

Discovering Multicultural Mathematics Dispositions

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Culture refers to the consistent ways in which people experience, interpret, and respond to the world around them; it represents the “ways of being” of a collective population.... Culture is a feature of all human groups and is shaped by historical, social, political, economic, and even geographical factors.... Additionally, culture can be reinforced through contacts with social institutions such as places of worship and schools. (Marshall, 2002, p. 8)

There is a well-documented relationship between culture and learning with studies highlighting how mathematics classroom cultures act as a context that supports or constrains different forms of knowledge (Boaler, 2006; Gutierrez & Rogoff, 2003; Nasir, Hand, & Taylor, 2008). Nasir and colleagues argue, “mathematics classrooms are inherently cultural spaces where different forms of knowing and being are being validated” (p. 206). As U. S. public school populations become increasingly diverse (Aud et al., 2011), we must prepare teachers to work effectively with all students especially in mathematics where too many Black students are underperforming. According to Kitchen (2005), mathematics teachers can be prepared to meet the needs of an increasingly diverse student population by learning how to understand and recognize students’ cultural backgrounds while engaging and challenging students in mathematics.

There is an emerging literature that suggests establishing preservice teachers’ (PSTs) dispositions toward culture in mathematics helps them to understand that “no culture is monolithic; every culture consists of multiple subcultures” (Leonard, Brooks, Barnes-Johnson, & Berry, 2010, p. 267) and that culturally responsive teaching (Gay, 2000, 2002; Ladson-Billings, 2000; Leonard, 2008) can

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be used with all students. As schools and colleges of education are responsible for challenging prejudices and cultural biases of PSTs, and for finding strategies to shape these beliefs (Sleeter, 2001), mathematics methods courses can provide an opportunity to explicitly address issues of culture and diversity. Furthermore, because teachers' dispositions toward students' cultural background play an important role in their teaching practices and effectiveness (Thornton, 2006), it is important to find ways to develop PSTs' dispositions toward multiculturalism.

In particular, as we prepare PSTs to educate Black children, we need to look beyond the often documented "achievement gap" that has encouraged the idea that Black students are deficient in mathematics. Focusing solely on achievement fails to take into account how and why Black students experience mathematics as they do and how mathematics learning and participation are racialized forms of experience (Martin, 2007). When we focus on *experience* rather than achievement, we are better able to consider how we can prepare teachers to work effectively with not only *all* students but also specifically with Black students. Studies that document the relationship between teacher knowledge and increased student achievement fail to question "teachers' dispositions and beliefs about who can or cannot learn mathematics, who is math literate and who is not, and why they believe what they do" (Martin, 2007, p. 14). To understand how to best prepare teachers to teach Black children, we have to think about dispositions and beliefs as well as how teachers act on their perceptions given that these actions will help shape the cultural, racial, and mathematical identities of Black students.

The study reported in brief here, suggests that a cultural awareness unit provides a reasonable starting point to examine PSTs' dispositions to culture in mathematics. In this paper, we use written responses from the cultural awareness unit to describe PSTs' *multicultural mathematics dispositions*. After a brief overview of the relevant literature, we define multicultural mathematics dispositions and its use as the conceptual framework undergirding this study. We then present the results of the study and propose implications for mathematics methods courses.

Relevant Literature

The literature on teaching for diversity puts forward that many forms of pedagogy are effective. Teachers can incorporate multiculturalism (Kitchen, 2005), social justice (Gutstein, 2003; Martin, 2003), or culturally responsive pedagogy into their classrooms. Culturally responsive pedagogies use "the cultural knowledge, prior experiences, frames of reference, and performance styles of ethnically diverse students to make learning encounters more relevant to and effective for them" (Gay, 2000, p. 29). However, many White teachers assume that culture is something other (non-White) people have (Sleeter, 2000, 2001) and that

mathematics is culture free. Given that White teachers comprise the majority of public school teachers (Aud, et al., 2011), we need to prepare *all* PSTs to understand the role of culture in the teaching and learning of mathematics. That is, PSTs need to become critically conscious of their own view of the world and cultural socialization in mathematics to understand how it affects their attitudes and behaviors toward people and cultures of other ethnic groups (Gay, 2002; Villegas & Lucas, 2002).

