

## MULTICULTURAL MATHEMATICS DISPOSITIONS: A FRAMEWORK TO UNVEIL DISPOSITIONS TO TEACH CULTURALLY DIVERSE STUDENTS

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*We used the Multicultural Mathematics Dispositions (MCMD) framework to analyze preservice teachers' (PSTs) dispositions to teach diverse student populations during a cultural awareness unit in a mathematics methods course. The framework is defined as a function of three constructs: openness, self-awareness/self-reflectiveness, and commitment to culturally relevant mathematics teaching. We selected two assignments from the unit as our data sources. Using the framework, we analyzed the ways in which PSTs expressed any of the MCMD constructs in each of the assignments. Our analysis found that self-awareness/self-reflectiveness was the most common dispositional construct expressed by the PSTs, which led to their openness. However, few PSTs committed to using culturally relevant pedagogy in their future classrooms. Additional coursework may be needed to prepare PSTs to teach culturally diverse student populations.*

Keywords: Teacher Education-Preservice, Equity and Diversity

### Introduction

As the number of Black and Hispanic students, English Learners (ELs), and students living in poverty enrolled in U.S. public schools continues to increase (Kena et al., 2014), preservice teachers (PSTs) need to be prepared to work effectively with all students. Several mathematics teacher educators (MTEs) agree that it is important for PSTs to learn how to recognize and build on students' cultural and mathematical backgrounds to meet the needs of an increasingly diverse student population (Foote et al., 2012; Gutiérrez, 2009; Kitchen, 2005; Leonard, 2008). PSTs need to be made aware of the relationship between culture and learning and the way mathematics classroom cultures act as a context that supports or constrains different forms of knowledge (Gutiérrez, 2013; Nasir & Cobb, 2007). Being aware of culture and how it interacts with learning is especially important in the mathematics classroom because mathematics is typically thought of as a subject that is culture free (Nasir, Hand, & Taylor, 2008). MTEs can help PSTs examine their beliefs about mathematics and mathematics pedagogy, and learn that mathematics classrooms are places of enculturation where certain social norms and practices are valued, while others are considered inadequate (Diversity in Mathematics Education Center for Learning and Teaching [DiME], 2007). MTEs can also help PSTs "take into account the diverse ways in which students understand and see mathematics rather than automatically discarding them as deficient or inappropriate simply because they are different from their ways of thinking" (White, DuCloux, Carreras-Jusino, Gonzalez, & Keels, 2016, p. 164). This requires PSTs to have a disposition that is conducive to teaching mathematics to diverse populations.

### Conceptual Framework

Mathematics teachers' dispositions "are critically important because they underlie distinctions teachers are likely to make in moment-to-moment classroom activity" (Hand, 2012, p. 234). These dispositions play an important role in teaching practices and effectiveness. Thornton (2006) has asserted that it is imperative for teacher educators to find ways to develop PSTs' dispositions toward

multiculturalism. She defined dispositions as “habits of mind including both cognitive and affective attributes that filter one’s knowledge, skills, and beliefs and impact the action one takes in classroom or professional setting” (p. 62). White, Murray, and Brunaud-Vega (2012) argued that “teacher disposition can provide a more comprehensive perspective towards the construction of a teacher’s identity in the context of a multicultural classroom” (p. 33). Thus, PSTs need to develop culturally sensitive/critical dispositions in mathematics, which White et al. (2012) call *multicultural mathematics dispositions* (MCMD). The MCMD framework is defined as a function of three dispositional factors: openness, self-awareness/self-reflectiveness (SA/SR), and commitment to culturally relevant mathematics teaching. *Openness* is receptiveness to the role of culture in teaching and learning mathematics. It includes being open to (a) others’ cultures in perceptions about teaching, learning, or doing mathematics; (b) the inclusion of culture in mathematics classrooms; and (c) the use of culturally relevant strategies to teach mathematics (Ladson-Billings, 1995). *Self-awareness/self-reflectiveness* is understood as (a) identification of one’s own culture and perception of the differences between it and another culture, (b) awareness of one’s own beliefs about the influence of culture on teaching and learning mathematics or mathematics classroom culture, and (c) the ability to think critically about those issues. *Commitment to culturally relevant mathematics teaching* is the explicit intention of teachers to use culturally relevant strategies in the classroom.

