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Exploring the Nexus of African American Students' Identity and Mathematics Achievement

Francis M. Nzuki
The Richard Stockton College of New Jersey

In this article, the author explores five African American students' racial, mathematical, and technological identity construction and how these identities shape each other and the sense of agency exhibited in the process. Data collection for the study included classroom observations and interviews, including a task-based interview. The stories told by the participants, their solutions for the mathematical tasks, and their participation in the figured world of mathematical learning illuminated their sense of identity and agency. An analysis of the data revealed that the participants' positioning and authoring of their identities were influenced by how they negotiated and interpreted the constraints and affordances in the figured worlds in which they participated. It is through this process of negotiation and interpretation that the participants exhibited a sense of agency, or lack thereof, which, in turn, shaped their opportunities to participate in mathematics and hence the authoring of their mathematical identities.

KEYWORDS: African American education, agency, equity, graphing calculators, identity, mathematics achievement

Recently, mathematics education researchers have begun to utilize the notion of identity to examine issues of equity (see, e.g., Gutstein, 2003; Martin, 2000, 2006a, 2006b; Nasir & Hand, 2006; Stinson, 2010a). From this perspective, researchers consider the social and cultural features of the *figured worlds* (Holland, Lachicotte, Skinner, & Cain, 1998) in which students participate in mathematics and how these figured worlds shape how they position themselves as learners and doers of mathematics and how they are positioned by others. This perspective also considers the concept of *agency*—the understanding that individuals have the capacity to author their identities by resisting and/or reacting against the structural and cultural forces that might shape their identities.

Holland et al. (1998) define figured worlds as socially and culturally constructed realms "of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others" (p. 52). Within Holland et al.'s figured worlds the concept

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FRANCIS M. NZUKI is an assistant professor of developmental mathematics in the School of General Studies, at the Richard Stockton College of New Jersey, P.O. Box 195, Pomona, NJ 08240; email: francis.nzuki@stockton.edu. His research interests include issues of equity in mathematics education with a focus on students' identity construction and use of technology in the mathematics classroom.

space of authoring refers to the responses that people give with human agency and with improvisation, and the concept *positional identity* refers to the ways in which people understand and enact their positions in the worlds in which they live, implying that identities are developed in and through practice (Boaler & Greeno, 2000).

Boaler and Greeno (2000) claim that the mathematics learning environment is a particular social setting where teachers and students construct interpretations of the actions that take place in it; thus, the mathematics classroom could be considered as a figured world or a community of practice (Wenger, 1998). Several studies have documented underachievement and limited persistence of African American[1] students in the figured world of the mathematics classroom (Martin, 2000, 2003; Oakes, 1985; Tate, 1997b). However, drawing on critical race perspectives, including critical race theory (Tate, 1997a), a few scholars have begun to focus on the salience of race and identity in regards to African American students' mathematics learning and participation (see, e.g., Gutstein, 2003; Martin, 2006a, 2006b; Nasir & Hand, 2006; Stinson, 2008), uncovering the structural and cultural factors that perpetuate the racism embedded within American social structures and practices. These scholars are interested in understanding the relationship between the ways that African American students, who come to learning contexts with their experiences as African Americans, think about themselves as African Americans and their conceptions of themselves as learners and doers of mathematics. In other words, the focus is on the dialectic relationship between racial and mathematical identities.

Moreover, in discussing equity issues in mathematics, the use of technology in classrooms has been recommended as useful in helping engage low-SES[2] and minority students in learning that encourages them to use complex thinking skills in mathematics (Hennessy & Dunham, 2002). The National Council of Teachers of Mathematics (NCTM) (2000) states, "technological tools and environments can give *all* students opportunities to explore complex problems and mathematical ideas" (p. 13, emphasis added). NCTM also posits that technology can attract students who disengage from non-technological approaches to mathematics, and that all students should have opportunities to use technology in appropriate ways that

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[1] The terms *African American* and *Black* are used throughout to refer to a person of African ancestral origins who self-identifies or is identified by others as having the cultural identity of the United States.

[2] According to National Assessment of Educational Progress (NAEP), individual social economic status (SES) is defined by a student's participation in the federal free and reduce-priced lunch program, while a school's SES is defined by the percentage of students enrolled in the federal free and reduce-priced lunch program. Thus, schools with a high (or low) percentage of students participating in the federal free and reduce-priced lunch program are classified as either low or high SES schools.

will afford them access to interesting and important mathematical ideas. As such, through the opportunities afforded to them to interact with technology when learning mathematics, it is worth examining the relationship between the technological identity that low-SES and racial minority students develop and their developed identity in mathematics.

The study reported in this article, derived from my dissertation (Nzuki, 2008), builds on the emerging research about identity and the mathematical learning of historically marginalized students. In particular, I explore African American students' identity construction—racial, mathematical, and technological—and how the nexus of these identities affects the students' mathematics participation and achievement. Two questions guided the study:

1. What are African American students' perceptions of their mathematical experiences in the figured worlds of mathematics education in which they participate as learners?
2. How do African American students position and author their identities—racial, mathematical, and technological—within the figured worlds of mathematics education in which they participate as learners?

Here, I take a sociocultural perspective and view *identity* to be the basis "from which people create new activities and new ways of being" (Holland et al., 1998, p.5), as well as the means through which individuals assert themselves, care about the conditions of their lives, and attempt to direct their own behavior. In other words, I view identity as the means through which individuals enact agency. It is a dynamic concept, one that is constructed by individuals as they actively participate in cultural activities, and one that both shapes and is shaped by the social context. In this study, *racial identity* refers to the ways in which individuals perceive themselves in relation to their group, while *mathematical identity* considers the perceptions of individuals regarding their abilities to participate and perform effectively in mathematical contexts. And *technological identity* pertains to the ways that individuals appropriate and interact with technology. (Here, I restrict technology to the use of graphing calculators in the mathematics classroom.)

Theoretical Framework

In the study, I draw on the following sociocultural theoretical perspectives: (a) Holland et al.'s (1998) framework of figured worlds, positioning, and authoring; and (b) Goos, Galbraith, Renshaw, and Geiger's (2003) metaphors of technology as master, technology as servant, technology as partner, and technology as extension of self, that describe the varying degrees of sophistication with which students and teachers interact with technology. Additionally, in theorizing about how race and racism operate to affect African American students' mathematics learning and participation, I draw on critical race theory (CRT).

Sociocultural Theory

The sociocultural perspective that I draw upon is Holland et al.'s (1998) identity and agency framework that locates identity and agency as aspects of participation in particular communities of practice. Holland et al. discuss social systems in terms of figured worlds, positioning, and authoring. Cultural artifacts play an important role in figured worlds because they can serve as *pivots* (Vygotsky, 1978), which shift the frame of activity and provide the means by which figured worlds are "evoked, collectively developed, individually learned, and made socially and personally powerful" (Holland et al., 1998, p. 61). Through engagement with artifacts, learners enact their identities and agencies through processes of positioning and authoring within the figured worlds. Additionally, this enactment is patterned and governed by not only the learners' negotiation of classroom norms with the teacher and among themselves but also by their adaptations to the constraints and affordances of the figured worlds in which they participate (Boaler & Greeno, 2000).

This sociocultural perspective, therefore, places emphasis on the socially and culturally situated nature of mathematical activity, where the classroom, as a community of practice, supports a culture of sense making in which meanings are shared among students and the teacher. From this perspective, learning entails the collective process of enculturation into the practices of mathematical communities (Galbraith, Goos, Reinshaw, & Geiger, 1999) where students interact among themselves, with the teacher, the mathematics tasks, and classroom artifacts within the social context of the classroom. These interactions are patterned and governed by social expectations, conventions, norms, habits, and rituals (Galbraith et al., 1999; Goos, Galbraith, Renshaw, & Geiger, 2000; Warschauer, Knobel & Stone, 2004). An essential aspect of sociocultural theory is that learning is mediated by cultural tools and is fundamentally transformed in the process. The graphing calculator technology is an example of how such tools transform mathematical tasks. Learning, thus, is a process of appropriating the cultural tools (e.g., graphing calculators) recognized by a community of practice, and participation in such classroom communities requires learners to acquire new forms of reasoning and action that is beyond their established capabilities (Galbraith et al., 1999; Goos et al., 2000).