Teacher disposition can provide a more comprehensive perspective towards the construction of a teacher's identity in the context of a multicultural classroom. Dispositions are "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" (Thornton, 2006, p. 62). Teacher educators must consider PSTs' dispositions in order to help PSTs develop awareness and sensitivity to diverse learners.

de Freitas (2008) explored PSTs' resistance to include issues of social justice in school mathematics. Twelve PSTs analyzed their classroom practices and wrote self-study narratives as a form of critical reflection. Through the narratives, they became aware of how the mathematics classroom represents a place of enculturation and a place where particular teacher and students' identities are developed. Some PSTs realized that their teaching practices repeated the same patterns of exclusion for underrepresented students, but were unable to recognize how their "teacher identities" (p. 53) were related to the sociopolitical framing and power relations in the mathematical classroom. de Freitas found that self reflection had a profound influence on PSTs' awareness of mathematics classroom cultures and recommended implementing some form of reflection in mathematics method courses.

Kidd, Sanchez, and Thorp (2008), in their study of 19 elementary PSTs' dispositions and teaching practices, reported five experiences that impacted PSTs' dispositions. These included readings concentrating on issues of race, culture, poverty, and social justice, critical reflection, and discussion. The researchers concluded that opportunities for critical reflection and discussions were essential to changes in dispositions. Similarly, Dunn (2005) studied elementary PSTs' reflections on diversity activities in a mathematics method course. She found that in order to engage in critical reflection, PSTs need to experience a paradigm shift and a phase of disequilibrium while their beliefs about mathematics content, teaching, learning and students are challenged. She recommended challenging PSTs preconceived notions of diverse learners and encouraging critical reflection to broaden PSTs' vision of teaching and learning mathematics.

Garmon's (2004) case study of a White female PST identified important factors that facilitated multicultural awareness and attitudes toward diversity. More specifically, he identified three dispositional factors: (a) openness to diversity, (b)

self-awareness/self-reflectiveness, and (c) commitment to social justice. Garmon concluded that personal experiences with diversity coupled with the opportunity for processing them “may be critical to developing greater multicultural awareness and sensitivity” (p. 212). Thus, dispositional factors may determine how ready a PST is to learn from his or her multicultural educational experiences and may predict the success of programs designed to develop PSTs’ awareness and sensitivity.

The aforementioned literature suggests that teacher education courses that engage PSTs in critical reflection through discussions about culture and diversity promote awareness of the role of culture in the teaching and learning process. By challenging PSTs’ beliefs and awareness, teacher educators can support the development of PSTs’ critical reflection and responsive dispositions. Responsive dispositions are necessary to prepare teachers to work in culturally diverse classrooms in order to “reverse the cycle of underachievement and educational disadvantage for diverse learners” (Dunn, 2005, p. 144). However, we need to further identify the essential factors that comprise critical reflection and responsive dispositions in mathematics education.

The Multicultural Mathematics Dispositions Framework

Extending the scholarship of Garmon (2004) to mathematics education, we developed the construct *multicultural mathematics dispositions* (MCMD), which are characterized by three dispositional factors: Openness, Self-awareness/Self-reflectiveness, and Commitment to Culturally Responsive Mathematics Teaching. Each construct of MCMD and its relation to Garmon’s work is described in Table 1.

Table 1
Comparing Garmon’s Dispositional Factors and MCMD

Garmon	MCMD
<i>Openness</i> : “Receptiveness (i.e., open-mindedness) to others’ ideas or arguments, as well as receptiveness to diversity” (p. 202).	<i>Openness</i> is receptiveness to the role of culture in teaching and learning mathematics, including being open to: (a) others’ cultures and arguments about teaching and/or learning mathematics, (b) the idea that different cultures may think about and do mathematics differently than oneself, (c) the inclusion of culture in mathematics classrooms, and (d) the value of using culturally responsive strategies to teach mathematics.

Self-awareness/self-reflectiveness: “Having an awareness of one’s own beliefs and attitudes, as well as being willing and/or able to think critically about them” (p. 202).

Self-awareness/self-reflectiveness is perceiving the differences between one’s own culture and other cultures. This entails: (a) awareness of personal culture beyond recognizing differences from others; (b) awareness of personal 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 social justice: “A sense of social justice as a commitment to equity and equality for all people in society” (p. 202).

Commitment to culturally responsive pedagogy includes: (a) understanding students’ cultures and different ways of incorporate culture in teaching, (b) holding high expectations for all children, and (c) exposing children to rigorous mathematics. MCMD should encourage mathematics teachers to see mathematics as a cultural activity and their role as a mediator between students’ culture and mathematical learning.

