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How Do We Learn? African American Elementary Students Learning Reform Mathematics in Urban Classrooms

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In this article, the author uses qualitative methodology to investigate how African American elementary students in an urban school engaged with a National Council of Teachers of Mathematics standards-oriented mathematics curriculum and how their engagement converged with or diverged from the offered patterns of teaching practices in classrooms. The findings suggest that student practices converged with teaching practices that reflected the African American cultural dimension of social/affective interactions such as focused collaboration and active participation and diverged when students enacted practices that reflected expressive creativity and nonverbal interactions as with dramatic expression and improvisation. Rather than looking at the divergent behaviors as social problems or behaviors needing remediation or punishment, considering what can be learned from these behaviors could enhance the mathematical identity and academic achievement of African American students.

KEYWORDS: African American children, elementary mathematics, student learning, reform mathematics, urban education

In the United States, the mathematical under-achievement of many African Americans has been a source of concern for numerous reasons. Studies have shown that mathematics achievement is affected more by the school environment (e.g., curriculum, teacher qualifications and expectations, materials) than by the home environment (Lee, 1998; Roscigno, 1998); that mathematics is critical in advancing to higher education due to its filtering effect (Schoenfeld, 2002); and that mathematics is a civil rights issue in that, if children are not mathematically literate, they will be relegated to second-class economic status (Moses & Cobb, 2001). These studies demonstrate the importance mathematics holds in the arena of academic advancement and success. Researchers such as Gloria Ladson-Billings (1998), William Tate (1995), Na'ilah Nasir (2002), Danny Bernard Martin (2000) and others have studied African American students and mathematics

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teaching and learning in an effort to understand many African American students' persistent low levels of achievement on standardized assessments and in schools (The College Board, 1999; Langland & Emeno, 2003; National Center for Educational Statistics, 2001).

Many solutions have been suggested in the effort to provide better educational opportunities for African American and low-income students: higher curriculum standards, testing regiments and accountability measurements, supplemental education programs, improved teacher–student relationships, and more qualified teachers (see, e.g., The College Board, 1999; Ferguson, 2001; National Center for Educational Statistics, 2001; Ogbu, 2003). These solutions focus closely on improving schools, curricula, and the work of teachers to create better and more specific opportunities for African American students to excel. What is missing are studies that look closely at how students respond and interact with mathematics in light of these efforts by teachers and other school personnel.

In this article, I describe a study about how a group of African American elementary students in an urban school negotiated and learned mathematics in National Council of Teachers of Mathematics (NCTM) standards-oriented classrooms. By studying their patterns of interaction and engagement, I consider how their actions connected to and supported theories of African American cultural dimensions. Four questions guided the study:

1. What kinds of individual mathematical interactions occur when African American students engage in standards-oriented activities, tasks, and events?
2. What patterns of practice emerge across these African American students in their mathematical interactions?
3. In what ways do student practices converge with or diverge from the classroom practices and teacher anticipated norms?
4. To what extent do these student patterns of practice connect with research on African American cultural dimensions?

What is Standards-Oriented Teaching?

The NCTM (2000) *Standards* consist of two main parts: content standards and process standards. They are "inextricably linked" (p. 4); the foundation of the reform vision is built upon the fusion of these parts. The content standards are what NCTM has selected as the most important mathematical topics for each grade level. They are comprised of related ideas, concepts, skills, and procedures that form the foundation for understanding and lasting learning as defined by NCTM. The process standards describe the five teaching and learning processes that NCTM promotes as necessary elements in the development of an investigatory mathematics classroom: problem solving, communication, connections, reasoning and proof, and representation. These processes are crucial as the

framework of a classroom that strives to develop students who are mathematical inquirers and critical thinkers. The process standards support what is called *mathematizing,* "developing mathematical understandings from initial instructional activities that focus on material objects, actions, and events, through the process of coming to see concrete situations in mathematical terms" (Lampert & Cobb, 2003, p. 240).

A standards-oriented mathematics classroom is supported by a social constructivist view of learning. Ernest (1996) described social constructivism in terms of the interconnectedness between the individual and the social. He stated, "Human subjects are formed through their interactions with each other as well as by their individual processes" (p. 342). In his work on social interactionism, Voigt (1996) also explained that, in learning, the focus is on the interaction between the individual, or subject, sense making and the social processes in which the individual participates. Students bring their prior knowledge and cultural understandings to bear on mathematical activities or tasks. They then negotiate meanings within these tasks through individual cognitive dissonance, through their work with others, or through teacher feedback (explicit or implicit). This negotiation of meaning occurs mainly through discourse, which can be rigidly directed by teacher actions or more fluidly built through numerous interactions between students, teachers, and tools. As students have more and more opportunities to interact with others around particular meanings and concepts, "taken-as-shared" (p. 33) meanings develop. Only through the interaction of the participants in the development of routines and obligations can the stabilization of meanings and the creation of mathematical themes occur (p. 41). Wood's (1994) concept of *mutual orienting* also describes the actions and interactions of classroom community members. She explains, "Patterns of interaction are seen as emerging from the individual's interpretation of another's actions and from the mutual orienting that occurs between the teacher and students…they build up negotiated expectations and obligations over the course of the school year" (p. 151). Cobb (2000) called this negotiation of classroom actions and interactions "social norms"; these norms are established through the interactions between the teacher and the students and amongst students themselves.

From the view of these researchers, the vision of standards-oriented mathematics learning can be described as the negotiated mathematical meanings that develop through participation with provided tasks and tools; meanings that become shared by the group or community through interactions leading to the establishment of classroom norms. To enhance this process of negotiating mathematical meanings within an activity or task, teachers provide students with opportunities to interact with other students and tools. Students should have opportunities, when working on mathematical tasks, to reflect on their own processes and the processes of others; this opportunity provides time to reorganize

information and to be taught to engage in the critique of and inquiry into mathematical concepts. These opportunities to reflect, critique, and inquire also provide the teacher with more information about the nature of students' prior knowledge, backgrounds, worldviews, and interests, thereby allowing more connections to the students' lives and understandings.

Research on the Implementation of NCTM Standard-Oriented Curricula

In the current political landscape, it is important to consider if standards-oriented practices for teaching mathematics will help engage all students in learning mathematics deeply and with understanding and increase levels of achievement in course grades and testing for all students. Numerous studies have analyzed and considered the effects NCTM standards-oriented curricula have had on student test score achievement and how African American students have fared in these classrooms and schools.

One such study that focused on overall test score achievement was conducted by the Alternatives for Rebuilding Curriculum (ARC) Center (2002), a part of the Consortium for Mathematics and its Application in Massachusetts. They conducted a study that focused on the three National Science Foundation (NSF, 2002) funded standards-oriented curricula to establish what effect these types of curricula had on student test score achievement. The three curricula—*Investigations in Data, Number, and Space*; *Everyday Mathematics*; and *Math Trailblazers*—were implemented in three states: Massachusetts, Illinois, and Washington.[1] Schools and grades chosen to participate in the study were selected by their usage of the NSF curricula and the length of implementation (at least 2 years) determined through telephone surveys and standardized test score record availability. It is important to note, however, that this data collection process did not provide details into particular teaching practices, nor did it examine the meaning or level of curricula implementation beyond the requirement that the curricula be in place for 2 years. Nevertheless, it yielded 742 classrooms and more than 100,000 students from Grades 3 to 5 in the three states. Each school was then matched to a comparison school based on reading test scores, income measures, and percentage of White students in the school. Overall, they found standards-oriented schools outperformed their matched counterparts on all test measures and mathematics strands, with measurement and computation showing the largest

[1] *Everyday Mathematics* is a comprehensive pre-kindergarten through sixth-grade mathematics curriculum developed by the University of Chicago School Mathematics Project, published by Wright Group McGraw-Hill. *Math Trailblazers* is a full mathematics curriculum for grades K–5 that was developed by the Teaching Integrated Math and Science (TIMS) Project at the University of Illinois at Chicago, published by Kendall/Hunt Publishing Company. A complete description of the *Investigation* curriculum is described later in the methods section of this article.

gains. When the results for all three states were disaggregated by race/ethnicity and SES, all reform schools again outperformed the comparison schools. When examining data on African American students as a racial group, students in the standards-oriented classrooms performed approximately 4 percentile points better on all subtests and total scaled score than comparison students. What was disconcerting, however, was that African American students, as a group, scored far below all other race/ethnic categories of students regardless of the type of curriculum implemented in the school.

A study by Briars and Resnick (2000) of the Pittsburgh, Pennsylvania School District analyzed achievement test scores and curriculum implementation levels to determine how well students achieved when the school district adopted the standards-oriented curriculum *Everyday Mathematics*. They grouped schools by two levels of teacher curriculum implementation, strong and weak, and matched these schools by demographics (e.g., free and reduced-priced lunch, family structure, mobility rate, and percentage of African American students). For their study, they defined strong implementing schools as having a majority of teachers who used all of the components of the curriculum and provided students with opportunities to engage in mathematics according to the NCTM process and content standards. Weak implementing schools were schools that had only one or two teachers using the curriculum as prescribed by the curriculum developers. They found that students in the strong implementing schools outperformed those in weak implementing schools on three strands of the standardized test used to measure achievement: computation skills, conceptual understanding, and problem solving. The scores of African American students in the strong implementing schools also rose, and, although the test score gap between them and White students narrowed, it was still large except on computational skills where the African American students outscored the White students (see also McCormick, 2005; Secada, 1992).