Sociocultural Theory and Technology

To describe the varying degrees of sophistication with which students and teachers work and interact with technology and the ways in which technology can mediate learning, Goos et al. (2003) draw from a sociocultural perspective of learning to theorize four metaphors of technology usage: technology as master, technology as servant, technology as partner, and technology as an extension of self. The lowest level is that of *technology as master*. Here students have limited operational skills, and the complexity of usage confines their activity to the few operations over which they have competence. If students have insufficient mathematical understanding, they blindly accept the output produced irrespective of its accuracy or worth. In the next level, *technology as servant*, the user is in control and applies the technology as a fast and reliable mechanical aid to replace mental, or pen-and-paper computations, but the technology is not used in creative ways to change the nature of the mathematical tasks. At the third level, *technology as partner*, technology is seen as a companion with which to explore rather than just a tool for producing results. Aside from being in control, the user not only appreciates that the outcome has to be judged against mathematical criteria other than just the technology-produced response but also recognizes that there needs to be a balance between the authorities of the technology and mathematics. *Technology as an extension of self* is the highest level of functioning. Here, the technology provides as extension of students' mathematical abilities and becomes an integral part of their mathematical repertoire, something that shares and supports their mathematical argumentation.

While these modes of interaction are hierarchical in that they depict an increasing level of technology use that students and teachers attain, Goos et al. (2003) contend that these modes are not necessarily related to the level of mathematics taught or the sophistication of the available technology, and once a user has shown that he or she can work at a higher level, it does not mean that he or she will do so on all tasks. Rather, these modes describe an expansion of the technological repertoire, which gives the user a wider range of modes of operation available to engage with a particular mathematical task.

Inequities that arise from differential access and use of educational technology in mathematics for racial minority students and low-SES students are usually considered in terms of (a) physical access, the physical presence of the technology, and (b) experiential access, how the technology is used, by whom and for what mathematical tasks (Gorski, 2005; Warschauer et al., 2004). Research shows that, even when they had the physical access to technology, many racial minority students and low-SES students were more likely to use technology for drill-and-practice activities that involve lower thinking skills (Hennessy & Dunham, 2002; National Center for Educational Statistics, 2002). Thus, the dynamics of technology access and use often end up reflecting, recycling, and strengthening the already existing inequities in mathematics education related to race and SES.

Moreover, Dunham and Dick's (1994) and Penglase and Arnold's (1996) allegation of graphing calculators' relative physical access when compared to other forms of technology, because of price, portability, and ease of use, still holds true today. Thus, inequities in the use of graphing calculators are more likely to arise because of experiential access—the extent of instruction incorporating graphing calculators received by students, as well as the opportunity that they have to make use of the graphing calculator's mathematical functions, which is what the NCTM (2000) envisions as the appropriate use of technology that can promote equity in mathematics classrooms. Furthermore, the consensus of research reviews is that students who use graphing calculators display better understanding of function and graph concepts, enhance their problem-solving skills, and score higher on achievement tests for algebra and calculus (see, e.g., Adams, 1997; Graham & Thomas, 2000; Hollar & Norwood, 1999; Schwarz & Hershkowitz, 1999; Thompson & Senk, 2001). The use of graphing calculators has also been shown to improve students' attitude towards mathematics (Ellington, 2003).

The aforementioned modes of interacting with technology can provide the lens through which to examine technological inequities by looking at the various ways in which students' appropriate technology to engage with mathematical tasks. As students gain more control in the use of technology, the technology becomes a means to equip them with skills and strategies to solve mathematical tasks by engaging them in active and meaningful learning that stimulates their creativity and critical thinking, thereby, in turn, increasing their level of understanding and participation.

Critical Race Theory (CRT)

To understand the role of race and racism in the academic learning and participation experiences of African American students, it is important to consider CRT as a framework for understanding the social inequalities arising through race and racism. Scholars of color who were working in academic legal circles initially developed CRT; it grew out of their dissatisfaction with the slow rate of racial reform since the growth of the Civil Rights Movement (Ladson-Billings, 1998). Grounded in the recognition that African Americans have a unique history of oppression and discrimination in the United States, including slavery, CRT posits that this distinct historical background contributes to a racialized minority experience and cultural identity for African Americans (Tate, 1997a). The lives of African Americans in the United States continue to be impacted by this history of race and racism.

For this reason, CRT advocates scholarly discourse that raises race consciousness, rather than masking racial identity through colorblindness or race neutrality (Ladson-Billings & Tate, 1995; Solórzano & Yosso, 2002; Tate, 1997a). Additionally, critical race theorists espouse the idea that race is socially constructed to mean that race is neither biologically determined nor fixed. Instead, race is ever evolving as a function of social, political, legal, and economic pressures (Delgado & Stefancic, 2001). This thinking implies that race categories are created by the dominant society in order to manipulate these categories to its own advantage. In educational research, CRT has been used to expose racism within existing educational practices and policies. While some researchers have drawn from CRT to explore the experiences of people of color as students and faculty in secondary or higher education (Bernal, 2002; Solórzano & Yosso, 2002), others have used CRT to critique certain legal cases in education (Villenas, Deyhle, & Parker, 1999). Additionally, CRT has been used to examine practices for preparing teachers to teach culturally diverse students (Ladson-Billings, 1999).

CRT often relies on counter-storytelling, which is a method of telling a story with the objective of casting doubt on the validity of accepted premises or myths, in particular, the premises or myths held by the majority (Delagafo & Stefanic, 2001; Solórzano & Yosso, 2002). In drawing from CRT's style of storytelling, I used McAdams and Bowman's (2001) definition of a life story. They define a life story as an internalized narrative that depicts an individual's life in time and consists of the reconstructed past, perceived present, and anticipated future. Further, life stories reflect an individual's understanding of self by both the individual himself or herself and also through the wide variety of cultural influences within which the individual's life is situated. Therefore, the life stories that the five participants of this study told through interviews entailed their own narratives of their mathematical experiences. This process allowed the participants to locate their stories within a context, which provided a fuller understanding of how they perceived themselves as learners and as doers of mathematics.

Methods

This research was a case study of an Intermediate Algebra III mathematics classroom at Graham High School (pseudonym, as are all proper names used in this study), serving a culturally diverse student population with the majority being African American. Of the 30 students enrolled in the class, 22 were juniors (11th graders) and 8 were seniors (12th graders) who were taking their last mathematics course before they graduated from high school. The school was chosen because of its demographic factors. First, it was a low-SES school based on the percentage of students eligible for free and reduce-priced lunches. Second, although there were relatively more Black students in the school, there was a fair share of other racial groups, particularly White students, at the school. This factor allowed for the examination of African American students' schooling experiences as they interacted with students from other "races."

I chose the Intermediate Algebra III class, one of the "lower-track" mathematics courses at Graham High School, because (a) I wanted a classroom where there were several African American students, most of whom had been relegated to the lower-track courses, and (b) I wanted a classroom where students used the graphing calculator on a frequent basis. Generally, teachers of the lower-level mathematics courses at Graham used graphing calculators less frequently than those of higher-level courses. This was particularly true among the lower-tracked courses. Thus, on this basis, of the lower-tracked mathematics courses, the Intermediate Algebra III class students were more likely to employ the use of graphing calculator. Additionally, by studying only one class, I wanted to examine how success and failure could exist among African American students with similar experiences within the figured worlds and learning communities in which they participated. These equivalent experiences include similar SES backgrounds, similar mathematical experiences, and, most notably, the same teacher.

Data Collection and Participant Selection

Data were collected through both quantitative and qualitative means. I employed a survey instrument, as well as classroom observations, and three interviews with each of the five student participants and the classroom teacher. Data collection took place in two stages. In stage 1, I administered a survey instrument (see Appendix A) to all students in the classroom. The survey had two distinct parts. The first part consisted of five-point, Likert-scale statements based on surveys developed by Fleener (1995) and the Fennema-Sherman Mathematics Attitudes Scales (Fennema & Sherman, 1976). The second consisted of open-ended questions, which asked the students to provide their names, descriptions of their race and/or ethnicity and their experiences with and use of graphing calculators. The survey instrument intended to (a) collect demographic information on the students (i.e., race, ethnicity, gender, etc.), (b) provide insights into students' perceptions towards graphing calculators and mathematics, (c) assist in preparing interview questions, and (d) facilitate the selection of the five participants for the study.