The constructs of MCMD enable researchers to characterize and analyze PSTs’ dispositions to work with diverse student populations. Thus, we examined PSTs’ MCMD during a cultural awareness mathematics unit we designed for mathematics methods courses (White et al., 2016). The research question guiding the study presented here is: How does the MCMD framework unveil PSTs’ dispositions to teach culturally diverse students?

## Methods

### Participants

Three cohorts of PSTs who participated in the unit were enrolled in three different mathematics methods courses (*Elementary Mathematics Methods II*, *Middle Grades Mathematics Methods I*, and *Secondary Mathematics Pedagogy II*). Of the 60 PSTs, 48 were White females, 2 were Black females, 1 was a Black male, and 9 were White males. The distribution of the 60 PSTs enrolled in the three methods courses is shown in Table 1.

**Table 1: Distribution of Preservice Teachers by Cohort, Race, and Gender**

Cohort	White		African American		Total
	Males	Females	Males	Females	
Elementary	1	26	0	1	28
Middle Grades	3	12	1	0	16
Secondary	5	10	0	1	16
Total		57		3	60

### Cultural Awareness Unit

The goals of the cultural awareness unit were to help PSTs become aware of (a) the roles of teachers’ cultures, students’ cultures, and mathematics classroom cultures in students’ mathematical learning; (b) stereotypes about who can do mathematics; and (c) strategies for infusing culture in mathematics classrooms. In particular, the cultural awareness unit encouraged PSTs to reflect on their own views about culture and to challenge borders that limit diverse students’ access to mathematics in classrooms. We used Dumitrescu & Iacob’s (2012) definition of *cultural awareness* as “recognizing that all people do not have the same cultural background. It signifies one’s ability to stand back from oneself and become aware of both one’s own culture and another’s culture, i.e.

cultural values, beliefs, perceptions” (p. 122). The unit included an *Article Critique* (article search and reflection), *Class Discussions*, and a *Post Reflection* (post-discussion reflection). Table 2 details how each component is related to the MCMD constructs.

**Table 2: Components of the unit and corresponding tasks**

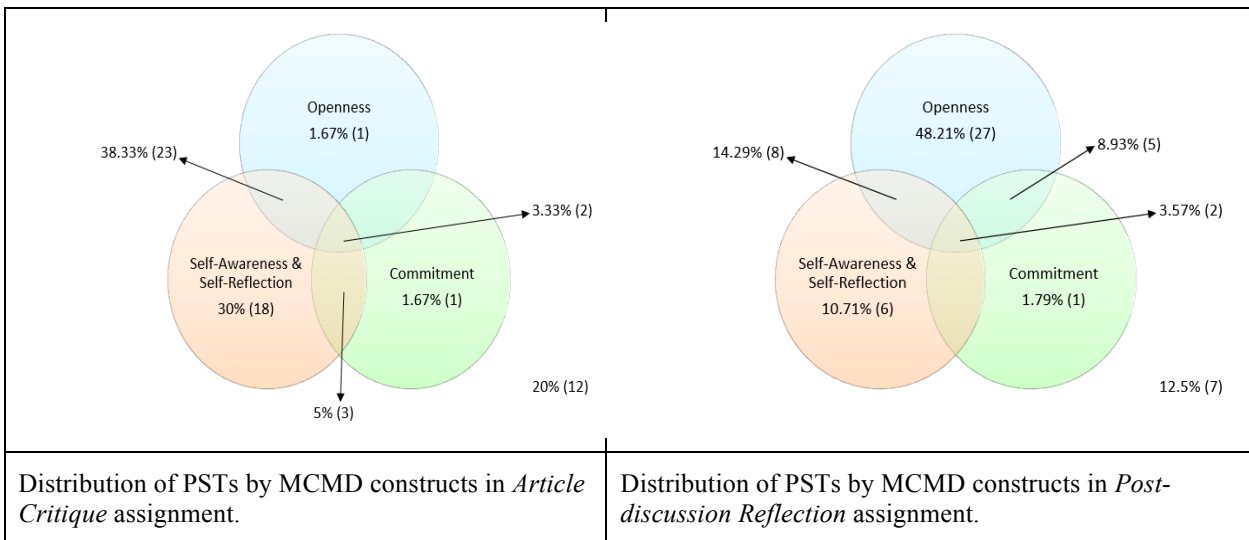
Component	Tasks	Development of MCMD
<i>Article critique</i>	<ul style="list-style-type: none"> <li>▪ Search for an article and write a reflection about teaching or learning mathematics to students who are culturally different than themselves</li> </ul>	<ul style="list-style-type: none"> <li>▪ Self-awareness by identifying their own culture and comparing to others.</li> <li>▪ Openness by learning culturally relevant strategies.</li> <li>▪ Openness by learning how others do mathematics.</li> </ul>
<i>Class discussion</i>	<ul style="list-style-type: none"> <li>▪ Share cultures and strategies discussed in article.</li> <li>▪ Define culture and create cultural tool list.</li> <li>▪ Discuss how culture relates to mathematics classrooms norms.</li> <li>▪ Discuss differences between stereotypes and generalization.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Openness as defined above.</li> <li>▪ Self-awareness/self-reflectiveness by reflecting on personal culture and experiences in the mathematics classrooms.</li> </ul>
<i>Post Reflection</i>	<ul style="list-style-type: none"> <li>▪ Write reflection on unit</li> </ul>	<ul style="list-style-type: none"> <li>▪ Openness and self-awareness as defined above.</li> <li>▪ Commitment by encouraging them to adopt culturally relevant strategies.</li> </ul>