In a similar study, Riordan and Noyce (2001) also found a positive correlation between the length of time (in years) that a teacher used the *Everyday Mathematics* curriculum and the achievement of the students, though as in the ARC study, they did not have a detailed way of analyzing the level of implementation other than the length of time the curriculum was in use. Their study, using regression analysis on test score data, compared three groups: early implementers (more than 4 years of implementation), late implementers (less than 4 years), and non-implementer schools. The data were collected from the statewide Massachusetts standardized test scores from 1999. They found that the student scores of the early implementer schools were the highest, followed by the late implementer schools. The non-implementer schools had the lowest average scores, though just slightly lower than late implementing schools. Thus, the longer a school has been using the standards-oriented curriculum, the higher the students scored on the

standardized test. An important note for this study, however, was the improved achievement of the African American students. The African American students in early implementing schools had average scores 9 points higher than African American students in the non-implementing schools. This point difference between test schools was larger than all other racial groups except Hispanics. However, in all schools, the overall scores of the African American students were lower than those of other student groups.

Overall, these studies suggest that standards-oriented curricula have a positive impact on the achievement of African American students after at least 2 years of implementation. However, the test score achievement gap continues. This points to a need to consider the implementation of curricula and teaching practices found in standards-oriented classrooms to have a more detailed view of the impact standards-based teaching practices have on students. Interactions with standards-oriented teaching practices, teacher beliefs and knowledge, response of the students to these practices; each of these can create markedly different patterns of practice in classrooms generally regarded as standards-oriented. Being able to document the practices, established norms, and cultures in standards-oriented classrooms can assist in creating a sharper picture of implementation and what standards-oriented classrooms might "look like."

African American Cultural Dimensions and Learning

For several decades, social scientists have studied and described how (some) African Americans interact with and interpret the world and how this interpretation affects learning (see, e.g., Boykin, 1983, 2001; Boykin & Bailey, 2000; Jones, 2003; Ladson-Billings, 1994; Shade, 1982, 1992). It is important to note, however, that this growing body of research does not intend to essentialize African Americans into some monolithic group of sameness but rather attempts to highlight shared beliefs, values, and customs (i.e., culture) that might be uniquely shared historically among Black Americans. For instance, Boykin (1983) identified nine cultural dimensions that might be considered unique among African Americans: spirituality, harmony, movement, verve, affect, communalism, expressive individualism, orality, and social time. He offered these dimensions as "motifs, patterns of behavior, and predilections" (p. 348) that distinguish African Americans from other groups of people in our country. More recently, Boykin and Bailey (2000) researched three of the African American learning dimensions that stemmed from Boykin's earlier work on dimensions of African American cultural themes: *communalism*, an acculturation toward social and family relations; *movement*, rhythmic and expressive orientation toward life; and *verve*, heightened appreciation toward physical stimulation. Their study, conducted with 163 low-income African American students in grades 2 through 5 in a large urban city,

was designed to understand how these three cultural dimensions (might) affect learning preferences and orientations. They administered six surveys to see how cultural practices related to movement, communalism, and verve in the students' homes correlated to the same areas in the students' learning preferences in school. Their findings suggested that students most strongly oriented toward movement factors both at home and in school, which were expressed by items related to how music is incorporated into and improved everyday well-being. The communalism theme was shown through student preferences focused on a sense of common duty and support within the family (and extended family) on the home scale and a similar preference for working within a group and valuing friends on the school scale. Verve, while having a higher correlation between home and individual learning preferences than communalism, showed average scaled scores that were at or below the Likert mid-point range for those same items in school, which included student preferences in active oriented activities in the classroom and when playing.

Though Boykin and Bailey's (2000) work did not focus specifically on the mathematics learning of students, it could be said that most U.S. mathematics classrooms have social and participation norms that are at odds with these three themes of African American cultural dimensions. Vervistic and movement opportunities, such as activities that require high levels of energy and participation, do not regularly show up in classrooms (other than physical education). Berry (2002), in his study of successful African American middle school boys, found that boys who displayed vervistic behaviors were kept out of higher-level mathematics classrooms, as the teachers and administrators did not consider the students' academic abilities, only their social ones. According to Boykin (1983), this mismatch in cultural styles is a challenge that needs to be addressed as we move toward improving the academic achievement of African American students.

Similarly, Shade (1992) studied an expanded view of cognitive style—perceptual, intellectual, and social domains—to examine the possibility of a unique African American learning style. She defined cognitive style as "a culturally induced way in which individuals organize and comprehend their world" (p. 256). In her research, 178 grade 9 students were stratified by achievement levels and sex, and consisted of 92 African Americans and 86 European Americans with similar socioeconomic backgrounds. The students were administered three tasks that aligned with three areas of cognitive style under consideration. Her results found a significant difference between the African American and European American students on the perceptual processing task ($p<0.0001$), which aligned with the domains of field sensitive/field dependent, in which African American students showed preference for field sensitive tasks. This finding suggested that African American students focused on ideas holistically, in context, and in relation to the environment rather than in a field independent view—using analytic

and systemic approaches to situations found in many mathematics classrooms (Stiff & Harvey, 1988). On the social interaction style instrument, a small, but statistically significant difference ($p<0.025$) was found between African American and European American students in the area of orientation toward the world around us, where African American students tended to be more adaptive and spontaneous to occurrences in the world, as opposed to making plans and attempting to organize the outside world. These findings led Shade to suggest that African Americans demonstrated a preference for considering the world in a more spontaneous, flexible, and less structured way than European Americans.

In other research on African American cultural orientation, Jones (2003) developed TRIOS, a theory that represents the attitudes, beliefs, and values of African American culture that arose out of African Americans' need "for self-protection and self-enhancement in a universal context of racism" (p. 239). TRIOS is defined by five main components: *Time, Rhythm, Improvisation, Orality*, and *Spirituality*. Through these components, Jones noted a collaborative, rather than oppositional, duality of individualism and collectiveness in African American culture: a sense of independence, "be yourself at all times" through improvisation and orality; along with interdependence, "harmony in *my* group" through a sense of collectiveness with other African Americans. This duality means that there is a sense of a collective group identity that supports a need for individuality, rather than conformity.

Jones's (2003) research on TRIOS, which in many respects mirrored Boykin's (1983) work, was conducted with 1415 respondents of different races and ethnicities ranging in age from 14 to 62 from across the country, with most respondents being college-aged students. They responded to a 77-item survey in which they were asked to respond to statements concerning different aspects of the TRIOS dimensions. In his study, he found that four dimensions of TRIOS were captured well in the statements on the survey: *spirituality*, belief in a higher power that influences all living things; *improvisation*, goal directed individualistic and creative problem solving in a distinctive style; *orality*, preference to face-to-face communication and personal expression; and *time* (also called present orientation), personal perspectives are in the present and time is derived from tasks and not prescribed by them. In an analysis of racial and gender differences in orientation to the different dimensions of TRIOS, the study showed that African Americans tended to exhibit more dimensions of TRIOS than non-African Americans. In particular, spirituality and time provided the strongest African American correlations and greatest Black–White differences in his study. Although this study focused on adolescent and adult respondents, the findings can also be relevant to younger African Americans.

Willis' (1989) review of the research on African American learning styles allowed her to categorize the research on cultural dimensions into four areas. In

this study, those categories were used to frame an overarching organization to the cultural themes and orientations found in the work of Boykin (1983), Shade (1992) and Jones (2003) (see Table 1): *social/affective response*, African Americans are people-oriented, emphasize the affective domain, interaction and learning in social groups is important; *harmonious*, interdependence and communal aspects of people and environments are respected, knowledge is to be relevant and thought about holistically; *expressive creativity,* African Americans tend to prefer environments that offer adaptive, variable, and novel situations, and stylistic simultaneous stimulation is preferred with verve and oral expression; and *nonverbal response,* use of intonation and body language are important ways of communicating, movement and rhythm are vital. Here, I added a fifth category, *spirituality*, to capture the belief that a greater power than humans influences all things and actions, as reflective of the work by both Boykin (1983) and Jones (2003). When considered in school settings, these cultural dimensions act as filters for the students' understanding of and participation in classroom interactions.