From the survey instrument, 12 out of 30 students self-reported their race to be African American. Of these 12, I examined each student's responses to the items on the survey instrument. After reversing the responses of the negative statements so that the (strongly) disagree responses were reported as (strongly) agree and vice versa, I determined my initial pool of high achievers to be those students who agreed or strongly agreed with at least half of the items. From this pool, I chose three "high achievers" (two male students and one female student) who had the highest strongly agree/agree responses. I followed the same procedure to determine the "low achievers," except here the focus was on those with the highest strongly disagree/disagree responses. In the end, I chose three low achievers (two female students and one male student). In the next step of choosing the participants, I consulted with the teacher to get his opinion of my list of high achievers and low achievers. In doing so, I wanted to determine if the teacher agreed with the students' self-reporting and responses to the items on the survey instrument and if these responses corresponded with their overall performance in the class. I also wanted to get the teacher's assistance in determining the regular attendees. Based on the teacher's assessment of the students' performance and participation in class, the teacher disagreed with only one male student's responses, leading me to classify him as a high achiever. In addition, according to the teacher, one of the male students I had classified as a low achiever was not a regular attendee. After my discussion with the teacher, I narrowed my participants to two high achievers (Caleb and Karen) and two low achievers (Annabel and Danielle). I decided to retain the male student, whose responses were challenged by the teacher, without initially classifying him as either a low or a higher achiever, because I wanted to (a) find out why he self-reported as a high achiever when and if indeed he was not, and (b) have a fairly balanced number of female and male participants. With extended time in the classroom and from my observations and interviews, I came to classify this student (Amos) as a low achiever. By focusing on these five participants, I was able to examine in depth the issues of identity and agency among African American students and how they impacted the students' mathematical learning. Summary information about the five participants is provided in Table 1 (for a detailed description of the participants see Nzuki, 2008).

In the next stage of data collection, I conducted classroom observations for two to three classroom periods per week from September 2007 to December 2007, for a total of 20 classroom observations. For these classroom observations, guided by a sociocultural framework, I observed the classroom dynamics in terms of classroom interactions between teacher and students, among students themselves, and among teacher, students, and technology (as previously noted, in this case, graphing calculators). I also explored the classroom discourse and the instructional methods employed by the teacher including how the graphing calculator was used to enhance teaching and learning strategies. During each classroom observation, I took field notes to record details of classroom tasks, teacher actions, and student actions involving graphing calculator use. I also documented the important visual or physical components of the classroom interactions. To capture accurately the teacher and student actions during the classroom interactions, all the classroom observations were audio taped.

To gain a deeper understanding of students' sense making of identities and agencies within the figured worlds of mathematical learning, I conducted three interviews with each of the participants. I conducted the first semi-structured interview at the beginning of the study. Given that the figured worlds in which students participate shape their beliefs, values, and understandings that they develop, the prompts for the semi-structured interview included questions pertaining to those beliefs and understandings related to their sense of identity and agency (Holland et al., 1998).

Table 1
Description of Participants

	Name	Family Background	Occupational Aspirations	Year	Course Grade
Low Achievers	Annabel	18-years old, lived with mother and two brothers, no family member had graduated from high school, father jailed because of drug-related charges	Elementary school teacher	12	47
	Amos	17-years old, 16 brothers and 4 sisters, lived with dad and a few siblings, other siblings either in college or working	Professional football player, musician, computer engineer	12	50
	Danielle	17-years old, one brother and one sister, lived with Aunt because her mother could not care for them, did not know where her father lived	Pediatrician	12	56
High Achievers	Caleb	17-years old, six sisters and two brothers, lived with mother and stepfather, biological father died when he was 8-years old, working class	Computer programmer	11	80
	Karen	16-years old, six sisters and four brothers, godmother to her friend and schoolmate's baby, lived with her mother and one of her sisters, two of her sisters and mother are in nursing profession	Licensed Practical Nurse	11	88

The second interview occurred toward the middle of the study, at which time I asked the students to share their reflections and reactions to some of the mathematics lessons covered since the beginning of the study. In particular, I asked them about (a) the lessons they particularly liked or disliked, (b) the effect of graphing calculators on their enjoyment, skills, and understanding, (c) features of the graphing calculator used in lessons and their relative importance, (d) students' use of graphing calculators in the observed lessons, and (e) students' perceptions of the role of graphing calculators in mathematical learning. Moreover, I investigated the students' perceptions of the opportunities offered by the classroom interactions between the students and the teacher, among themselves and with graphing calculators. The central focus was how these interactions allowed students to engage constructively and critically with mathematical ideas within the specific classroom contexts.

The last interview, which was conducted near the end of the study, was a task-based interview. I engaged the students in problem-solving tasks that were similar to those they had worked in class during the course of this study. I was interested in assessing the students' understanding of the mathematical content and the extent to which the graphing calculator appeared to contribute (or not) to their understanding, and the choices of strategic purposes of calculator use favored by the students. Some of the requirements of the tasks presented to the participants included: determining the roots and the axis of symmetry of a quadratic function, solving an algebraic linear equation with one unknown variable, finding the output of a quadratic function given a specific input, solving questions of a quadratic model describing the height of a baseball in the air after it is hit and of an exponential model depicting the elimination of caffeine from the body at a given rate.

To capture how students used the graphing calculator, I videotaped them as they solved the tasks. I also asked the students to explain their thinking and justify their strategies. In addition, I made notes about the strategies they used and collected all the written work that they produced as they solved the problems.

Data Analysis

I used the qualitative data from the classroom observations, student interviews, and field notes to address the research questions. I analyzed these data using a grounded theory approach (Strauss & Corbin, 1998). I began my analysis by conducting a general read-through of the data, paying attention to the data as a whole, and making analytic memos about the insights, patterns, possible themes, and categories emerging from the data. I then explored these categories in a holistic manner to answer the research questions, grouped them into meaning categories, and compared them repeatedly to identify any possible links (Strauss & Corbin, 1998). In coding the data, I used a combination of pre-established codes, drawn from my theoretical frameworks, and open codes, which emerged from my initial review of the data.

During my analysis, I focused on the participants' conceptions of mathematics and how they related mathematics to themselves and to their lives to investigate their mathematical experiences within the figured worlds of mathematics education in which they participated as learners. Moreover, to gain an understanding of how the participants positioned and authored their identities, I analyzed all data from each of the participants, including interviews and classroom interactions. In my analysis, I examined what participation in mathematics "looked like" across time and how it might fit into each participant's construction of identity and his or her sense of agency exhibited in the process. In analyzing students' interaction with and use of the graphing calculator in the classroom and as they solved the mathematical tasks presented, I drew upon the framework described by Goos et al. (2003).

Research Site and Context

The school. Graham High School was one of the four public high schools in a mid-sized, urban school district in the northeastern part of the United States. It was located on the west side of the city. From the state School Report Card, Graham High School serves approximately 1000 students in grade 9–12, most of them from low-income families. The percentage of students eligible for free and reduce-priced lunch was 64%, 70%, and 68%, in the 2003/04, 2004/05, and 2005/06 academic school years, respectively. During the 2004/05 and 2005/06 academic school years, African American students had the highest enrollment compared to other racial groups (see Table 2). Additionally, student stability in the 2005/06 academic year was 47%, which was significantly lower compared to that of 75% and 86% in the 2003/04 and 2004/05 academic years, respectively.

Tracking and ability grouping of students in mathematics courses did not begin when students entered Graham High School; it started in eighth grade. Based on their teachers' assessment of their achievement level, test scores and the final course grade from seventh grade, students were placed in either a "regular" mathematics course (lower track) or an integrated mathematics 1 course (upper track). Middle school teachers recommended which students should be placed in which track when they began the 9th grade at Graham High School; teachers recommended either a Math 1 course (upper track) or Math 1A (lower track). Those students who were successful in the Math 1 course and continued to be successful in the upper-track courses move to Math 2, then Math 3, and then take pre-calculus, calculus, and/or statistics courses before they graduated high school. These students took the state's Regent exams, Math A and Math B, after the completion of Math 2 and Math 3 courses, respectively. However, if an individual student did not perform "well" in any of the upper-track courses, he or she was relegated to the lower-track courses.

The lower-track courses were slower in pace compared to the upper-track courses in the sense that it took a longer time period to cover the same material. Thus, students were exposed to a different type of instruction and curriculum based on their track placement (Oakes, 1985). Students who were placed in Math 1A (lower track) in 9th grade, if successful continued to the next lower track, Math 2A. Those students who did not pass these courses after the first attempt were required to repeat the courses. As such, a student could have been in the 10th grade, taking Math 1A; or could have been in the 11th grade, taking Math

2A; and so on. From Math 2A, the next track in the sequence was usually Math 3A, which was the Intermediate Algebra III course that I chose for this study.