Methods

Context

The study took place in the College of Education at a large southeastern university. Three cohorts of PSTs ($n = 76$) enrolled in mathematics methods courses, taught by the first author, participated in the cultural-awareness unit. Two of the cohorts were elementary education majors and the third consisted of middle school education majors. Most PSTs were White females, except for one African American female, two African American males, and four White males.

Cultural-Awareness Unit

The cultural awareness unit in this mathematics methods course allowed PSTs to express their MCMD as they learned how to teach mathematics. We focused on PSTs’ awareness of the role of culture in the teaching and learning of mathematics, stereotypes about who can do mathematics, and strategies to teach mathematics. The unit consisted of: (a) article search and reflection, (c) class discussions, and (c) post-discussion reflection. Each part is discussed below with attention to how it enabled us to characterize the three constructs of MCMD among the participants.

Article search and reflection. This first assignment required PSTs to search for, read, and write a reflection on an article that addressed teaching and/or learning mathematics to students who are culturally different from them. Prior to this assignment we did not discuss culture to avoid influencing PSTs views about cul-

ture as they wrote their reflections. Having the freedom to select a culture required them to express *self-awareness*, given that they had to recognize their own culture to find differences between their culture and the culture in the article. Reflecting on the strategies for infusing Black culture in the mathematics classroom helped PSTs reveal their *openness* to the idea that different cultures may think about and do mathematics differently and their valuation of using culturally responsive strategies in mathematics. This assignment was expected to be enlightening and informative about PSTs' points of view (Taylor & Sobel, 2001).

Class discussions. The second part of the unit included class discussions of the article reflections, the nature of mathematics classrooms, and how culture influences students' access to mathematics. The discussions lasted two days and began with the Kola Nut Welcoming Activity (Ukpokodu, 2002). Ukpokodu suggests PSTs are more likely to engage in discussions when they are welcomed into a safe space. Instead of kola nuts, we passed a bowl of Hershey kisses to mirror a southern custom of welcome and to set the tone for the class discussion. Next, each PST shared his or her article with the class. This allowed them to learn from each other and to further their *openness* to other ways of thinking about doing, learning, and teaching mathematics.

The activities of the second day helped PSTs think critically about the role of culture in mathematics education. We began with Marshall's (2002) definition of culture and had the PSTs discuss their personal cultures by completing a *cultural toolkit*. In this activity they listed up to 10 characteristics to describe their culture (e.g., Southern: likes sweet tea and football; values education and religion). They then reflected on whenever they had been part of the "other" or non-dominant culture, how they felt and what they did. Rather than present PSTs with a particular scenario to critique, we wanted them to talk about their personal experiences to further develop their *self-awareness/self-reflectiveness*.

Finally, PSTs thought about and discussed how teachers' cultures, students' cultures, and mathematics content interact in classrooms. We considered various stereotypes related to who is and is not perceived as being good at mathematics, the implications of stereotypes on students' mathematics learning, and how teachers can combat some of these stereotypes.

Post-discussion reflection. In the last part of the unit, PSTs reflected on the previous activities and discuss how those activities influenced their views about the role of culture, teaching, and learning mathematics. These final reflections allowed us to note the aspects of the cultural awareness unit that seemed to influence PSTs' views and *commitment* to teaching culturally responsive mathematics.

Participants

The cultural awareness unit required preservice teachers to learn about teaching mathematics to a culture other than their own. Students chose to learn

about a variety of cultures, including Black (African-American, Caribbean, or African), Hispanic and Latina/o, Native American, urban, low SES, and Ancient Egyptian. Forty-two percent ($n = 32$) of the preservice teachers chose to explore Black culture and were included in this study. Thirty were White females, one White male, and one African-American female. In this paper, we describe the MCMD of the 32 PSTs as they provide insight into the preparation of teachers of Black children.

Data Analysis

Thematic analysis (Braun & Clarke, 2006) was used to analyze the data. Thematic analysis is “a method for identifying, analysing and reporting patterns (themes) within data” (p. 79). First, we read all the article reflection papers to categorize the culture PSTs explored. Then we selected only those papers related to Black culture ($n = 32$) for further analysis. According to Patton (2002), “purposeful sampling focuses on selecting information rich cases whose study will illuminate the questions under study” (p. 230). Next, we read the article-reflection and post-discussion papers to identify the presence of the MCMD constructs. For each paper, we highlighted and analyzed passages that showed evidence of the constructs as understood from the PSTs’ perspectives. Any coding questions or disagreements were discussed until we reached consensus.