Table 1
Categories of African American Cultural Dimensions
(Adapted from Willis, 1989)

African American Cultural Dimension Categories	Related Cultural Dimensions as Described by Researchers		
	Boykin (1983)	**Jones (2003)**	**Shade (1982)**
Social/affective – affective response to stimuli, values social interactions above object interactions	Communalism Affect Orality Social time	Time orality	Social cognition
Harmonious – interdependence, holistic approaches to the world, purposeful uses of information	Harmony Communalism	Rhythm	Field sensitive Worldview
Expressive creativity – creative, adaptive, spontaneous, vervistic, dramatic and enthusiastic oral expression, multiple stimuli preferred	Orality Verve Expressive individualism	Improvisation orality	Stimulus variety Conceptual tempo
Nonverbal – use of intonation in oral language, body language, movement and rhythmic expression	Movement Verve Affect Harmony	Rhythm	Stimulus variety Field sensitive
Spirituality – belief that a greater power than humans is at work and influences all things and actions	Spirituality	Spirituality	Conceptual tempo

In more recent work, Boykin and Jones (2004) discussed how African American cultural dimensions and themes can be used to analyze the interactions between the learner and the learning environment provided by teachers and schools. Using the previous research on African American cultural and TRIOS dimensions, they developed a psychosocial integrity approach to teaching that can

enhance opportunity for learning and achievement not only for African American students but also for all students. The notion of psychosocial integrity considers that people experience life through: *complexity*, experiences are understood in multiple facets, variations, and depths; *coherence,* making sense of life through our frame of reference; and *texture*, experiences can be examined through many points of view. Boykin and Jones believe that schooling practices that draw on psychosocial integrity ideas as assets of the students could lead to enhanced outcomes for all students. Such an approach incorporates five practices that should be the focus of school activities: promoting meaning making through multiple modalities; teaching thinking and learning strategies while fostering critical thinking processes; building a learning community; utilizing cultural resources of students, families, and their communities; and providing a supportive yet demanding learning environment. This approach is supported by the work on social constructivism; individual sense making is considered and built upon in the process of developing and negotiating community norms and practices in the classroom (Ernest, 1996). Psychosocial integrity also closely connects with the research on culturally relevant pedagogy as both approaches draw heavily on understanding and incorporating students' lives into classroom practices (Ladson-Billings, 1994). Table 2 shows how psychosocial integrity practices relate to research on African American cultural and learning dimensions as well as culturally relevant pedagogy.

Promoting meaning making through multiple modalities is guided by cultural dimensions that encourage students to draw on their knowledge and the knowledge of others to make sense of tasks. Students draw on ideas and beliefs of the world around them and on feelings and thoughts within themselves to understand the world. The dimensions of harmony, social/affective responses, and spirituality are reflected in this theme. By *teaching thinking and learning strategies*, teachers are providing students with opportunities to focus deeply on tasks and topics in many forms and in many ways and use whatever tools are necessary to accomplish those tasks. Allowing movement and physical and oral expression when working, along with paying close attention to task understanding and completion, supports the dimensions of harmony, nonverbal response and expressive creativity. To have the collaboration skills necessary to engage with others on a topic and use others as learning resources, teachers *build learning communities in their classrooms.* Working communally, speaking with others while working, and interpreting others' ideas encourage students to turn to others as learning partners. Understanding that students come from a neighborhood or community that supports particular cultural and social habits and these habits have a large impact on their lives in school is an important reason for considering and *using students' cultural resources* in teaching. Using individual differences as a teaching tool and making clear connections to students' lives outside of school can provide students

with a sense of belonging. The African American cultural dimensions of harmony, expressive creativity, and nonverbal response support these ideas. Finally, creating a *supportive but demanding environment* can be used to develop a sense of harmony among the students as they rally together in support of success for all (Ware, 2006).

Learning about each student and their individual levels of understanding can help teachers focus on student improvement and create attainable goals and expectations. These psychosocial integrity practices could allow school personnel and teachers to develop pedagogical practices for African American students that draw on their often-preferred modalities and cultural and psychological schemas.

Table 2
Psychosocial Integrity Practices and Related African American Cultural Dimensions

Psychosocial Integrity Teaching Practices	**Psychosocial Integrity Practices Defined**	**Supporting Cultural Dimension Categories** (Willis, 1989)	**Culturally Relevant Pedagogy** (Ladson-Billings, 1994)
Promoting meaning making	Making connections among topics, to students experiences, and prior and common knowledge	Harmonious Social/Affective Spirituality	Drawing on prior knowledge, cultural themes, individual differences
Teaching thinking and learning strategies	Providing tools for deep, constructive, active engagement with academic content; multiple stimuli and a variety of activities are used in teaching	Harmonious Nonverbal Expressive creativity	Considering knowledge as something constructed and critiqued
Building a learning community	Learning is interdependent, collaboration is fostered through personal interactions	Social/Affective Harmonious	Development of learning community and collective empowerment through collaboration
Using cultural resources	Drawing on students' every day practices, cultural habits, and worldviews in every day practices	Harmonious Expressive creativity Nonverbal	Community connections outside of the school walls
Creating a supportive and demanding learning environment	Maintaining high expectations, focus on effort and improvement	Social/Affective	Academic skill development and achievement is paramount

Standards-oriented practices in mathematics most strongly correlate to the psychosocial integrity practices of promoting meaning making, teaching thinking and learning strategies, and building a learning community. These practices offer opportunities for teachers to develop mathematical understandings in their students, draw on students' prior mathematical knowledge, help students use a variety of tools and modalities to communicate mathematically, and support student collaboration and interdependence. Through the explicit development of mathematical ideas in discussions and in tasks, and supported by continuous classroom discussions on expected behaviors and norms, standards-oriented practices en-

courage the development of a supportive and demanding learning environment as well. Understanding how to incorporate these psychosocial practices into the everyday work of schooling will require long-term investment into teachers' professional development.

African American Student Identity, Engagement, and Agency in Mathematics

Nasir (2002) and Nasir and Hand (2008) studied how student identity and engagement might create opportunities for students to learn. Studying African American students in mathematics-based activities that occurred outside of school as well as in-school mathematics activities raised the question of how these students could be successful with mathematics in out-of-school activities but unsuccessful with mathematics in school, and the impact of student identity in each these settings. Nasir framed identity as "being constructed by individuals as they actively participate in cultural activities.…[It] both shapes and is shaped by the social context" (p. 219). The concern was how the learning communities or settings influenced the development of identity. In particular, Nasir and Hand focused on practice-linked identities, "identities that people come to take on, construct, and embrace that are linked to participation in particular social and cultural practices" (p. 147). Drawing on Wenger's (1998) idea of how identities are formed within a community of practice through engagement, alignment, and imagination, Nasir analyzed how students developed identities and goals when playing dominoes and basketball. She focused on the practice-linked goals the students created for themselves that allowed them to participate in the games. Embedded in these were mathematical goals, such as calculating shot percentages or making number combinations, that allowed the students to reach their practice-linked or learner's goal. She noticed that students would develop goals that permitted them to be a part of the play and part of the player community and this, in turn, helped them identify with the game. This desire to be a part of the community of dominoes or basketball players motivated the students to create personal goals that meshed with the goals and rules of the game. In her view, learning was intertwined with student goals and their developing identity within the community of practice, in this case the community of dominoes or basketball. Students engaged and developed goals that allow them to participate in the community, which in turn helped them imagine and create new identities relative to the community. This engagement led to a desire to learn more about the activity/game and generate and align new goals to continue participation in that community. In this case, the ability of the students to imagine themselves as part of the basketball or dominoes community provided a motivation to engage with the community, when given the opportunity.

In another study that focused on African American students and their

mathematics learning, Martin (2000) studied the mathematical socialization of African American middle school students through a framework that allowed him to analyze how community, school, and individual themes and beliefs affected the success of African American students in school mathematics. Students in his study were interviewed and observed over a 1-year period, along with interviews of their guardians and teachers. He found that successful students were able to overcome a great number of negative forces, such as poor past mathematical experience or pressure to underperform, through student agency, which, for these students, was defined as "actively constructing meanings for mathematics learning and mathematics knowledge and acting on those meanings accordingly" (p. 170). The negative forces came from different areas of the students' lives—some from family, some from school, most strongly from peers—leading Martin to suggest that the students were motivated to succeed "by an inner drive and self-determination to succeed" (p. 183). He was less certain about how these students developed a strong sense of identity and motivation toward success in school because the students had widely varied lives and family backgrounds. Martin wrote, "although community and school forces do have the potential to affect their mathematics socializations and identities, these forces are not deterministic" (p. 185). How these students developed and used their identity and agency to manage negative forces and make beneficial academic choices determined their level of success in mathematics.

Why might students decide to engage with particular communities of practice? In these examples, students chose to participate in the community of domino or basketball players; they invoked their agency to make choices about what they needed to learn and what actions they needed to take in order to participate fully. Basketball and dominoes, for these students, were part of the social and historical culture of African Americans; these students saw other African Americans engage in these activities and that allowed them to imagine that they could participate in these activities as well. African American cultural dimensions such as improvisation could occur when making moves during these activities, the communalism among players that emerged when participating in these activities, or the verve with which these games can be played made these activities attractive to young African Americans.

Standards-oriented mathematics has the potential to provide a framework in which the identity and engagement needs of African American learners could be met. Teachers can create mathematical tasks and lessons that consider students' prior knowledge and ways of knowing, which can encourage students to develop personal goals in conjunction with the tasks. The whole class/community can share ideas, which can spark student participation in mathematics lessons. With the increase in participation, students begin to see mathematics as something they can engage in and, in turn, can increase their identification and alignment with

mathematics. Developing such a mathematics community can provide a space for students to interact with mathematical ideas through many modalities and preferred learning styles. In doing so, opportunities can emerge that entice students to engage with mathematics and align their practices and interactions with the mutually established meanings, routines, and obligations of the classroom.