### Data Sources and Analysis

Data were collected from the PSTs’ *Article Critique* and *Post Reflection* assignments. It should be noted that all the participants submitted the Article Critique, but only 56 of the 60 PSTs submitted the final assignment. A framework analysis (Ward, Furber, Tierney, & Swallow, 2013) method was used to analyze the data. Our analysis looked for patterns across the data sources to identify qualitative instances of PSTs’ MCMD. As a group, we read through the papers several times and coded sections of text according to whether they demonstrated openness, SA/SR, and/or commitment. Next, we reread the coded passages to further characterize the PSTs’ MCMD. More specifically, we wanted to know in what ways PSTs were open and SA/SR and what they were committed to doing in their future classrooms. Throughout the coding process, we discussed any discrepancies or questions until we reached consensus.

### Results

We were able to identify the presence of MCMD constructs in contributions from most of the PSTs. As shown in Figure 1, our analysis of the *Article Critique* unveiled openness in 26 PSTs, SA/SR in 46 PSTs, and commitment in 6 PSTs. By the end of the unit, analysis of the *Post Reflection* showed evidence of openness in 42 PSTs, SA/SR in 16 PSTs, and commitment in 8 PSTs. We were unable to characterize any of the MCMD constructs in 12 PSTs and 7 PSTs for the *Article Critique* and *Post Reflection*, respectively. What follows are examples of the PSTs’ MCMD for the two assignments.



**Figure 1.** Distribution of PSTs by MCMD constructs.

### Article Critique

The article critique was completed before the class discussion in order to limit our influence on PSTs’ views on culture and mathematics. By asking PSTs to read about teaching and learning mathematics to culturally diverse students and to reflect on their own cultures, we were able to unveil aspects of PSTs’ MCMD.

**Openness.** The majority of the PSTs were open to learning and including culturally relevant strategies to teach diverse students. A comment from Eva, an elementary PST, illustrates this form of openness:

I need to learn ways in which I can reach students who are culturally different from me. In fact, I think this strategy could be used for children of all cultural types. Having students create their own math problems that relate to their experiences not only helps them remember how to solve the problems, but lets the teacher get to know the students and what they are interested in.

Several PSTs were open to the idea that culture has a role in the way people do and learn mathematics. The article critique assignment helped them realize that there is no one way to do mathematics and that different students may think about mathematics differently. For instance, Joyce, an elementary PST wrote,

I was under the mistaken impression that numbers are just numbers, the same everywhere. The article pointed out, however, that symbols are often different in other languages, and words that we use to describe actions in math may be confusing, unfamiliar, or misleading ... Now that this has been brought to my attention, I will give it a lot more consideration as I am learning to be a teacher.