Table 2
Demographic Factors of Graham High School

	2003/04	**2004/05**	**2005/06**
Eligible for Free Lunch	54%	60%	59%
Student Stability[3]	75%	86%	47%[4]
Limited English Proficient	0%	0%	8%
Racial/Ethnic Origin			
American or Alaskan Native	2%	2%	2%
Black or African American	38%	41%	41%
Hispanic or Latina/o	18%	19%	20%
White	39%	34%	32%
Asian or Native Hawaiian/Other Pacific Islander	4%	5%	4%

Source: State School Report Card

The teacher. At the time of the study, Mr. Samson was in his second year of teaching at Graham High School. A White man in his late 20s, Mr. Samson held a B.S. in mathematics from a public university in the northeastern part of United States and a M.S. in mathematics education from a private university in the northeastern part of United States. Mr. Samson completed his student teaching and one of his field placements at Graham High School. Thus, in total, he had spent at most three years in the school during and after the completion of his master's degree program.

Similar to most teachers in U.S. schools, Mr. Samson claimed that he held all of his students to the same "standard" regardless of their cultural background or ethnicity (Williams & Land, 2006). In other words, similar to many professed "race neutral" teachers, he did not attribute differences in academic performance between low- and high-achieving students to their racialized identities and, in turn, to their racialized learning experiences, but rather to their low-SES backgrounds. He often associated the low-SES backgrounds of his low-achieving students with the likelihood of having "dysfunctional" families that "caused" students' problems such as skipping school to care for siblings, failing to do

[3] *Student stability* is the percentage of students in the highest grade in a school who were also enrolled in that school at any time during the previous school year. For example, if School A, which serves Grades 9–12, has 100 students enrolled in Grade 12 this year, and 94 of those 100 students were also enrolled in School A last year, the stability rate for the school is 94%.

[4] The source of this data, which is the only public data available, does not explain this drop. It also does not explain why the percentage of the students with limited English proficiency is zero in 2003/04 and 2004/05.

homework, or coming to school unprepared and/or hungry. Furthermore, Mr. Samson supported the educational policy of academic tracking, particularly in mathematics, because the slower, lower-level tracks provided the students "more time to understand the material, maybe they can do more stuff so that they don't have to do [homework]…maybe [the course] can be [taught] at a slower level for them to make them understand the material." In the end, Mr. Samson's short-term goal was to ensure that his students were excited about mathematics. But by his own account, he did not envision his students proceeding into mathematics related fields in the future.

Although Mr. Samson's claims to race neutral standards and efforts to have students excited about mathematics taken collectively were well intended, by not recognizing the effects of the persistence and permanence of race and racism in the educational experiences of racial minority students, he, similar to too many U.S. teachers, was subscribing to a color-blind ideology that overlooks the salience of race and racism in the daily lives and educational experiences of racial minority students (Ladson-Billings & Tate, 1995; Solórzano & Yosso, 2002; Tate, 1997a; Williams & Land, 2006). Under the pretense of race neutral policies, this color-blind ideology masks an underlying reality of racialized educational practices and policies such as tracking and ability grouping, low teacher perceptions and expectations, and high-stakes standardized testing that legitimize the placement of racial minority students in a subordinate position (Williams & Land, 2006). Mr. Samson's support and justification of some of these practices not only failed to acknowledge institutional racism but also concealed "dysconscious racism"—an "uncritical habit of mind that justifies inequity and exploitation by accepting the existing order of things as given" (King, 1991, p. 135).

Moreover, the color-blindness ideology afforded Mr. Samson (and other White teachers) "a safe space" (Williams & Land, 2006, p. 581) that allowed him to not confront race-issues in regard to the academic experiences and performance of racial minority students. Mr. Samson instead pointed to students' socioeconomic backgrounds as an explanation for the low academic achievement of many of his racial minority students. Mr. Samson's sentiments are in line with other teachers (of any "race") who subscribed to this color-blind ideology, using SES as a bad proxy for race. Such teachers most often (un)consciously fail to conceptualize race as a social construction and mistakenly believe that racism is no longer an issue in the post civil rights era (Ladson-Billings & Tate, 1995; Williams & Land, 2006). The endurance of this color-blind ideology among U.S. teachers—as suggested in my CRT analysis of Mr. Samson—demonstrates the crucial need for teachers to be provided multiple opportunities to learn about and understand the complexities of the racialized identities and, in turn, racialized learning experiences of racial minority students in their teacher preparation and professional development programs (King, 1991; Ladson-Billings, 1999).

The classroom. In his mathematics classroom, Mr. Samson usually began class by giving students some warm-up questions that were a review of the previous day's lesson. As the students worked on the questions, Mr. Samson walked around the classroom to monitor the progress of the students and to collect their homework, which students generally placed in the upper left hand corner of their desks. In nearly each class period, Mr. Samson reprimanded somebody for failure to bring his or her homework. Mr. Samson employed whole-class instruction techniques for the most part and made use of the various resources in the classroom to present the material to the students. These resources include transparencies, overhead projector, chalkboard, and the Smartboard interactive whiteboard. For example, he used the overhead projector to display the image of the graphing calculator whenever he wanted to integrate the use of graphing calculator. Mr. Samson often demonstrated the algorithm to solve a mathematical task and expected that the students would be able to follow the same sequence of steps when given a similar task to solve. Mr. Samson also expected the students to ask questions regarding a specific step in the problem-solving process at any time during the class period.

It is also noteworthy that, although the students did not have a permanent pre-assigned seating arrangement and could choose their seat in the class, the students had their favored sitting positions. There were those who preferred to sit near the front, as was the case for Caleb, and those who preferred to sit at the back, as Amos did. One of the observations I made over time was that the students' seating positions affected their participation in the classroom. More often than not, the students who sat in the front were more active in the classroom than those who sat at the back of the classroom who were relatively less engaged.

There was a classroom set of *TI-83* graphing calculators that students were free to use whenever they wanted to. Mr. Samson's perception of the use of the graphing calculator technology of his students whom he felt did not have "decent math skills" influenced how he integrated the graphing calculator technology in the classroom. He believed the graphing calculator served as an impetus to the students' mathematical problem-solving efforts. In this regard, the most exploited aspect of the graphing calculator technology was the facilitation of the multiple representations of mathematical tasks—algebraic, graphical, and tabular. The graphing calculator amplified the students' speed and accuracy of problem-solving strategies like graphing and reviewing a table of values. Thus, for the most part of his instruction, Mr. Samson and the students interacted with the technology as a servant. Additionally, students occasionally exhibited a level of subservience to the graphing calculator technology through their failure to connect their mathematical knowledge with their graphing calculator knowledge in solving mathematical tasks. For example, students sometimes specified unreasonable values for the window range and, as a result, scaling interfered with their efforts to solve problems.

Findings

The goal of this study was to investigate African American students' racial, mathematical, and technological identities construction. The following discussion focuses on these identities and how they coalesce to influence the participants' mathematical learning.

Racial Identity

All of the participants—the low achievers (Annabel, Amos, and Danielle) and the higher achievers (Caleb and Karen)—were fairly consistent in indicating that being an African American was important to their self-definition, and they felt good about being African Americans. For example, Annabel talked about how proud she was to be an "African American…people of African descent," while, when asked to describe herself, Karen said, "I am black and am 16." Additionally, all the participants, associated with the collective term of race with a perception of "we," meaning that they felt a strong and positive attachment to being African Americans. As such, a collective identity played a part in their perception of self.

Moreover, the participants were aware of the societal constraints and challenges that affected the academic participation of many African American youth including being "downed" or devalued by the society. As an example, Amos felt that "we are downed…they are just like we can't do nothing…like one time I came here because I wanted to try to go to [name of university] and there were all White people and they looked at me like…they didn't say anything but the way they looked at me…it was a mean look…I felt funny." Caleb argued:

> A lot of us…because of where we come from we do not have the type of…like the mental stability to be able to uphold…like I can't go to college…I can't do this or that because we are not in the right kind of environment around us to be able to do that…you see what I mean…I am lucky to have a mom that makes me want to do that, and she raised me to be the best I can be.

Other constraints they mentioned include (a) the lack of role models and encouraging family and community members who would make students appreciate the importance of academic (and mathematics) success, (b) the media that portrayed African Americans as being involved predominantly in sports, music, violent and crime-related activities, (c) the lack of resources, and (d) the low expectation that society had about urban public schools and about the success of African American students. Peer pressure had much to do with the courses African American students took, their attitudes towards school, and their academic performance. Caleb also talked about peer pressure that increased with school level. He shared:

> I think it harder for us to do better in school because we have…I mean it depends on what kind of school you go to…and what race is dominant…I mean there is more peer pressure...you know what I mean? And you kinda like start falling in and start falling out of the good crowd into the bad crowd…like…you know what I mean? …and the bad crowd is really the guys who do not do good in school, don't come to school, stuff like that…I mean the older you get as an African American, the harder it gets…unless you have education.