Methods

The work in this study was part of a larger ethnographic study, entitled *Mathematics PLUS* (MathPLUS), which examined the relationship between teacher learning and student performance in two urban elementary schools. The study reported here focuses on student performance and interaction within one of the schools. This school enrolled approximately 275 students from a range of ethnic and social class backgrounds during the data collection period. Sixty-five percent of the students were eligible for free or reduced-priced lunch. The school drew many of its students from the surrounding neighborhood, which was predominately African American, and included many low-income families along with some families from middle class backgrounds. As designated by the school district, the school was a desegregation school and, as such, drew a small number of White students who were admitted from outside the immediate neighborhood.

From this small school of 11 classrooms, nine classroom teachers are represented; the teachers' classroom experience ranged from 6 years to over 30 years by the end of the study. Because this study focused on the learning and interactions of African American students over a period of at least three years, seven African American students from these classrooms had sufficient data to be included (see Table 3; names of all students and teachers are pseudonyms).

Table 3
Students with Years and Grades During Study

Student Name	Years in Study	Grades
Kiana Ali	1999–2003	1st through 4th
Candace Brown	1999–2003	1st through 4th
Maya Connor	1999–2002	2nd through 4th
Jordan Jones	2000–2003	1st through 3rd
Samuel Quon	1999–2003	1st through 4th
Felix Robinson	1999–2002	2nd through 4th
Royce Rush	1999–2003	1st through 4th

The Investigations Curriculum

The school in the study adopted the mathematics program, *Investigations in Number, Data, and Space* (TERC, 2004), and this program was used throughout

the 4 years of the study. *Investigations,* a standards-oriented curriculum, focuses on developing conceptual understanding and mathematical thinking through visual models, strategy development, inquiry, collaboration, and communication. The goals of the curriculum, as stated by the developers, are to offer students meaningful mathematical problems, to emphasize depth in mathematical thinking rather than superficial exposure to a series of fragmented topics, to communicate mathematics content and pedagogy to teachers, and to substantially expand the pool of mathematically literate students. During lessons, students spend the majority of the mathematics period working on mathematical tasks, activities, or games that are designed to promote mathematical communication, questioning, and problem-solving skills. Teachers attended monthly professional development sessions throughout the study, facilitated by the principal investigator, to support their use of the program and discuss issues related to implementing a standards-oriented curriculum.

Data Sources and Analysis

Researchers visited the study classrooms informally once per week and took field notes on the classroom activities. Once a month, more formal observations were conducted in which classroom actions were audiotaped and transcribed. During each audiotaped observation, one researcher would be in the classroom observing the students in the room during the lesson, while another would observe the teachers. The teachers and students were also interviewed three times per year, in the fall, winter, and spring. The teacher interviews were audiotaped and transcribed, while the student interviews were videotaped and transcribed. Data analyzed for this study included teacher and student observations and the clinical student interviews.

To discuss how the African American children of this study interact with standards-oriented teaching practices, there was a need to define what those practices were and whether the teachers in this study enacted practices that could be regarded as standards oriented. The teachers' practices were drawn from either a 1 or 2-year period of observations, depending on the years the students in the study were members of each teacher's class. In order for a practice to be considered a pattern for an individual teacher, the teacher must have engaged in that practice in more than half the observations for the years being analyzed. And at least six teachers had to enact a particular practice for it to be included as a pattern of practice for this study. In all, there were nine standards-oriented practices enacted by the teachers that became common experiences for the students throughout the study: whole group discussion, encouraging active listening, questioning and probing, small group work, teacher support, sharing and explaining ideas, activating prior knowledge, modeling strategies and thinking, and modeling means of

communication (see Table 4). The patterns that emerged from the coding process for each teacher were analyzed to determine how they might fit with and reflect the themes reflected in the theories of African American cultural dimensions and psychosocial integrity themes as described earlier (see Tables 1 and 2). A compilation of all the teachers was then created to determine what learning opportunities were common across all the teachers, and thus, all the students (see Table 5).

Table 4
Nine Patterns of Practice Common Among Teachers

Teacher Practice	Description of Practice
Leading whole group discussions	Whole group discussion about mathematics topic of the day
Encouraging active listening	Encouraging students to listen to other students and focus on topic at hand during discussion
Questioning and probing student thinking	Teacher questioning used to solicit student ideas or information; probe student thinking
Creating opportunities for small group/partner work	Small group work offers opportunities to actively engage with task or activity
Facilitating student independent work	The teacher supports student learning during independent or small group mathematical tasks
Encouraging the sharing and explaining of student ideas	Allowing opportunities for sharing and explaining ideas and solutions
Activating prior math knowledge	Teachers consider and use prior mathematical knowledge as a mathematical tool
Modeling thinking and solution strategies	Modeling games and activities to emphasize strategies and thinking
Modeling multiple means of communication	Students are encouraged to use a variety of means and media to communicate in the classroom (e.g., models, drawings, graphs, materials, manipulatives)

The analysis of the research data continued with the individual coding of the student observations. Each transcribed observation was broken into events, defined as a teacher or student initiated segment of a lesson in which interactions between teachers, students, and their ideas are focused around the same mathematical goal. Each event was described using a number of categories: whole group participation, preparing for independent work, doing independent work, small group/partner interactions, choice and use of mathematics tools, communicating mathematical ideas, mathematical errors, mathematical understandings, and other. These categories reflected the different interactions and classroom practices that are expected in standards-oriented classrooms (NCTM, 2000). For the student data, codes were used that captured how students interpreted and responded to mathematical tasks, what they did in the face of confusion or lack of knowledge,

how they engaged with their work, and how they engaged with peers, teachers, and the classroom environments or routines. Each category had between four and eight codes to describe the students' interactions. These codes were drawn in part from the research on African American cultural dimensions and provided multiple ways to interpret what was happening for the students beyond a more typical interpretation, such as on-task or off-task. After the coding of all students was completed, counts of each code were made to provide initial information on patterns in students' interactions. These counts were tabulated for each student by grade and then again over the entire study. Patterns were determined by the percentage of times a particular practice was enacted by each student and then whether the practice was enacted over the number of years the student was in the study. The individual student practices were compared; those practices that were consistently found among at least five students were considered patterns (see Appendix A). Some patterns occurred among smaller student subgroups (e.g., just the girls) and this was noted and discussed as well.

Table 5

Psychosocial Integrity Practices and African American Cultural Dimensions Related to Teacher Patterns of Practices

Psychosocial Integrity Themes	**Themes Defined**	**Supporting Cultural Dimension Categories** (Willis, 1987)	**Teachers' Patterns of Practice**
Promoting meaning making	Making connections among topics, to students experiences, and prior and common knowledge	Harmonious Social/Affective Spirituality	Sharing and explaining ideas, leading whole group discussions, activating prior mathematics knowledge
Teaching thinking and learning strategies	Providing tools for deep, constructive, active engagement with academic content; multiple stimuli and a variety of activities are used in teaching	Harmonious Nonverbal Expressive creativity	Leading whole group discussion, encouraging active listening, questioning and probing, facilitating student independent work, modeling multiple means of communication, modeling thinking and solutions strategies, activating prior math knowledge
Building a learning community	Learning is interdependent, collaboration is fostered through personal interactions	Social/Affective Harmonious	Creating opportunities for small group/partner work, leading whole group discussions, facilitating student independent work
Using cultural resources	Drawing on students' every day practices, cultural habits, and worldviews as a tool in everyday practices	Harmonious Expressive creativity Nonverbal	Modeling multiple means of communication
Creating a supportive and demanding learning environment	Maintaining high expectations, focus on effort and improvement	Social/Affective	Facilitating student independent work, modeling multiple means of communication

How Have We Chosen to Learn? Coherence Between Student and Teacher Patterns of Practice

Candace, Felix, Jordan, Kiana, Maya, Royce, and Samuel—these seven African American students each had a story to tell. Each student's pattern of practice was connected to three areas: which classroom opportunities would allow or encourage the student pattern to emerge, which African American cultural dimension(s) were reflected in the practice, and which of the enacted teacher practices supported or allowed the engagement of a particular student practice. Once the student patterns of practice were connected to the teacher patterns of practice, the coherence, or lack thereof, was defined to be convergent, episodic convergence, supported divergence, or divergent. For a practice to be considered convergent, the students would have consistently engaged with that practice in about 80% of the events noted for that practice. That is to say, the classroom practices provided space and opportunity for the students to respond to mathematical tasks as the teachers intended. Episodic convergence practices occurred when students, for the most part, engaged with a particular practice in a way that was anticipated by the teacher and classroom norms, but occasionally interacted with activities and tasks in ways that are not expected or anticipated. These practices occurred in more than 50% but less than 80% of the noted events for that teacher practice. Supported divergence practices were practices enacted by the students that did not cohere with a pattern of practice of the classrooms in this study. These patterns, however, were often unnoticed, overlooked or ignored by teachers, possibly leading to the continued use of the pattern. Divergent practices were patterns of practice enacted by the students that were not supported by teacher practices or classroom norms. Even in the face of redirection or reprimand, students continued to engage with these divergent practices throughout their years in the study (see Appendix A).