**Self-awareness/self-reflectiveness.** Most PSTs expressed awareness of aspects of their own culture and how these aspects differed from the cultures described in the article. Their comparisons focused on differences across race (White vs. Black and Hispanic), class (Upper middle class vs. Poor), and geography (Suburban vs. Urban or Rural). As Bella, a secondary PST wrote, “I attended a small private school with very little cultural diversity. As a result, I was not exposed to much diversity, especially linguistic diversity.”

A few PSTs were self-aware and self-reflective of their own culture and their mathematical experiences. They reflected on their experiences in the mathematics classroom and compared them to those of students with different gender, language, and race. As Sophia, an elementary PST wrote,

Wood, M. B., Turner, E. E., Civil, M., & Eli, J. A. (Eds.). (2016). *Proceedings of the 38th annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*. Tucson, AZ: The University of Arizona.

I am a White female that was brought up in an upper middle class family. I always thought my mathematical learning experience was equal to my classmates until I read this article. The article mentioned that females do not receive the same equity as males. I had never thought about this before but it is true that in my high school mathematics classes the smartest people were always boys. It seemed like they always knew so much more than me which lowered my confidence in doing, mathematical problems. ... Realizing how this made me feel, I cannot imagine what this does to people that are even more different than White, upper class males. For example, someone who is an African American, lower class female must be very intimidated during math classes.

Sophia's quote shows how she positioned her mathematics experience in the classroom at the intersection of her gender and race. Sophia came to realize how our experiences in the mathematics classroom are shaped by cultural factors and how different we are from the "White, upper class males" standard.

**Commitment to culturally relevant mathematics teaching.** Although most PSTs saw the value of using culture in the classroom, only a few expressed their commitment to use culturally relevant strategies to teach mathematics. PSTs who expressed a commitment to using culture in their future classrooms made comments similar to the following quote by Wade, a secondary PST:

One of the strategies from this article I would implement in my future math classroom is opening clear pathways for communication between students, parents and myself. Another strategy I would use is having material that applies to their culture and that students can relate to culturally. This strategy can be achieved by learning about your students and determining what the students are interested in and what they may deem culturally relevant.

Wade's quote suggests that the article critique assignment offered concrete examples that PSTs could access if they were considering using culturally relevant strategies in their own classrooms.

### Post Reflection

The post reflection was the last component of the unit. PSTs reflected on their experiences writing the article critique and participating in the class discussions where they shared their ideas and listened to the ideas of their peers and us as instructors.

**Openness.** More than half of the PSTs showed openness to the idea that different cultures may think about and do mathematics differently and they have a role in supporting students' mathematical learning. A quote from Hannah, an elementary PST, is an example:

Looking at cultural diversity, especially through a mathematical lens, has changed the way I look at teaching. I thought that being culturally different really only affected a person in reading and maybe social studies, but not math. However, now I know that's not true. Different cultures view and do math in different ways. Some algorithms are completely different across the world and teachers need to be prepared to teach students with all these varieties of methods. Students who speak different languages cannot grasp a strong or a conceptual understanding of math because they cannot understand what is being taught. Overall, this focus has really opened my eyes and made me more aware of cultural diversity in the classroom. I know this will impact my methods and actions as a teacher.

As Hannah's quote suggests, the post reflection challenged her assumption that mathematics is a universal and culture-free subject. Hannah realized that culture has a prominent role in shaping the way people do and learn mathematics, and hence it is important to take cultural diversity into account when teaching mathematics.

Several PSTs also mentioned how listening to their peers helped them realize the role of culture in learning and teaching mathematics. These PSTs expressed that the unit opened their minds to the importance of cultural awareness for teachers. Hope, a secondary PST, described this effect:

I think the biggest help for me was just listening to what other students in our class thought. ... It is so great to be able to see so many different views. After this unit, I feel like I see a clearer need for cultural awareness in our classroom environments. Until it is pointed out, I think people have a hard time understanding how their culture may be so much different from someone else's. It is so important that we are aware of this as teachers. Learning about and being aware of our students' cultures will have us connect with them as well as help us to [not] unintentionally offend them.

Hope explained how listening to her peers helped her pay attention to different “key points” from the article critiques and others’ points of view.