Thus, all the participants not only had strong and positive affiliation to their race but also they were cognizant of the obstacles and the social devaluation prevalent in society that face African Americans. Differences emerged in the ways in which the participants interpreted and negotiated these obstacles and the sense of agency they exhibited in the process. This difference, in turn, affected how they positioned themselves and the kinds of mathematical identities they authored.

For example, Annabel appeared to blame her African American status for her tarnished identity in mathematics. She seemed to associate the barriers and social devaluation that African Americans face in the society with her poor performance in mathematics. Thus, instead of exhibiting a sense of agency to overcome these barriers, Annabel appears to have cast herself as a victim who was trapped in a society that looked down upon African Americans. Danielle was disinterested and unfocused on racial issues in the school setting. I did not take this to mean that she had adopted what Fordham (1988, 1996) describes as a raceless persona—the notion that, for African American students to be successful they must distance themselves from African American cultural attributes. Indeed, Danielle saw herself as, and said that she was proud to be, an African American. Her responses to questions pertaining to her perceptions of the impact of race on her academic experiences were, however, noncommittal. For example, in responding to a direct question about race and her academic experiences, she said, "Honestly, I can't even answer that question because I don't remember anyone saying or doing something racial and if they did it was a joke…I take everything for a joke." Because Danielle, in general, was aware of the racial bias in society against African Americans, I took her response to mean that she was not interested in interrogating the salience of race in her academic pursuit. Indeed, her focus seemed to be to "just finish high school and graduate." This focus appears to coincide with her overall air of disinterest towards schooling and particularly towards taking mathematics courses.

Amos perceived his intellectual capability to perform well in the course was questioned by some White students and was unhappy about this experience. He remarked, "when I was going to this class there was a bunch of people, some White students were telling me I have to be smart to be doing mathematics…to be in the class…lots of stereotypes…it's like you have to prove yourself." These are some of the constraints that can cause African American students to feel ambivalent about their success in school and even doubt their own abilities. As an African American who faced these constraints, Amos did not respond to them as a passive victim; rather, he reacted through resistance and criticism. He resisted by being argumentative and disruptive in class, which sometimes took away time from covering new material. His failure to do homework, which was another form of resistance, sometimes led to heated verbal exchanges between Amos and Mr. Samson. Additionally, Amos blamed and criticized his teachers for their reactions towards him although he admitted his anger and attitude, which annoyed the teachers, played a part in these reactions. Amos's racial identity, which was influenced by the social devaluing of African Americans, corresponds to the oppositional student described by Fordham and Ogbu (1986). Fordham and Ogbu offered an explanation of the school-resistance phenomenon as it relates to African American students in terms of the sense of collective oppositional identity that Blacks develop in response to racial stigmatization by Whites.

Like the low achievers, the high achievers, Caleb and Karen, were aware of the societal constraints and challenges that operated inequitably to affect the mathematical participation of many African American students negatively. In response to the social devaluation of African Americans by society Karen remarked:

> Being an African American…like people do down you but if you put your effort, you don't have to worry about what people say, that is how I feel it…like I don't care…I am equal to everybody else, I can do the same thing everybody else can do…I don't see what I cannot do because of my skin color…like I can't learn mathematics, I can't do this or I can't do that…I don't see nothing like that…I just think an African American can do whatever you want to do…Like White people, they can down you a lot but you just stick around and do what you want to do to make it in life.

Caleb shared Karen's sentiments by saying, "I don't care what people say," and "there are certain things you have to prove people wrong and show them that you can do it." He also attributed his success to his mother who kept pushing him to be the best he could be.

Thus, the awareness of these societal constraints and challenges shaped the high achievers' authoring of positions for themselves as learners of mathematics and as African Americans. Unlike the low achievers, they perceived these constraints as a source of motivation and that as African Americans they had to work twice as hard to overcome them, thereby demonstrating their sense of agency. Their racial identity shaped their resourcefulness and resiliency in the sense that they did not see race as a limiting factor but a resource that empowered them. They had a firm belief that in spite of the obstacles and challenges that negatively affected the mathematical participation of many African American students, they had the capacity to overcome them and be successful in mathematics.

Mathematical identity

Martin (2000) defines mathematical identity as being shaped by students' "beliefs about (a) their ability to perform in mathematical contexts, (b) the instrumental importance of mathematical knowledge, (c) the constraints and opportunities in mathematical contexts, and (d) the resulting motivations and strategies used to obtain mathematics knowledge" (p. 19). In examining students' mathematical identity, it is imperative to draw from their past and perceived present experiences and to link these experiences to their anticipated future experiences. The students' stories assist in this regard. By linking past, present, and future experiences, one can examine the students' trajectory of mathematical experiences given that it is within this trajectory that students' identities are developed and refined as a result of the cumulative effect of their mathematical experiences. To illustrate, take the case of two of the participants—Annabel, a low achiever, and Caleb, a high achiever. Annabel's mathematical identity could be traced back to her earliest unpleasant mathematical experiences. She claimed that "the first time I did division and I did a horrible, horrible job because I did not know what I was doing…I felt sad…and I lost the interest right there." Annabel remarked that she had since hated mathematics all her life because she "couldn't learn it…they don't stick." Annabel created a portrait of herself as a mathematics victim and blamed her failure on various constraints in the figured worlds of the mathematics classroom and school. She complained about her lower grade teachers who passed her to the next grade "even though they knew I didn't know mathematics," instead of giving her the help she needed. Over and over again she said that she hated mathematics, and she didn't know whether it "is because I am black American or not." Saying that she had failed mathematics all her life and that she did not have the essential basic skills which left her feeling helpless, she argued that she needed "an assessment of disability but they won't do it." She claimed that she never had a high point in mathematics and positioned herself as "just getting by" because "I have to take the course in order to graduate."

Caleb's trajectory, however, tells a different story. Recalling his earliest memories of mathematics, Caleb claimed that he was good at mathematics at first, but when it got to multiplication and division he started falling behind. He attributed this falling behind to his failure to work hard or pay attention. Other constraints included the difficulty of the subject and also his lack of realization of the importance of mathematics. With time, however, there was a shift in his trajectory of participation in mathematics that was influenced by the positive identity that

Caleb developed upon realizing the importance of mathematics for college admission. This realization caused him to be more actively involved in the learning process by paying more attention, writing extra notes, and asking questions in class. Such behaviors demonstrate his sense of agency through improvisation and innovation:

> I started paying more attention…I started writing stuff down and extra side notes like...instead of just the notes he [Mr. Samson] writes on the board…I write my own so that I may have my own way of remembering because sometimes when I don't write my notes I don't remember.

Additionally, linking past and present experiences to future experiences provides a lens through which one can examine students' perceptions of who they are and who they would like to become—their occupational aspirations—and how this coincides with their mathematical identities. Caleb's future aspirations were "going to college and becoming a computer programmer" and as a consequence he saw himself being "big on mathematics because my major is technology, and technology and mathematics go together." Thus, Caleb believed that, to be successful in his future career, he had to be good at mathematics; that is, have a positive mathematical identity. On her part, Annabel also contemplated going to college and "major in education but I am not gonna teach like high school or middle school…'cause I don't think I can teach mathematics beyond elementary level…so I will teach the elementary kids and I am gonna minor in African American studies." As such, Annabel's perceptions towards mathematics seemed to have created tensions and limitations to her aspiration of becoming a teacher because she did not see herself capable of teaching beyond elementary school level mathematics.

Karen, a high achiever, aspired to join the nursing profession and believed that mathematics was useful in careers like nursing because "it helped in measurements." She further believed that mathematics would help her gain admission to college. Indeed, compared to low achievers, high achievers understood the role that mathematics would play in fostering or hindering their prospects of gaining entry to college. Amos, a low achiever, believed that his football skills would earn him a place in college. His future aspirations were working in the music industry, becoming a professional football player, and becoming a computer engineer. However, unlike Caleb, Amos did not see the connection between being good at mathematics and becoming a computer engineer, because "you know how certain people grow up knowing things…I think I just grew up with computers," implying that his knowledge about computers was innate, and he did not have to go through any formal training.

As I got to know more about Amos, I interpreted his behavior and actions to be that of a student who occasionally positioned himself as cocky and conceited.