Results

We discovered passages relating to at least one of the MCMD constructs in 28 out of 32 PSTs’ written work. We were unable to identify any passages relating to MCMD in the remaining four PSTs work. For these PSTs, their comments were generic in nature. For example, when students talked about teachers in general, rather than personal experiences or understandings, we did not code the passage as MCMD: “Presenting multiple views of mathematics allows the teacher to touch all types of learners.” These comments were vague, and seemed to be paraphrasing the article or another’s ideas, or did not display an understanding of culture or culturally relevant teaching.

Openness

Nineteen PSTs demonstrated some form of openness. They were open to learning about Black culture and ways to include culture in the classroom. Through this unit they learned more ways to think about and do mathematics:

Learning about other culture’s differences and appreciating these differences opens our minds up to the way children in our class perform math. It is so important to respect children’s cultural differences because as teachers we need to realize that they

may have different views on things and may have been taught different mathematical methods. We were influenced by this article to not only embrace cultural differences, but to learn something new from someone's culture whether it be the way they perform math, the clothing they wear, customs, etc. [Hazel]

Most PSTs were open to classroom strategies that make connections between mathematics and real world contexts. They saw the value of creating mathematics problems from Black students' lived experiences:

Another strategy that was discussed in class was relating mathematics to everyday life and to the culture of your students. I found this extremely interesting because I have never thought of using hair braiding to learn mathematics. I think that as a teacher I will relate math to anything I can that will help my students learn...I think it does make a difference if you use real life ideas that students are interested in for the premises in math problems. [Karen]

In addition, some PSTs saw learning more about students' cultures and using culturally relevant strategies would help their students learn mathematics and make them better teachers: "It is this type of connection with culturally relevant ideas and practices that will excite our students and help them become invested in their mathematical learning."

Self-Awareness/Self-Reflectiveness

Most PSTs ($n = 24$) were aware of and could identify aspects of their own personal culture, such as gender, race, socioeconomic status, and language. Some mentioned family and community characteristics, including religion and country of origin as being a part of their culture. They identified their culture and how it was different than Black culture. However, oftentimes their self-awareness was at the surface level and included assumptions about Black students:

One of the biggest differences between me and the students discussed in the article is that I am Caucasian and they are African American. I am originally from a small town, and I grew up very far from the city. However, these children live and attend school in the middle of a bustling metropolis. I am used to slow paced, uneventful, quiet days where these students are used to the total opposite. In my community, church is a big part of our culture, but I feel it is an even bigger part in this African American community. Through it is not stated in the article, I am assuming that the students come from a low socioeconomic status, which also differs from me. [Karmen]

Self-awareness/self-reflectiveness includes the ability to reflect on personal beliefs about culture in teaching and learning mathematics. Several PSTs reflected back on the mathematics classroom cultures they experienced as students of mathematics and became aware of different practices for teaching mathematics.

One PST wrote about traditional mathematics teaching and how her parents stressed this culture at home:

I attended public schooling where the teacher taught me particular algorithms as a way and the only way to compute. I was never allowed to be creative and invent my own way to solve a problem. It was always the teacher's way or it was wrong, even if I arrived at the correct answer. My teachers were all about memorizing the formula instead of understanding the concept. I was rarely ever taught two different ways to solve one specific problem. My parents were also taught this way so they reinforced this idea of mathematics. However, many of the people mentioned in this article are from diverse backgrounds where they were taught a different way to think about mathematics. [Alma]

The few PSTs who thought critically about the role of culture in mathematics education, reflected on their personal culture and how minorities are viewed in society:

The African American urban population also differs from myself in the way that they are viewed by others. I am a Caucasian coming from a suburban, middle class area. I believe that society at large would consider someone like myself as having a good chance of having a successful and accomplished career and personal life. [Kim]

Finally, PSTs reflected on how they were treated differently based on personal characteristics and the role of stereotyping. The following excerpts exemplify how stereotyping in mathematics classrooms privileged or disadvantaged PSTs as mathematics students:

I was usually in gifted or accelerated mathematics classes, so my teachers were continuously challenging me to go beyond the basic answer and understand my thought processes behind it. I feel that because classmates and I were Caucasian, many of our teachers assumed we could handle the workload that we were given, even if some of us were not academically adept in that regard. [Rebecca]