Focused Collaboration

The students most often displayed direct and focused collaboration on the assigned tasks or activities when working in small groups with their peers. They were mathematically engaged during this time, with their collaborative focus becoming stronger in grades 3 and 4. Teachers consistently provided small group independent work time for students. Work on learning styles by Dunn et al. (1990) found that African American students preferred to work with others more often than other ethnic groups (e.g., Mexican American, Greek American, Chinese American), supporting the finding that the students look for opportunities to interact with each other when working. This finding is also supported by the work of Nasir (2002). She found that, when African American children were engaged

with others during activities, they would work toward learning more about that activity in order to align their practices with the activity's expectations. The students in this study made the effort to be a part of the classroom mathematics community and worked toward aligning their practices with the expectations of the teacher, thus establishing a norm about the importance of working together with others when learning mathematics. Considering African American cultural dimensions, the strong collaborative focus during independent time allowed the students to enjoy social/affective interactions with others while learning. In this example from grade 3, Candace was using the traditional regrouping algorithm to subtract. The students were given place value mats and base ten blocks (see Figure 1) to help them solve the problems. She was then assigned to work with Kiana, and together they worked through solving the problem 95 minus 56.

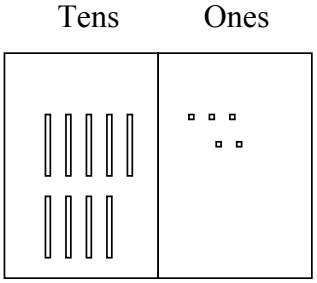

Figure 1. Illustration of base ten blocks.

> OBSERVATION: They carried a supply of base ten blocks with them and a place value mat. Kiana instructed Candace: "Show me 95." Candace built 95 without any problem. Kiana asked her if she could subtract six from five and Candace said she needed more ones. Kiana indicated the tens section and said, "Take one away from here and add ten more." Candace did that correctly. Kiana said, "Make sure you have 95 still." She then took Candace through this same problem on the paper. "You would have to turn that 5 into a 10. So what do you have up here? You have a 15." Candace crossed out the five in 95 and writes 15. Kiana continued her coaching, "So the nine… if you are taking one away from nine what do you have?" Candace didn't seem to follow. "What comes before nine?" Kiana hinted. Candace said, "You cross that out and make an eight." Then they worked the subtraction: "15 minus 6." Candace counted on her fingers and Kiana did too in order to confirm Candace's answer of nine: "8 minus 5." They got the answer 39.

We see here the collaborative nature between these two students; they were focused on the task and worked through the problem without interruption. Although to some, this interaction may appear to be more directed by Kiana in that she is telling Candace what to do and is not focused completely on understanding the mathematics. The interaction, however, demonstrates the efforts of one student to

support the work of another, with Kiana acting as the more knowledgeable other. In many "traditional" classrooms, this type of student interaction is often discouraged. Kiana took on the role of coach and supported Candace's effort to make sense of the subtraction by asking Candace questions and allow her to participate in the problem solving—moving the blocks and writing all the steps.

Active Participation

Students actively participated in whole group lessons, by listening, watching, and engaging in mathematics discussions without engaging in other activities unrelated to the mathematics at hand. They followed the lesson or activity, and many students eagerly supply responses and ideas. By creating almost daily opportunities for the students to come together for whole group discussions and using questioning and probing techniques to encourage participation, the teachers provided a space in which the students interacted with mathematical ideas. In the following fourth-grade observation, Maya is actively engaged with the lesson, even though her engagement pushed against the norm of quiet listening and turn taking.

> OBSERVATION: Teacher Laura began working on the poster board at the front of the rug and wrote: "How many hundreds" and below that question wrote 200+400. She asked the students to show with their fingers how many hundreds there were. Maya held up six fingers. Teacher Laura then wrote 201+403, and again asked how many hundreds. Maya whispered "604," and then raised her hand. Maya said, "It would be six hundred and something, these are easy." Teacher Laura wrote the next one 199+404, and then asks what they should do. Maya whispers, "It's 603". Teacher Laura then asked, "What if we had 199 pennies and something cost $2.00…." Maya commented softly, "If they gave her $2.00 then she can give one penny back." Teacher Laura asked, "How much is 404, how many hundreds?" Maya said softly, "Can I blurt out the answer? I want to so badly." The class decided there are four hundreds in 404. As the class prepared to move on to the next activity, Maya raises her hand and says, "Teacher Laura, can somebody say the answer now?" Teacher Laura seemed confused. "Can I say the answer?" Teacher Laura said, "We said the answer." Maya responded, "That's not the answer, the answer is 603."

This observation illustrates that within most of the study classrooms, there were limits on how students were allowed or encouraged to interact during whole group lessons. Students were expected to listen closely to others, respond to the given question or prompt, and stay focused and attentive to what was happening in the discussion. When students called out a response or idea without acknowledgment from the teacher, chose to attend to other things during the lesson (active inattention), or did not pay attention to what was going on (passive inattention), they were most often reprimanded or redirected toward the expected behavior. Here, Maya maintained a steady stream of comments while continuing to focus on the

lesson, even though she was not interacting in the discussion as Teacher Laura had intended. Looking back to African American cultural dimensions, calling out by students or engaging in other related activities during whole group time could be construed as a student's need for orality or movement expressiveness (Boykin & Cunningham, 2001; Foster, 1992).

Physical Tool Use

The next convergent pattern of practice that focused on the students' interactions with mathematical tasks and activities was the practice of using physical tools to solve problems and accomplish tasks. Physical tools were the concrete mathematics materials for modeling and counting (blocks, cubes, etc.), drawings, pictures, or written algorithms, but not mental tools or models. The students were adept at using physical tools in many different ways to support their problem solving. The teachers supported tool use as they supplied the students with access to tools, modeled tool use often, and encouraged students to share how they used tools in their work. Thus, heavy use of tools was expected and the data showed that the percentage of physical tool use in both the classroom and interview events ranged from a high of 95% of the time by Felix to a low of 51% by Samuel. As an example, when solving problems, Felix was adept in using tools and models to support his efforts. In grade 4, he was able to use snap cubes to solve the problem 4 times 8:

> *Interviewer*: What is 4 times 8?
>
> *Felix*: (counting the cubes by 4, taking sticks of 4 cubes from the long stick, lining up the short sticks on the desk): These are 4s and then add them up. Add 4 eight times. And then…4, 8…(counting the cubes of the third stick one by one) 12, (counting the cubes of the fourth stick) 16, (counting the cubes of the fifth stick) 20, (counting the cubes of the sixth stick) 24, (counting the seventh) 28, (counting the eighth) 32.
>
> *Interviewer*: Great. So just how you explained to me. Can you explain to me one more time?
>
> *Felix*: I put all these 4s and put them into one group (piling up the sticks, holding them together, separating the sticks and placing them one by one on the desk, murmuring). Then you add them together (putting the sticks back together). You'll come up to 32.

He also used physical tool modeling for addition and subtraction problems, as well for solving story problems for all 3 years in the study.

Having access to many tools connects to the African American cultural dimension of nonverbal interactions and expressive creativity; tools allowed students physical activity while working with mathematics, drawing on the ideas of

rhythm/patterns and movement as integral parts of the African American life experience. Tool use, as it was enacted in these classrooms, also allowed personal interactions with others in that students generally shared tools and worked together on mathematical tasks requiring tools.

Although using physical tools was well supported by the teachers in this study, the reliance on tools was expected to lessen, as the students got older. By the end of third grade and all of fourth grade, students were expected to rely on mental models to support solving problems more than was expected of them in the earlier grades, particularly with basic facts and to support work on more complex problems. However, only two of the students, Samuel and Maya, used mental models efficiently and effectively. The other five students had some basic strategies for using mental models, but only for simpler problems. They instead continued to rely on physical tools to support their problem solving efforts. Fuson (2003) found that some students using a reform curriculum continued to use lower-level counting strategies to solve computation problems without moving on to higher-level strategies up into the fourth grade. Similarly, Siegler's (2003) review of literature on individual differences in students' mathematics cognition found that students with mathematics difficulties had limited strategies for retrieving correct answers from memory and would rely on elementary counting strategies. He contended some of these mathematics difficulties arose from the children's "limited exposure to numbers before entering school" and "from poor families with little formal education" (p. 295). Although I do not agree with Siegler's deficit family view, he did suggest that greater practice and instruction in how to execute strategies as well as addressing limited background knowledge and conceptual understanding would allow students with mathematics difficulties to learn with reasonably high levels of proficiency. Addressing the issue of bridging concrete and physical representations to more abstract mathematical symbols and language is an important topic and provides for a possible extension of this research study.

Direct Communication

Students in the study made attempts to clearly and directly respond to questions and prompts by the teacher during whole group discussions and, most times, their responses stayed on the topic under discussion. The teachers encouraged strong communication through the practices of encouraging active listening and modeling clear mathematical communication; the teachers' practices also supported students' communication efforts by allowing the students to share their ideas during whole group discussions and independent work time, which also created opportunities for peer modeling. Considering African American cultural dimensions that would support these practices, social affective opportunities entail

encouraging and valuing interaction among classroom members. By engaging in whole group discussions orally and through the use of tools, students were given the opportunity to engage in personal interactions with other classroom members and to develop a sense of community in the classroom. Lampert and Cobb (2003) discussed using communication to learn as a goal in standard-oriented classrooms; as students are provided opportunities to participate in mathematical tasks, teachers model ways of communicating and make explicit the acceptable forms of classroom communication. As students have additional opportunities to express themselves mathematically, they become more adept in using mathematical language to express their ideas.