In other words, it was hard to talk him out of something. This positioning might have prompted the occasional arguments he had with his teachers who determined if and when he was wrong and at times ended up sending him out of the of the classroom. Moreover, I found the way Amos presented his abilities and achievements to be sometimes misleading and pretentious. This overstating might explain his self-reporting on the statements of the survey instrument, which had led me to initially classify him as a high achiever. When I asked about his experiences of the current mathematics course, Amos, who was retaking the course after failing the first time, responded:

> I took the course last year and I failed the test—that is why they wanted me to take it again…I get everything in this class…this class is so easy. Everything I can do because I have learned it before. I know all he [Mr. Samson] knows.

Amos's overall performance and participation in the course, however, told a different story. Indeed, while repeating a course may place a student at a somewhat more advantageous position to understand the topics than a student taking the course for the first time, the student will still have to put it in effort and work hard to author his or her positioning as a capable learner and doer of mathematics. All these attributes, which culminated in Amos authoring a somewhat distorted mathematical identity, affected his participation in mathematics.

Danielle, another low achiever, perceived mathematics to be useful in her future aspirations of becoming a pediatrician because it helped in measurements of the "right amount of scoops and right amount of diets." However, she did not quite appreciate the role that mathematics would play in facilitating the process of gaining entry to college and studying to eventually become a pediatrician. She claimed that she did not see herself taking any mathematics courses in the future. She described her mathematical experiences as "a pain in the neck, and every day is a low point for me" and that she took mathematics courses not because she wanted to but because she had to. No matter how hard she tried, she claimed she "still don't get it…my brain cells are gone…I have probably like three brain cells working and they ain't working hard enough…mathematics is just…I don't care for mathematics…mathematics don't care for me." These comments seem to reveal that during her years of schooling she had developed a disinterested mathematical identity. Further, her disinterest in the subject had reached to the point where she did not feel she had the agency to author a positive identity and position herself as a capable learner and doer of mathematics.

Closely related to the students' future aspirations were their valuations of mathematics or their perceptions of the utility of mathematics. Their perceptions appear to have been limited to experiences and functions to do with measuring, numeracy, and calculations of mundane tasks particularly pertaining to handling money and balancing a checkbook. Karen's statement captures this perception best:

> When you think about saving money you need to know how to add this, to multiply this, subtract that…and like when you go to the store, you need to know how much money to spent…you know…be able to add stuff up…they try to cheat you sometimes…so you need to know mathematics so they won't.

The students' perceptions of the utility of mathematics not only reveal that mathematics had little purpose outside of school but also expose the disconnect between their in-school and out-of-school mathematical experiences. This disconnect could also explain the gap between the students' perceptions of future aspirations and the importance of mathematics in helping them achieve those goals and aspirations. Further, although all participants mentioned that they thought mathematics was important because it was a requirement for high school graduation, only the high achievers saw mathematics as important for success with future college coursework. To this end, therefore, there appears to be a connection between students' perceptions of their future aspirations and the value and utility of mathematics on one hand, and the kinds of mathematical identities they develop on the other hand. When students see the usefulness and value of mathematics and its role in their future aspirations, they seem to develop more positive identities in mathematics and vice versa.

It is also imperative to examine how students' identities are shaped by both their negotiation of classroom norms with the teacher and among themselves, and also by their adaptation to the constraints and affordances of the figured worlds in which they participate (Boaler & Greeno, 2000). Equally important is the individual agency exhibited by students in the process. One of the norms that emerged in Mr. Samson's classroom was the expectation and obligation for students and the teacher to ask and answer questions. This study showed that this norm both constrained and afforded students' opportunities to participate in mathematics. For example, asking questions was one of the aspects of Caleb's participation that made him visible in the classroom. This agentive role, which positioned him as a questioner, ensured that he was able to (a) seek clarification on concepts that he did not understand, and (b) pose challenging questions for the rest of the students to think about.

This classroom norm of questioning afforded Karen the opportunity to be an active participant in the figured world of the mathematics classroom where she positioned herself as an explainer. Whenever the teacher asked a question, Karen participated by both raising her hand and calling out answers. In some cases, the teacher would call upon a student to work a problem on the board, which is something that Karen loved to do. Her seating position in the front row of the class was beneficial because it helped the teacher to not only see her hand first whenever he asked a question but also to easily hear her responses. As for Annabel, because of her lack of confidence in mathematics, she believed that asking questions in class would waste time for other students. As such, the figured world of the mathematics classroom where she had to interact with other students created a constraint for Annabel that prompted her to avoid participating in the classroom.

Some of the constraints in the classroom included disruptions from other students talking in class. High achievers exhibited a sense of agency to overcome the temptation of giving in to pressures from their peers and misbehaving in class. In contrast, low achievers were more prone to being distracted and losing focus. The many students in the classrooms also constrained the opportunity to participate for low achievers because they felt that they had to compete for the teacher's attention with the other students. High achievers, Caleb and Karen, exhibited a sense of agency to overcome this constraint by sitting in the front where the teacher could easily spot them. The perception that some students, particularly the low achievers, lacked the skills and understandings necessary to perform mathematical tasks also created a constraint that limited their participation.

We see, therefore, that students' effort to enact agency within the figured world in which they participated created spaces that were inherently full of tension that Holland et al. (1998) referred to as contested spaces or spaces of struggle. These contested spaces help to illuminate the interplay between students' participation in figured worlds and the sense of identity and agency they exhibit in the process. Moreover, how students positioned themselves and authored their mathematical identities was influenced by how they negotiated the classroom norms and the constraints and affordances in the figured world of mathematics learning in which they participated. It is through these negotiations that they exhibited a sense of agency that afforded or constrained their opportunities to learn and participate in mathematics.

Technological Identity

To describe students' technological identities, I engaged the participants in problem-solving tasks that were similar to those they had worked in class during the course of this study and examined the varying degrees of sophistication with which students interacted with and appropriated the use of the graphing calculator to solve the mathematical tasks. In doing so, I drew from Goos et al. (2003) and their framework that theorizes four metaphors of technology usage: technology as master, technology as servant, technology as partner, and technology as an extension of self. The lowest level of interacting with technology is that of technology as master, while technology as an extension of self is the highest level of functioning.

The graphing calculator amplified the participants' problem-solving strategies and scaffolded them through the tasks where they lacked the algebraic facility. By influencing the participants' capabilities to solve mathematical tasks, the graphing calculator had an effect on how the participants positioned themselves and authored their identities as learners and doers of mathematics. However, the extent to which this authoring happened was contingent upon how the participants positioned themselves in using the technology—the modes with which they interacted with graphing calculators.

For example, Karen, a high achiever, always took time to go through the tasks to make sure that she fully understood their requirements. She showed her sense of control of technology in knowing when and how to use the graphing calculator. For instance, in determining the maximum height of a baseball in the air after it is hit, Karen knew it was important to have a good view of the graph of the quadratic model. Before going to the WINDOW function to adjust the window to a reasonable domain and range, Karen looked at the TABLE function to get a sense of how big or small the values were. This sense making also enabled her to get a rough idea of what the maximum value was. By doing so, she blended her mathematical knowledge (of domain and range) and her graphing calculator (of adjusting the window). She then used the MAXIMUM function of the graphing calculator to find the maximum value and correctly interpreted this output to be the maximum height of the baseball in the air. Consequently, Karen's ability to blend her mathematical knowledge and her graphing calculator knowledge to interpret the output of the technology meant that the use of graphing calculator did not result in the replacement of her mathematical skills but rather formed an extension of those skills and her abilities to solve the mathematical tasks. Karen's process represents the highest functioning of technology as an extension of self, which shaped her positioning as a capable doer of mathematics. Nonetheless, in a few instances, Caleb, another high achiever, failed to blend his mathematical and graphing calculator knowledge, which hampered the effectiveness of the graphing calculator use. Based on when and how he appropriated the use of the graphing calculator, however, Caleb exhibited a sense of autonomy and control of the technology that could be enhanced by more guidance and support from the teacher and enabled him to achieve the highest level of functioning—technology as an extension of self.

Among the low achievers, Annabel and Danielle, there was the tendency to immediately reach out for the graphing calculator even before, in my estimation, they had thoroughly understood the task. This tendency was particularly evident for tasks where the algebraic equation was given because they could easily enter the equation into the Y=EDITOR of the graphing calculator. While they may have used the graphing calculator as a starting point with the goal of getting oriented to the task, failure to take time to reflect on the information relevant to the mathematical task at hand affected how they appropriated the use of graphing calculator. When confronted with tasks where they had to find the algebraic equation, they were unable to determine the equation and were, thus, unable to solve the task altogether. The lack of strategic use of the graphing calculator, however, was not the only issue that affected how the participants, particularly the low achievers, interacted with technology and hence the kinds of identities they exhibited in the process.

