelings about their efforts to engage students.
- **Evaluation:** PSTs evaluate how others react to their teaching and begin to make judgments about their processes. This is where university faculty would expect to see connections to theoretical frameworks.
- **Analysis:** This involves incorporating insights from cooperating teachers and university discussions.
- **Conclusion:** PSTs summarize the previous sections.
- **Action Plan:** PSTs explicitly state how they will apply what they have learned in the future.



This structured approach aims to enhance the effectiveness of reflective practices among PSTs, ultimately leading to improved teaching outcomes.

### **Promotion of inclusive environments**

PSTs' commitment to differentiation, individualization, and engagement strategies underscores their dedication to fostering inclusive classrooms. By recognizing and addressing learner diversity across various dimensions, PSTs create environments where all students feel valued, respected, and empowered to succeed. This inclusive approach not only enhances student engagement but also cultivates a positive and supportive learning environment, as noted by Tomlinson (2014). PSTs can implement differentiation strategies, such as using tiered assignments and flexible grouping, to better meet the needs of all learners.

### **Impact on student learning**

Creating inclusive and supportive learning environments in mathematics education significantly impacts student outcomes, as highlighted by Gay (2010b). By promoting equity, diversity, and inclusivity, PSTs contribute to a classroom culture where students can thrive academically, socially, and emotionally. This nurturing environment not only enhances student engagement and motivation but also leads to improved overall academic achievement.

### **Continuous professional growth**

The study highlights the critical role of continuous professional development for PSTs. By engaging in reflective practices, identifying areas for growth, and adapting their instructional techniques to meet student needs, PSTs can enhance their teaching practices and respond to the evolving requirements of their students. This ongoing professional growth is essential for promoting equity and inclusivity in mathematics education, ensuring that all students receive personalized and high-quality instruction, as emphasized by the National Council of Teachers of Mathematics (NCTM, 2014). PSTs should participate in workshops focused on culturally responsive teaching and collaborative learning communities to gain practical insights into their professional growth.

### **Influence of Institutional Policies and Cultural Contexts**

The study acknowledges that institutional policies and cultural contexts play a significant role in shaping PSTs' equitable teaching practices. Institutional frameworks, such as curriculum standards and assessment policies, can either facilitate or hinder the implementation of inclusive teaching strategies. For instance, policies that prioritize standardized testing may limit the flexibility teachers have in addressing diverse learner needs. Additionally, cultural contexts, including the demographics of the student population and community values, influence how PSTs perceive and enact equity in their classrooms. Understanding these dynamics is crucial for PSTs as they navigate their teaching environments. By critically engaging with these institutional and cultural factors, PSTs can better align their beliefs with their practices, ultimately fostering a more equitable and inclusive mathematics education. Future research should further explore how these external influences impact the effectiveness of equitable teaching practices in diverse educational settings.

### **Implications and Conclusion**

This study explores the realm of equitable mathematics teaching, focusing on the perspectives and practices of PSTs in addressing the learning needs of students. The findings highlight the alignment between PSTs' beliefs and their practical implementation of strategies to promote inclusivity and equity in the mathematics classroom. Through reflective practices, differentiation techniques, and engagement strategies, PSTs demonstrate a commitment to creating supportive and inclusive learning environments.

However, it is important to acknowledge the limitations of this study. The reliance on self-reported data may introduce bias, as participants might present their practices in a more favorable light than is accurate. Additionally, the narrow demographic scope of the participants limits the generalizability of the findings, as the sample primarily reflects the racial makeup of teachers in the United States, which is predominantly white females. This lack of diversity may not fully capture the experiences and challenges faced by PSTs from varied backgrounds.

To mitigate these limitations in future studies, it is essential to incorporate a more diverse participant pool that represents a broader range of racial, cultural, and socioeconomic backgrounds. Employing mixed-methods approaches, such as observational data and interviews, could provide a more comprehensive understanding of PSTs' practices and reduce the reliance on self-reported measures. Furthermore, longitudinal studies could track the development of PSTs' beliefs and practices over time, offering deeper insights into their growth and the impact of teacher education programs.

The implications of this study extend to teacher education programs, professional development initiatives, student learning outcomes, and educational policies, emphasizing the importance of fostering a culture that values diversity and promotes equitable mathematics education. By empowering teachers with the necessary tools and knowledge to effectively address student needs, schools and districts can work towards creating a more inclusive and supportive educational landscape for all learners. Teacher education programs should focus on equipping future teachers with the skills to promote equity in mathematics. Preparation should include reflective practices, differentiation, and strategies for writing lesson plans that accommodate all students. Since professional development can enhance teachers' ability to implement equitable mathematics teaching practices, schools and districts should provide continuous support for teachers to improve instructional strategies and build inclusive environments.

The study's findings have implications for policies regarding equity and inclusivity in mathematics education. Equitable teaching practices benefit student learning outcomes, motivation, and engagement in mathematics. Student-centered approaches, differentiation, and cultural responsiveness contribute to creating inclusive learning environments, leading to improved academic achievement and a greater appreciation for mathematics. Therefore, policymakers can utilize this research to guide decisions on curriculum, teacher training, and resource allocation. It emphasizes the importance of a collaborative educational ecosystem that prioritizes equity, diversity, and inclusion to support student success.

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