In this study, the girls were more vocal than the boys; they averaged over 104 events where they engaged orally with mathematics topics, while the boys averaged only 81 events in comparison. This finding could be related to the fact that the girls used more dramatic expression (discussed in the next section) than the boys and consistently used oral means for expressing their vibrancy when interacting with mathematics.

Direct communication is considered an episodic convergence practice because, although the students did communicate mathematically in the way the teachers expected during whole group lessons most of the time, the number of times that they had difficulty being clear and concise when explaining their thinking and solutions during interviews and small group settings was quite large (33% of all communication events). The students often used imprecise language when attempting to explain a solution or idea—using language that was vague; talking in circles; or starting to talk, stopping, then starting again, but staying on or close to the topic under discussion. This imprecise form of communication was evident in all years of the data analyzed. In the classroom, students were often questioned and guided through imprecise oral explanations by the teacher, which often times interrupted the flow of the speech. In her review of literature on sociolinguistics of African American children, Foster (1992) also found that African American students were interrupted more often by teachers when speaking imprecisely than were White students who spoke in a more factual, linear, lecture style. She noted:

> Teachers failed to comprehend or appreciate the stories being narrated. Frequently interrupting students with inappropriate questions or attempting to redirect the narrative to focus on a particular but often insignificant aspect of the story, the teachers questioned the African American students' intellectual competence and emotional stability (p. 305).

Learning to query, rather than curtail, imprecise speech would honor the students' cultural funds of knowledge and allow teachers to consider whether a student is using speech to coordinate their thinking or if the student needs support through the thinking and communicating process.

Understanding how students' cultural norms impact the communication of their thinking and how to support that communication is important in standards-oriented classrooms, due to the emphasis placed on the use of communication to enhance and solidify learning. Without considering the frameworks students use in their interactions, teachers can get caught up in funneling the student toward a more desired response or action rather than working toward understanding what in the student's frame of reference produced the particular outcome or solution (Wood, 1994). Moschkovich (2002), in her study on the communication practices of bilingual students in mathematics classroom, concurred:

> In particular, this perspective can affect how teachers assess a student's competence in communicating mathematically. For example, if we focus on a student's failure to use a technical term, we might miss how a student constructs meaning for mathematical terms or uses multiple resources, such as gestures, objects, or everyday experiences. We might also miss how the student uses important aspects of competent mathematical communication that are beyond a vocabulary list. (p. 193)

In this study, although the teachers may have had difficulty understanding the verbal reasoning of students who were attempting to solve a problem, the students were either able to solve the problem or were working toward solving the problem. In many cases, it appeared as though the students used their oral speech as a thinking tool; speaking their thoughts out loud as a way to solidify their solution. If students were using their speech as a way to organize their thinking, interruptions to that speech could impede the thinking process and make problem solving and explaining difficult for the students. This type of speech was evident in an example of Felix as he tried to explain how to mentally add 10 to 128:

> *Interviewer*: What number is 10 more than 128?
>
> *Felix* (murmuring and looking down): I'm not sure.
>
> *Interviewer*: Well, if you started up from 128, and you counted up 10 numbers, what would you get?
>
> *Felix*: I've counted 10 numbers, but I made a mistake…so stop counting…kind of get to 38.
>
> *Interviewer*: Okay. What number is 11 more than 128?
>
> *Felix* (looking ahead and touching his chin with his left hand): The second one is 138, and the third one is 139.

Felix attempted to solve the problem of adding 10 to 128, but did not readily have a solution. When trying to explain, he sounded as if he was talking to himself about what he was doing in his head, attempting to understand what was being asked of him and how he could go about solving the problem. The interviewer,

not appearing to understand what Felix was doing to solve the problem, continued on to the next problem. After a few moments, Felix was able to put his explanation together and give correct solutions to both problems. Having an opportunity to verbalize his thinking and mentally grapple with the wording and ideas in the problem appeared to be needed communication for Felix to solve the problem.

Divergent and Supported Divergence Student Patterns of Practice

In Wood's (1994) research on patterns of interactions, she stated, "teachers have unwittingly undermined their own goals by failing to realize that the consequences of their interaction (and inaction) are often quite different from their intentions" (p. 149). In supported divergence patterns of practice, the teacher would encourage particular behaviors or beliefs either because they were unaware of the students' engagement in that practice or belief or they were unaware of how their actions helped create or continue particular patterns or beliefs. Divergent and supported divergence patterns of practice occurred far less frequently than convergent patterns, but appeared, in many ways, to be common practices of interaction and communication for the students.

Activating Personal Knowledge

When solving problems, students used their personal knowledge as a tool. Students made connections to ideas they held about the world or to the experiences they had in their daily lives. These connections not only occur when solving word problems that were designed to draw on student background knowledge but also when students used personal knowledge to solve problems about patterns or to develop solution strategies for computation problems. In most instances, however, the teachers did not solicit personal connections in problems; the students initiated these connections. Nor did teachers explore the personal solutions in an attempt to connect them back to the original problem. Particularly in the interviews, students, when asked to explain, made connections to their understanding of the world and used that understanding for making sense of the problem. In the following interview from grade 4, Royce was working on problems related to theoretical versus experimental probability. In answering, she considers what is important in trusting someone to tell you the truth rather than considering the mathematics of the situation:

> *Interviewer* (after discussing problems of drawing red and yellow cubes from a bag): Suppose someone in your class said, "It's been yellow five times in a row so I'm due for a red one now," or, "It doesn't matter that I got all those yellows. It's still an equal chance of red or yellow." What would you say to that person?

> *Royce*: Disagree. It depends what classmate says it.
>
> *Interviewer*: Would you agree if Brent (a "high level" mathematics student) said it?
>
> *Royce*: No, I wouldn't agree with him.
>
> *Interviewer*: Would you agree if…who would you agree with then?
>
> *Royce*: I would agree with Jeri because she's my best friend. She's my best friend in the classroom.

Here, by considering what is important when believing what someone tells you, Royce does not attend to the mathematical concepts of the probability problem. She privileged her personal knowledge over her mathematical knowledge. This action does not mean, however, that she does not possess the mathematics knowledge to solve the problem. Exploring her reasoning and then connecting her response back to the problem would allow her response to be valued, considered, and redirected. Additionally, by allowing her to present her understanding of the task, a teacher can expose misunderstandings or roadblocks to strengthening mathematical ideas.

This practice of drawing on personal knowledge when learning resonates with the African American cultural dimension of harmonious interactions: providing students with the opportunities to draw on their personal and previously held knowledge to support their mathematical development through the purposeful use of information. Interestingly, drawing on students' background knowledge and making connections to the world at large are also practices supported by standards-oriented teaching. Unfortunately, the teachers in this study, as a group, did not consistently make personal connections an explicit part of their teaching practices. It is important to note that although the teachers attended ongoing professional development designed to support the implementation of the curricula, the content of those sessions was not available for analysis to know whether teachers discussed issues of using personal versus school knowledge as a learning tool.

Dramatic Expression

Another divergent pattern of practice enacted by the students was their use of dramatic expression when working on or talking about mathematics problems. All seven students demonstrated the use of dramatic intonation and movement during interviews and in small group work to demonstrate ideas or punctuate speech. One student, Maya, displayed dramatics in all areas of the classroom setting as well as in small groups and interviews. Foster (1992) also noted that African American students, when sharing their writing, "resembled performed narratives, with stylistic features—gestures, dialogue, sound effects, asides, repetitions, shifts in verb tenses for emphasis—similar to those in a dramatic stage performance" (p. 304), which supports the findings of this study. In the following

observation, Royce displayed her dramatic side during a grade 4 interview task:

> OBSERVATION: Royce (reading the problem aloud): Jeanine has 40 cookies. She wants to share them evenly among 8 friends. How many cookies will each friend get? (sighing loudly) Ok, this is what I hate.
>
> (She pulls out blocks and separates them into 8 piles.)
>
> Royce (with an exasperated voice): Evenly. Each of them will get 5 cookies. I put these together, each of them equals 10 and ten 4's equal 40. And then I broke them up by 5s, and 4 plus 4 equals 8. That's how I got it (she looks at the interviewer with a dramatic pause). Any questions?

This pattern of practice is considered divergent because the teachers in the study reprimanded students who used dramatic or excessive movement while working or speaking. Particularly during whole group sessions, students who moved around or talked exuberantly were redirected to sit down, sit still, quiet down, and so forth, because the behavior diverged from the expectation of being a quiet classroom participant and not disturbing other students from learning. Thus, most of the events where students displayed dramatic expression were found outside of the view of the teacher in a setting where disciplinary action would not be taken. When engaged in dramatic and expressive speech and movement outside of the teacher's view, they were less likely to be reprimanded and thus were able to engage in this behavior. As an example, Jordan used dramatic action when interacting with mathematics tasks during interviews. He used verbal expressiveness—shouting "Timber" when he dumped out a container of cubes—as well as movement expression—pretending to be deep in thought while quickly pacing back and forth when working on a difficult problem—throughout his interviews. He also moved around quite a bit during the end of his interviews; he stood up, lay on the floor, and walked around the interview area while working on the tasks. These dramatic examples and constant movements, however, did not deter Jordan from solving the problems he was assigned to do; he still worked on the tasks and focused his attention on them.