Another important issue was how students blended their mathematical and graphing calculator knowledge in solving the problems. For example, in some cases, the low achievers were unable to juxtapose the mathematical knowledge (of domain and range) and the graphing calculator knowledge (of adjusting the viewing window). This failure restricted them to lower levels of interacting with technology. In addition, given that a student's ability to use technology influences how he or she interacts with technology, Amos (another low achiever) resisted the use of graphing calculator by saying: "The graphing calculator has many steps…you have to press the 2nd [key] and do this and that…you are not going to be able to remember all of that—it's just that it is too many steps to do it…I don't like using it…I will never have a calculator in the class unless somebody gives it to me." As DeGennaro and Brown (2009) point out, having the knowledge and seeing the need to use technology is an issue of identity concern. This resistance impacted Amos's knowledge base concerning using the graphing calculator technology and shaped his potential interaction with the technology.

It is also important to point out how the figured world shaped the participants' interaction with graphing calculators. In this regard, the teacher's role in integrating technology into classrooms is pivotal given that it is the teacher who guides instruction and shapes the instructional context in which the technology is used. This guiding and shaping implies that the decisions the teacher makes pertaining to the use of the graphing calculator directly affect students' technological identities as they interact with the technology to perform different tasks. First, by his own account, Mr. Samson did not think that, "a lot of those kids are going to go into mathematics fields outside of high school…I think they are so phobic of mathematics and everything in mathematics scares them." Mr. Samson, in addition, believed that the graphing calculator was most beneficial to students who "have decent mathematics skills." Second, Mr. Samson admitted that he had not spent as much time in class teaching them how to use graphing calculators because he had expected them to have had acquired the graphing calculator knowledge already. Unfortunately, most of these students were products of previous lower-tracked mathematics courses where the appropriate use of graphing calculators was limited. Mr. Samson, however, remarked that in the future he would make a concerted effort to ensure that his students had an adequate knowledge of using the technology. Third, because most of the students did not own their own graphing calculators, Mr. Samson did not assign homework that required the use of graphing calculators. Mr. Samson found this lack of ownership problematic because students did not get the opportunity to hone their skills in using graphing calculators to solve mathematical tasks.

Discussion

This study contributes to knowledge on issues of African American students' identity construction—racial, mathematical, and technological—and how these identities shape each other, and the sense of agency exhibited in the process. In doing so, I injected the role of race and racism and their relationships to mathematics learning and participation by exploring how the overlapping learning communities including school, peer, family, community, and societal forces shape students' construction of themselves as learners of mathematics (Martin, 2000).

This study also brought out the individual agency that students enact within the figured worlds or learning communities in which they participate as learners of mathematics. The analysis demonstrated that students' efforts to enact agency created contested spaces or spaces of struggle (Holland et al., 1998), which were inherently full of tension. Additionally, how students positioned themselves and authored their mathematical identities were influenced by how they negotiated the classroom norms and the constraints and affordances in the figured world of the mathematics learning in which they participated. It is through these negotiations that they exhibited a sense of agency that afforded or constrained their opportunities to learn and participate in mathematics.

To some extent, this study offers an explanation as to why, in spite of all the participants facing similar constraints as African Americans who came from similar SES backgrounds and attended the same class, taught by the same teacher, there were both high and low achievers. As such, this study's focus on students' identities revealed how both success and failure can exist within the same figured worlds and learning communities of the students.

This study also challenges Fordham and Ogbu's "burden of acting white" theory (1986; see also Fordham 2008; Ogbu, 2004). This theory suggests that long periods of oppression and discrimination by the dominant society have led African Americans to develop responses and behaviors that emphasized their distrust of and opposition to the dominant society and its institutions, including schools. A significant limitation of this theory is that the notions of agency and resistance are not thoroughly interrogated, if at all. As Foley (1991) noted: This perspective sees African Americans as "discouraged and trapped in the racist myths of the dominant society. They are unable to see that they can both be successful and Black" (p. 77). By so doing, this theory disregards the ability and facility of disenfranchised groups to respond to the oppression and the struggles in their lives with a sense of agency and positive resistance. In other words, this theoretical perspective "underestimates the capacity of ethnic resistance movements to empower individuals" (Foley, p. 78).

In his critique of Fordham and Ogbu's (1986) theory, Stinson (2010b) claims that it offers an insufficient justification as well as an oversimplified explanation for the Black–White achievement gap. His critique emanates from a participative inquiry study (Stinson, 2004) in which he examined the influence of socio-cultural and -historical discourses on the agency of four academically and mathematically successful African American male students. Stinson defined agency as "the participants' ability to negotiate—that is, to accommodate, reconfigure, or resist—the available sociocultural discourses that surround male African Americans in their pursuits of success" (p. 3) The participants were requested to respond to theoretical perspectives that discussed the schooling experiences of African American children, including Fordham and Ogbu's burden of acting White theory.

Stinson (2010b) explains that throughout the participants' "individual and collective counter-stories of success there were instances where they managed the burden of acting White by accommodating, reconfiguring, or resisting the discourse" (p. 15). Further, the participants' counter-stories demonstrated their "complex, nuanced, and multilayered schooling experiences" (p. 18). Stinson argues that these experiences provided a context within which the participants negotiated, with a sense of agency, the discourses that unjustly shifted the responsibility for African American students' underachievement away from factors like the structure of U.S. public schooling and onto the shoulders of the students themselves. Stinson contends that it is this contextualization that negates the oversimplification posed by Fordham and Ogbu's (1986) theory.

Additionally, according to Fordham and Ogbu's burden of acting White theory (1986), the dysfunctional aspects of African American students that undermine their academic success are adaptations to the hostile sociocultural discourses that they face and not inherent cultural traits as posited by the deficit theory. However, like the participants in Stinson's (2010b) study, the participants in this study, particularly the high achievers, did not respond to the unfavorable discourses by adapting to them but by negotiating them within the figured worlds in which they participated. Thus, the factors that enhance or constrain meaningful academic and mathematics participation of African American students should be contextually traced in how they negotiate and interpret the socio-cultural and socio-historical forces that shape their schooling experiences (Stinson, 2006, 2008, 2010a).

In the context of learning mathematics, Foley's (1991) and Stinson's (2010b) remarks are in alignment with the recent emphasis on student identity and agency by other researchers who examine issues of equity in mathematics education (e.g., Gutstein, 2003; Martin, 2000, 2006a, 2006b; Nasir & Hand, 2006).

These researchers use the notion of agency to examine the importance of historically underachieving students having a robust and empowering identity in relation to mathematics. Additionally, this perspective serves to challenge the stereotypical and essentialist perspective that often comes as an entailment of classification—the notion that members of a particular ethnic, racial, socioeconomic, gender, or other group, by virtue of their membership in that group, all share important attributes and therefore can be treated in ways appropriate for members of that group. As Martin (2000) and Nasir (2002) contend, this shift in perspective affords students the sense of agency to act and change their experiences in spite of the constraints and obstacles that they face. From this viewpoint, learning is therefore associated with the practices in which students engage, and as such the learning communities within which they participate shape the identities and agencies that students develop. Given that these learning communities influence students' mathematical background, and experiences that they come with in the figured world of the mathematics classroom, they ultimately shape the students' perceptions of their future aspirations, the value and utility of mathematics, and their ability to do mathematics, all of which are connected to their mathematical identities. Indeed, when students see the usefulness and value of mathematics and its role in their future aspirations, they seem to develop more positive identities in mathematics and vice versa.

Focusing on students' development and enactment of their identities within the mathematics classroom offers mathematics educators an opportunity to gain an understanding of the contested spaces within which students negotiate the classroom norms and the constraints and affordances in the figured world of the mathematics learning in which they participate. Given that it is through these negotiations that students exhibit a sense of agency which affords or constrains their opportunities to learn and participate in mathematics, mathematics educators, including teachers and administrators, can begin to look into factors that affect, in a positive or negative way and at a more personal level, students' participation in mathematics.

One of the important aspects of this study regards listening to the voices of the students in examining their identities. The counter-stories told by the students brought to the fore the confluence of the forces that filter into the figured world of the mathematics classroom, affecting their perspectives of themselves, their abilities in mathematics, and their future goals and aspirations. To ensure that these students have an opportunity to learn, special consideration must be given, at a more individual level, to the factors that affect their identities. Mathematics educators and researchers, therefore, need to develop and identify strategies to help students with negative mathematical identities.