**Self-awareness/self-reflectiveness.** We found the most common characterization of PSTs’ SA/SR included awareness of their role in creating an inclusive mathematics classroom culture, the impact of stereotypes on student learning, and the importance of teachers critically thinking about the intersection of various cultures -- teachers, students, classroom, and school -- in the classroom:

This unit has helped me see that students and teachers bring their cultures into the classroom, and that these cultures affect how mathematics is learned. Teaching students with diverse backgrounds does not involve ignoring differences, but rather involves drawing on these differences. Students should not feel as though they must set aside their cultural identity when learning mathematics. [Justin, secondary PST]

I feel that this exercise was one that every teacher should be exposed to because we see in our classrooms how teachers that have been around lack the ability to see outside their own experiences. Stereotypes are running rampant and are reinforced by accident everyday. We as future educators need to realize that impartiality is crucial to having a fair classroom and setting up a classroom culture that mirrors reality. [Derrick, secondary PST]

As Justin suggested, the unit helped PSTs become aware of the importance of incorporating cultural differences in the classroom rather than ignoring them so that all students feel included. Some PSTs were more reflective, as illustrated by Derrick’s quote. These PSTs reflected on the negative impact of stereotypes on student learning and the importance of being able to “see outside of their own experiences” to avoid stereotyping students.

**Commitment to culturally relevant mathematics teaching.** Similar to what we found in the article critique, few PSTs showed some form of commitment. The PSTs who showed commitment in the post reflection were motivated to include diverse methods of doing mathematics, methods that come from different cultures. Paula, a middle grades PST, wrote

I also learned how important mathematics is in different cultures. I will take this new knowledge and apply it to my classroom. I will be sure to research again the mathematics principles of cultures other than the American culture so that I can accommodate all of the students in my classroom. Even if the students in my class are from one culture, I will still include methods of instruction that other cultures are accustomed to. I believe this will make math more interesting for both me and my students. They will view math as a universal commodity that is helpful for real life applications.

### Discussion

Establishing PSTs’ dispositions toward culture in mathematics helps future teachers to understand “no culture is monolithic; every culture consists of multiple subcultures” (Leonard,

Brooks, Barnes-Johnson, & Berry, 2010, p. 267) and that culturally relevant teaching is useful. This study contributes to the growing literature on ways to help PSTs reflect on issues of equity in mathematics and to prepare them to effectively teach all students. We used the MCMD's three constructs – openness, SA/SR, and commitment— as a lens to unveil PSTs' dispositions to teach diverse students. Our analysis suggests that PSTs want to learn and use strategies for teaching mathematics and they benefit from discussions with peers to reflect on their ideas about culture. An interesting finding from this study was the inverse relationship between the openness and SA/SR constructs. Initially the percentage of PSTs expressing self-awareness was greater than the percentage with openness; however, this relationship had shifted by the post reflection at the end of the unit. This finding supports Mills and Ballantyne's (2010) claim that SA/SR evolves towards openness.

We believe the multiple opportunities for PSTs to express their MCMD during the unit supported PSTs' progression towards openness. In this study, PSTs' self-awareness of their own mathematics learning experiences, especially their reflections on traditional approaches they had experienced, seemed to support them to want to provide their future students with more opportunities to learn mathematics. Learning about their students' cultures and using them in the classrooms is a strategy PSTs became more aware of and open to learn. The class discussion was an opportunity for PSTs to learn about their peers' views about culture and their experiences learning mathematics, mathematics stereotypes, and the various cultural norms that exist in mathematics classrooms. The PSTs' post reflections unveiled that PSTs broadened their views on openness as they realized that they were different from their seemingly same peers. Their post reflections showed more openness, and their SA/SR involved a more critical analysis of their own experiences. We were not surprised that only a few PSTs were willing to commit to using culturally relevant strategies. PSTs do not have their own classrooms and have limited opportunities to try strategies in the practicum classrooms. Our analysis suggests that additional experiences, reinforcement and practice are needed to adequately prepare PSTs to teach for diversity, especially PSTs' commitment to using culturally relevant strategies.

We have used the MCMD framework to unveil PSTs' dispositions toward diversity and culture during a cultural awareness unit. This framework has also been used to examine the development of equity and social justice dispositions among PSTs (Chao & Murray, 2015). Further research is needed to examine MCMD in various contexts, how to support the development of MCMD, and the ways MCMD are enacted in classrooms with diverse student populations.

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