Mathematical communication is an important part of standards-oriented teaching practices. The emphasis is on providing opportunities to verbally communicate and encourage students to develop a vocabulary that will allow them to engage in reasoning, justifying, conjecturing, and explaining; however, other ways in which students might communicate are not addressed in detail in standards-oriented practices. Consider the African American dimension of orality, which is described as using oral communication to express feelings and emotions with movement and verve. Expressing oneself in dramatic and vervistic ways departs from traditional norms of classroom interaction—raising your hand and waiting for your turn to speak, letting one person speak at a time, not embellishing your speech or dramatizing parts of your ideas—as the students in this study have

done. Boykin and Cunningham's (2001) research on movement expressiveness of elementary African American children showed that the children had better retention of information when learning in an environment that was movement oriented as well as learning with materials that incorporated high movement themes.

Improvisation

Another practice that students enacted outside of the attention of the teacher was improvising. As defined, improvising occurred when students followed an activity or task in an unexpected or un-prescribed manner, but still engaged with the task in a mathematical way. Studies on African American elementary students provided other examples of students creating alternative routes though activities as a way to complete them or make them personal (Dyson, 1999; Gadsden, 2001). In classrooms, improvising most often occurred when students had a limited understanding of the required activity. Teachers modeled activities and held discussions about what was expected in an activity prior to sending the students off to work on the activity with their partner or group. Some of the students may not have fully understood all the requirements for the activity but knew enough to create an alternative version of what was expected of them. In grade 1, Kiana was playing a card game with Royce in which the players had to choose, from an arrangement of 20 cards, two cards that summed up to 10.

> OBSERVATION: Once Kiana finished arranging the cards, she said to Royce, "Go, what makes 10?" Royce chose a 0 and a 10 and started to record it. The two had a brief argument over who should record, and finally agreed that the person who drew the cards should record the combination. Royce then wrote 10+0=11 on her paper. When it was her turn, Kiana dug through the pile of unused cards to find a seven. She replaced a six in the original arrangement with this seven card and said, "7 and 2." She counted the pictures on the cards and realized that it is only nine. She tried 1, 5, and 3, in that order, all coupled with the seven card. Each time she chose a new second card, she counted the pictures again, always starting with the seven card and counting each picture by ones. Eventually, she found that 7+3=10, but she wrote on her paper, "5+5=10." Next it was Royce's turn. She also tried to dig through the pile of unused cards to find a specific card, but Kiana got very angry and accused her of cheating.

Kiana not only took on the role of activity director but also improvised the rules to suit her needs of finding a combination of 10. Throughout grades 1 and 2, Kiana would often change the rules of an activity to match her mathematical understanding, but did not like others to do the same.

As discussed by Forman (2003), research on emergent goals in mathematics learning indicates that "children, especially while working in group settings, will establish their own priorities for problem solving" (p. 339) as they learn what it

means to work collaboratively on mathematical tasks. Dyson's (1999) work with African American children in an early literacy study also found students using the limited knowledge they held about a task in order to complete it, creating their own version of the final product. She focused on what students transferred from other tasks—the mechanics of tasks completion such as materials to be used, types of solution displays, and how to "talk" about your work—that helped them fill in missing information as the students then improvised and completed the current task. Her view was that a negotiation needed to occur between the experiences students draw on and the experiences the teacher wished to provide in order to develop a common meaning of the proposed task.

Another form of improvisation occurred during the clinical interviews. Students would be given a task to do by an interviewer and if they knew how to solve the problem, they might solve it in an unexpected way or if they were unsure of how to solve the problem, they might change the problem to a form a problem they could solve. What made the acts of improvisation during interviews intriguing was that although the interviewer was a proxy for the teacher, the students appeared to be less driven to hide their improvisation during interview tasks. An example of improvising or answering in an unexpected way was when Jordan was asked to circle three numbers from 1 through 9 that totaled up to 15.

> *Interviewer*: Can you circle three numbers on this page that equal 15?
>
> *Jordan* (uses marker, pauses and thinks for 5 to 6 seconds, then circles): I can't circle four?
>
> *Interviewer*: Just three. (Jordan circles three numbers, 9, 3, 2) How do you know they equal 15?
>
> *Jordan*: Doesn't.
>
> *Interviewer*: It doesn't?
>
> *Jordan*: Uh-uh.
>
> *Interviewer*: What does it equal?
>
> *Jordan*: 14.

Here, Jordan appeared to understand the task—he asked if he could circle 4 numbers instead of 3—but still completed the task by creating a sum of 14 rather than 15. These acts of improvising, although infrequent in total number, raised the question: Why would a student engage with a task in an un-prescribed manner? Is it a natural occurrence for young children? Although Forman (2003), drawing on the work of Saxe and colleagues, points out that young children will modify or improvise an activity in an effort to simplify it, there was no mention of why students would improvise when it was clear they were mathematically able to accomplish the task as given. If considered from the African American cultural

dimension of expressive creativity, this practice could be construed as an attempt by the students to express their individualism, particularly in the interview setting where they were less likely to be sanctioned by the interviewer for deviating from the expected path. By creating an alternate, yet mathematically sound response to a problem, students gain control over their work and present themselves as proficient and creative problem solvers, which allows a student to "save face" and not be negatively labeled or seen in a stereotypical light (Erikson & Shultz, 1992; Perry, Steele, & Hilliard, 2003).

Considering Divergent Student Practices

Considering divergent practices forces a closer look at the frameworks students draw upon when interacting with classroom activity. For many African American students, African American cultural learning dimensions provide students with a framework that they may use to make sense of classroom activities and tasks, which at times is at odds with the expectations of the teachers and/or school. As teachers attempt to establish particular norms of behavior and interaction for students, the disconnect between students' cultural understandings and the expected responses can, in some cases, make it seem as though the student is being willfully disobedient or is less competent than those students who are adhering to the norms. What is important to consider, however, is that students have an implicit knowledge of the meta-discursive rules of school. Sfard (2000) suggested that the ideas of mutual orienting, patterns of interaction, and negotiation of obligations all fall under the idea of meta-discursive rules, which regulate the discourse in mathematics classrooms (and other classrooms) and the ways in which classroom community members speak and interact with each other without overt acknowledgment. In essence, students knew that their dramatic expressiveness and improvisation would be censured by the teachers, but still engaged in these practices. What would cause children at such a young age to engage in behaviors that could possibly get them into trouble?

As these students worked on mathematics activities, they attempted to engage with mathematics in a way that made sense to them, which allowed them to participate in the activities and show that they are mathematically "sound." In other words, they engaged in mathematical activities as a way to align their practices with the classroom goal of successful mathematics participation, as might occur with the African American cultural dimension of improvising, or to divert attention away from the fact that they might not be successful, as might occur with the dimension of dramatic expression. This idea is similar to the findings of Nasir (2002) with African American children who aligned their practices to those of domino and basketball players as a way to engage with that community. In her study, even when the children did not know how to participate in parts of the

domino or basketball activity, they would find a way around their obstacle so they could be seen as successful participants. In this study, the students may have been attempting to create a mathematics identity that would be sufficient to allow them to engage and align with the mathematics practices of the classroom.

Nasir (2002) also described how many African American children, when sufficiently motivated in activities outside of school, engaged, imagined, and then aligned themselves as part of a community where they felt they could belong. She claimed that this process has not occurred in schools for African American students. This study suggests that, in elementary school, students do engage with mathematics, and attempt to align themselves with the practices in a way that makes sense to them. What is missing appears to be the level of imagination. Did the students see themselves as being in the community of strong mathematicians? Only one student in the study consistently stated that he believed himself to be a good mathematics student. The other six students, when asked whom they knew was good at mathematics, often named White boys in their classrooms. The students gave very similar reasons for why these boys were considered good mathematics students: they could answer the teacher's questions quickly, they studied and practiced at home and over the summer (or so the students thought), and had mathematics tricks that help them get the correct answer. Considering the racial demographics of Carter School, the fact that African American students outnumbered European American students in every classroom at a ratio of at least 4 to 1, and the presence of some very bright African American students in each classroom (consider Maya and Samuel of this study), it was a surprising finding that an African American student was mentioned only once. The students' choices, however, reflect the ideas that society holds as a whole regarding who is a good mathematician (Burton, 1994).

It would appear that the students held a view of a good mathematician that they did not reflect and thus could not imagine for themselves. This lack of imagination could play an important role in the increasing disidentification noted in many African American students as they progressed through mathematics in school (Erikson & Shultz, 1992; Martin, 2000; Nasir, 2002; Osbourne, 1997). Nasir (2002) stated:

> The importance of imagination in this process offers evidence that becoming is more than just what one does as a participant. It also includes the meanings one makes of that participation. Children's ability to imagine (and the affordances for such imagination in practices) their own learning trajectories and their place in relation to others is critical to the development of new goals and the access to new identities. (p. 241)

Although the teachers in this study did work toward breaking down the traditional view of mathematics through their enactment of standard-oriented mathematics practices, it is clear that the current societal view of what it means to be

be successful in mathematics is still a barrier for increasing the successful participation of many African American students. By expanding the definition of who is considered a strong mathematics student to include the ability to explain solutions or create multiple solutions to a problem, more students may begin to imagine themselves as good mathematics students, capable of succeeding in mathematics. This expansion appears to be a difficult task, as the teachers in this study developed classrooms that reflected a less traditional view of what it means to do mathematics but the students still continued to adhere to the beliefs that reflected a narrow view of mathematics success.