I really came to realize how I have been stereotyped and even how that happens to many of my friends...It seemed that some teachers came to expect less from me because I played sports. Sometimes I would play into this and not live up to my potential. My favorite teachers were the ones that often pushed me the hardest and had high expectations for me...I want to try and have an environment that doesn't really rely on stereotypes. I know that it will be up to me to monitor myself so that I do not stereotype my students. I also know that the less I stereotype the better the environment will be for learning math. [Bob]

Commitment to Culturally Responsive Mathematics Teaching

Ten PSTs expressed commitment to infusing issues of Black culture into their future mathematics classrooms. They wrote that they would teach mathemat-

ics by including: students' own strategies, students' culture, or culturally responsive strategies to teach mathematics. As Judy noted, "I feel that these activities would have really benefited me as a learner. I plan to use one or some of these activities in my future classroom." Others committed to abandoning the traditional way they were taught mathematics. Leslie's quote is an example, "Rather than following ineffective methods that my mathematics teachers used, I plan on using strategies from this article to benefit each of my unique students."

Conclusions and Implications

The literature on preparing PSTs to teach culturally diverse students highlights the need for critical reflection and discussion of issues of diversity (Kidd et al., 2008; Leonard & Evans, 2008), and the importance of developing multicultural dispositions (Dunn, 2005; Garmon, 2004). Our unit was designed for PSTs to make explicit their multicultural *mathematics* dispositions.

The purpose of this study was to examine preservice teachers' MCMD during a cultural awareness unit in a mathematics methods course. We exposed them to culturally different ways of doing and teaching mathematics, asked them to reflect on their own mathematical experiences (de Freitas, 2008; Dunn, 2005), and the ways race, class, and culture influence learning (Kidd et al., 2008). The class discussions allowed PSTs to share what they learned and invited others to ask questions or talk about their own article and experiences, which supported MCMD. Similar to Garmon's (2004) finding, our PSTs illustrated openness to new understandings about Black culture, strategies to connect Black culture with mathematics, and the importance of culturally responsive strategies.

de Freitas (2008) notes that reflecting on mathematics experiences help PSTs "understand the intersections between their experiences in school mathematics and the cultural framing of those experiences" (p. 50). In this study, most PSTs were willing and capable of thinking about how their cultures differ from Black culture, and how their experiences in mathematics classrooms influenced their views about what it means to do and learn mathematics. Further, most PSTs saw the value of using culturally responsive strategies in the classroom, but only ten were ready to commit. Therefore, while several PSTs' were self-aware about their own culture, their self-awareness/self-reflectiveness remained superficial and included assumptions about Black students. The unit made us aware of such pre-conceived notions of Black students, but additional research is needed to understand how PSTs' comments could be situated in MCMD and what additional coursework could help develop MCMD.

Mathematics methods courses provide an opportunity to develop MCMD by tackling issues of culture, diversity, and mathematics. PSTs need direction to understand the multiple layers of culture, the cultures surrounding them and those

they will create when they teach. Otherwise they will continue to create classroom cultures and engage in classroom practices that perpetuate limited opportunities and barriers for students to learn and do mathematics. This study highlights the potential of MCMD in the preparation of teachers in general, and mathematics teachers of Black students in particular. Our cultural awareness unit provides a reasonable starting point for the development of productive practices and habits of mind in cohorts of PSTs. In the future, we would like to build on this initial study to better understand what the presence, or absence, of certain constructs might tell us about PSTs.

In this study, we only focused on the presence of MCMD. Our analysis suggests that there are levels of openness, self-awareness/self reflectiveness, and commitment. In particular, we need a better understanding of how we might think about different levels of each construct and what these levels can tell us about PSTs' experiences, needs, and potential as future mathematics teachers of Black children.

At the Symposium

The conversations at the symposium allowed us to learn about current research. The MCMD framework was well received with several attendees stating that it would allow them to think more critically about the comments they hear from PSTs and classroom teachers. Additionally, many others expressed an interest in using the unit in their methods classes. Our presentation, and the presentations of others, highlights the need for researchers and educators to define what we want Black children to know and do in mathematics and the cultural norms that need to exist in mathematics classrooms to achieve these goals. We need to support the education of Black children and MCMD provides a tool to achieve this.

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White et al.

Multicultural Dispositions

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