Although the divergent practices of the students do relate to some of the dimensions of African American culture, they could also be explained through research that explored how lower socioeconomic children interact with the world. Lareau (2003), in her book *Unequal Childhoods* discussed what she called "the accomplishment of natural growth" (p. 238) to describe the development of children in working-class and poor (i.e., low-SES) families. She found that these children were raised with similar parenting practices that led to certain ways of interacting with the world. One characteristic she found was that working-class and poor children tended to spend time creating and recreating their own games and activities for play with other children, unlike middle-class children who were more often engaged with organized, adult-led activities. These independent playing opportunities could lead the children to be more comfortable with being inventive when engaging in games, similar to improvising that was noted in this study. Moreover, Lareau found that low-income children were more responsible for their lives outside of the home; this led the children to become more self-reliant and believe in their ability to take care of themselves without adult help. Being self-reliant encouraged the children to rely on their own personal knowledge as a tool for problem solving and decision-making. These findings from Lareau's study support the idea that SES can play a role in how students interact in classrooms and, in this case, the behaviors of low-income African American children. However, other studies also show that race also plays a part in student behavior and achievement in school (Lee, 1998; Roscigno, 1998; Wilson, 1998). Considering the work on African American cultural dimensions and how these dimensions take into consideration the historical evidence that African Americans have generally been part of the lower economic station in American society, some coherence between the practices and habits of low-SES families and African American families could be expected. Additionally, SES as well as race tend to explain only some of the differences in achievement and attainment for African Americans in school (Wilson, 1998) and, although more affluent African Americans score higher on standardized tests and have higher grade point averages than less affluent African Americans, they still score lower than students of other races (Nettles, Millet, & Ready, 2003; Steele, 1992; Vars & Bowen, 1998). Although

considering SES when discussing the relevance of African American cultural dimensions in student behavior and achievement confounds the issues, it appears that both factors play a role in these students' possibilities of achieving, and as such any practices that might support and enhance their success would be warranted.

Implications and Conclusion

In my analysis of the data, there appeared to be alignment with the practices the students enacted, African American cultural dimensions, and the research supporting those dimensions. The students enjoyed social interactions, talking and sharing, and connecting with others. They also used physical tools often and relied on them to help solve problems. Dramatic expression and improvising relate to the idea of expressive creativity; students wanted to be individual and unique in their work and using dramatics or creating their own rules allowed for this individualization and uniqueness. More comparative and in-depth research that focuses closely on the interactions and practices of African American students in standards-oriented classrooms is needed to better understand the influence of African American cultural dimensions on their learning and achievement and how to use those dimensions to better support African American students' learning and achievement.

Rather than looking at the divergent behaviors as social problems or behaviors needing remediation or punishment, teachers and schools could look at what can be learned from these behaviors that would enhance the academic achievement of students. As an example, the students desire to use physical tools and oral communication to support their thinking could lead teachers to make more efforts in bridging students' learning of abstract mathematics concepts. By lengthening the time that students have to use tools to solve problems, and making more explicit connections between how the tool use bridges to symbolic representations, teachers will be drawing on students' strengths while moving them toward deeper levels of mathematical understanding. Other areas of divergent behavior might be more difficult to incorporate into classrooms, such as dramatic expressions, consistent oral communication, or improvisation. However, if teachers understood and used these behaviors as tools to support students' learning in mathematics, African American students may have more success in learning mathematics and come to perceive themselves as mathematicians. Studies that explore the surrounding activities that accompany divergent behaviors can provide clues to understanding how African American students think about the mathematics they are learning while engaged in what may, to some teachers, seem to be unrelated activities or actions.

Most of the students in this study did not appear able to imagine themselves

as good mathematics students. We are still left with the question: How can African American students see themselves as part of the mathematical community? Breaking down the traditional view of what it means to do mathematics and who can succeed in it would be a step toward providing African American students with a vision of mathematics success that includes themselves. Teachers need to be encouraged and supported to develop and enact explicit practices that work to directly break down the cultural barriers and traditions about who can be successful in mathematics. More in-depth studies of teachers' practices over time in standards-oriented classrooms could help consider the effects of using cultural connections and resources when teaching African American students mathematics.

Candace, Felix, Jordan, Kiana, Maya, Royce, and Samuel represent the variety, complexity, and hope for African American students in our nation's schools. Although the vision and philosophy of standards-oriented practices in mathematics appears to be sound pedagogy, there is still much to learn about its implementation and effects on student achievement and attainment in mathematics. In the same way, African American cultural dimensions may not answer all questions about learning styles and preferences for learning by African American students, but by considering the ideas and research that support these dimensions, we are presented with opportunities to reflect on how teaching practices and school cultures affects the achievement of all students.

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Appendix A
Enacted Student Patterns of Practice Compared to Teacher Practices and African American Learning and Cultural Themes

Enacted Student Patterns, Interactions, Beliefs	Opportunity or Space within Classroom that Allow or Encourage Pattern	African American Cultural Dimension that Supports Pattern	Enacted Teacher Pattern Practice that Allow or Encourage Pattern	Student–Teacher Pattern Coherence
Focused Collaboration – students work on task at hand with little tangential or unrelated activities when working in small groups but occasionally needed teacher assistance in tasks	Small group work, teacher engaging as a support during independent or small group mathematical tasks, modeling of tasks for students prior to independent work, developing classroom norms of collaborative habits	Social affective Harmonious	Small group/partner work Teacher support Modeling strategies and thinking	**Convergent** – students occasionally needed teacher support in understanding the task or the mathematics of the task when working independently
Active participation – students listen, watch, and engage in mathematics discussions without a noticeable number of other activities unrelated to mathematics discussion at hand	Whole group discussion about math topic of the day, developing norms around participation behaviors, modeling participation behaviors, lively energetic discussions	Social affective	Whole group discussions Active listening Questioning and probing	**Convergent –** students can actively participate but within set norms and limits of classroom
Physical Tool Use – students understood and used blocks, cubes, paper, rulers, calculators, shapes, number cards, number lines, pictures, graphs, drawings, and so on to solve problems and accomplish tasks	Small group work to collaborate on tool use, modeling the use of tools, access to a variety of tools and ideas	Nonverbal Expressive creativity	Sharing and explaining ideas Small group work Whole group discussion Means of communication Modeling strategies and thinking	**Convergent –** students used tools effectively and regularly; sometimes would rely on concrete tools instead of moving toward more abstract tools
Direct Oral Communication – student speaks on the topic/task at hand without moving to a tangential or unrelated area when talking about mathematical ideas, tasks, or activities	Establishing norms during whole group discussion of listening to other classroom members, allowing opportunities to share ideas, modeling ways of responding and speaking	Social affective Harmonious	Sharing and explaining ideas Whole group discussions Encourage active listening Means of communication Modeling strategies and thinking	**Episodic Convergence** – listening and clear communication are important elements in classrooms; however, students sometimes used mathematical language that was limited or vague, did not always talk in a linear fashion, had false starts, retraced ideas; talked off-topic during speech
Activating Personal Knowledge – students used their personal background knowledge to understand and solve problems	Whole group discussions about tasks and activities; small group work, encouraging personal solutions to problems; sharing solutions in whole group setting	Harmonious	Sharing and explaining solutions Small group/partner work Whole group discussion means of communication	**Supported Divergence –** students used their prior knowledge and ideas often but sometimes would privilege their ideas over the ideas presented in the problem or task; teachers neither actively engage these connections nor did they sanction them
Dramatic Expression – students displayed movement while speaking; got up often while working; used body language and hand movements while working; used intonation, excitement, expression when speaking	Whole group discussion, small group work, using energetic activities, music and rhyme in activities; allowing movement throughout classroom often	Nonverbal Expressive creativity	Small group/partner work Whole group discussion	**Divergent –** although students engage in whole group discussion almost daily, they are not encouraged to be expressive or movement oriented in class; episodes of dramatic expression occur most during interviews

cont. on next page

Appendix A cont.

Improvisation – students worked on a task or activity by making new rules or changing the rules of prescribed activity, followed activities in unexpected manner while maintaining mathematical integrity of activity, created mathematically unexpected solution paths	Small group work time, student developed solutions; sharing of student solutions; allowing individualism in work habits and products	Expressive creativity Harmonious	Sharing and explaining ideas Small group/partner work Whole group discussions	**Divergent –** classroom expectations were to follow norms and rules, improvising falls outside this realm; students tended to improvise out of the sight of teacher, although improvising was sometimes an attempt to continue working on an activity or tasks in the face of difficulties
Self-Reliance – students believed in relying on oneself to understand and do mathematics	Independent and individual work time and space	Spirituality Expressive creativity	Modeling strategies and thinking	**Divergent –** classrooms practices supported collaboration and interdependence, but students maintained this belief in spite of the classroom practices
Boys as Mathematicians – students often professed the belief that boys, and most often white boys, were good at mathematics	Using male students examples during whole group discussions; using male students as partners for struggling students	N/A	N/A	**Divergent** – standards-oriented mathematics posits all students can be strong and capable mathematicians.