Students like Annabel, who had a disabled mathematical identity, need numerous opportunities to experience success in mathematics. These successes can be achieved through recognizing and rewarding small accomplishments and diversifying assessment methods to allow students to demonstrate multiple capabilities and intelligences of participating in mathematics. According to Wenger (1998), learning is a process of identity formation in which learners locate themselves within particular communities in a process of belonging and ultimately knowing. Thus, if students like Annabel and other low achievers are given opportunities to be successful in learning mathematics, these experiences can relate and become part of their trajectories. To increase the participation of these students, and especially students like Danielle who are disinterested in mathematics, teachers must ensure that the figured worlds of mathematics classrooms are learning environments that motivate, encourage, challenge, and empower students. One way of creating such environments is by introducing instructional activities that relate mathematics to students' life experiences and communities. Low achievers like Amos, with distorted perceptions of mathematics, can benefit from an awareness of themselves as students and as future adults. These types of students need to know that their future success and life chances depend on their current actions and academic performance.

Moreover, the societal and school discourses that have a disproportionately negative affect on the academic and mathematical participation of many African American students point to the racialized schooling experiences of these students (Martin, 2006a). In other words, being an African American within the figured world of mathematics learning influences how one is socially constructed and framed as a learner and doer of mathematics (Martin, 2006, 2009). For example, research has shown that teachers' preconceived notions about African American students may guide differential expectations for, and interactions with, these students and impact their academic achievement (see, e.g., Berry, 2008; Pringle, Lyons, & Booker, 2010). In his study, consisting of eight African American middle school boys who had experienced success in mathematics, Berry (2008) reported that teachers who, unjustly, had the propensity to focus on his participants' real or perceived behavioral problems instead of their academic work had discouraged most of them from taking advanced mathematics courses.

In addition, Amos's discipline issues and frequent brushes with authority figures point to a form of institutional racism that contributes to the marginalization of African American students through the construction of Black identity as an oppositional social identity that is in need of discipline, punishment, and control (Ferguson, 2000). There is consensus among most educators and scholars about the importance of having safe and orderly environments for meaningful teaching and learning to take place. Consequently, in a society where the construction of race shapes the interpretations of behavior, trying to keep an orderly learning environment can interfere with the learning opportunities of certain groups of students, particularly African American male students. Berry (2008) argues that the unfair judgment of African American students' academic ability based on their behavior undermines their success because "their behavior could be in reaction to symptoms of structural issues, such as teachers not being multi-culturally competent" (p. 479). As such, to assist in deconstructing this perception and possibly other misconceptions about African Americans, teachers need to be prepared to teach different racial/ethnic or cultural groups. Providing teachers and other school personnel with opportunities to become familiar with African American history and culture through staff development sessions or by attending classes that encourage positive counseling methods to enrich the lives of their student populations would assist in this deconstruction.

Moreover, the notion that students do not have control of their academic destiny, and that no matter how hard they try failure is inevitable, is yet another ideology of intellectual helplessness, exemplified by low achievers like Annabel, that teachers and school personnel in general must be prepared to counter. According to Perry, Steele, and Hilliard (2003) school personnel should make efforts to organize sessions that are inspirational and motivational and also attempt to create various environments within which students can construct positive academic identities. One way of organizing such sessions would be through inviting prominent and successful African Americans, such as mathematicians, lawyers, scientists, professors, to schools as guest speakers to speak to the students as role models and instill in them a sense of optimism—that despite the constraints, they too can be successful. Indeed, a study conducted by Zirkel (2002) revealed that having the same race-and-gender-matched role models were "significantly and consistently predictive of a greater achievement concerns" (p. 371) on the part of minority students. Having matched role models can provide concrete information to minority students in regard to what is possible for them as members of specific social groups. Zirkel noted:

> Similar others in desirable positions may enable young people to construct their own images of themselves in similar contexts, helping them to generate not only the thought "if he (or she) can do that, maybe I can too," but also "if he (or she) can do that, maybe people like me can do any number of different things." (p. 359)

Thus, having the same race-and-gender-matched role models can impact the development of identities of minority students and their academic achievement.

In addition, the high achievers in this study reported that one of the factors that influenced their academic achievement was their parental support, expectations, and involvement. This is consistent with other research findings (e.g., Berry, 2008; Ladson-Billings, 1995), which indicate that parental involvement in terms of advocating for, helping, motivating, and encouraging their children at home and school contributes to improved academic performance, behavior, and self-esteem of minority and low-SES students.

Moreover, the role of peers in the socialization process of African American youth and in shaping their racial identities and academic achievement is paramount. Fordham and Ogbu (1986) attributed the underachievement of African American students to oppositional behavior that involved peers in school settings. This opposition was brought about by the notion that because Black students viewed academic success as the domain of Whites, this was seen as fundamentally in opposition to Black culture and established achievement norm of peer groups. As Caleb, one of the high achievers, argued, an African American student has to exhibit individual agency that defies the negative influences of peer group pressure in order to be academically and mathematically successful. Berry (2008) reported that it is this sense of agency and resiliency to overcome peer pressure that influenced his mathematically successful participants to construct alternative identities. Berry further argued that in doing so the participants

> did not develop alternative identities that chose White culture over African American culture; rather, they used racial identities and parental discussions of racialized experiences to promote achievement. Three primary components influenced these alternative identities: (a) co-curricular and special academic program identity (b), religious identity, and (c) athletic identity. (pp. 482–483)

Research has also shown that the pervasive notion regarding negative peer-group influences among minority students does not always hold true. Indeed, the role of supportive and high-achieving peer groups has been reported as instrumental in promoting the mathematical achievement of minority students (Walker, 2006). In her study involving high-achieving minority students at one of the high-poverty schools in New York City, Walker found that collaboration and peer support played a critical role in supporting the participants' mathematical knowledge. Walker noted that the participants

> helped each other in several ways and on several mediums, with academic work (tests, homework), with advice about problem solving and course taking, and with encouragement. Also they helped each other in multiple settings; in class, out of school, on the phone, and in the cafeteria (as well as other 'school spaces'). (p. 68)

It was through the intellectual collaboration and interaction with their peers that Walker's participants were afforded the opportunity to co-construct their individual and collective identities in relation to mathematics.

Research reviews also reveal that educators and school personnel should capitalize on cultural learning styles and culturally relevant curricula because students bring different cultural patterns to the classroom through language use, problem-solving techniques, and interactional styles. They also bring different prior experiences and frames of reference for imagining concrete applications of abstract ideas. School administrators should provide instruction that supports these varied cultural styles and experiences using culturally relevant materials (Delpit, 1995; Ladson-Billings, 1995; Reyes & Stanic, 1988). To ensure that classroom-learning experiences are meaningful and relevant to African American students, instructional strategies should be employed that allow them to see the connections between what they learn in the classroom and the mathematics that occurs in their day-to-day lives. That is to say, their appreciation of the value and importance of mathematics needs to be expanded to go beyond numeracy and calculations of mundane tasks particularly limited to money. This expansion is essential in fostering the development of identities related to mathematics. Moreover, one way of ensuring that African American students effectively develop technological identities is to give them the opportunity to create with and learn through technology (DeGennaro & Brown, 2009). This goal can be accomplished by using graphing calculators to model and interpret real-world situations using data collected from sources and activities that connect to the students' everyday experiences (Gutstein, 2003).

To achieve the NCTM's (2000) goal of ensuring that access to and use of technology in the mathematical learning process of students does not result in another dimension of inequity, it is also important to look into factors that relegate the students' use of graphing calculator technology into lower levels of functioning. For one, failure to plan and implement a strategy that appropriates when and how to use the graphing calculator so that its use is not always the starting point has the danger of technology taking the place of, instead of extending, students' conceptual understanding, computational fluency, or mathematical problem-solving skills. There is no doubt that technology has the potential to positively impact students' mathematical identities. However, this depends on *how* technology is appropriated in the mathematical learning of students. In the lowest level of interaction, technology as master, students' lack of mathematical understanding and subservience to technology influences them to blindly accept the output generated by the technology irrespective of its accuracy or worth. For students to develop the capacity or sense of agency to question the output of the graphing calculator, they need to have a mathematical knowledge base. Through guidance and support, teachers can provide students with opportunities to blend their mathematical and technological knowledge base, given that this will allow them to interpret the graphing calculator output and judge it against the pertinent mathematical criteria. In other words, as demonstrated in this study, the blending of the mathematical and graphing calculator knowledge bases is important in facilitating the co-construction of African American students' technological and mathematical identities.

Low-achieving students can learn a few lessons from the high-achieving students. For example, they can learn that they have the capacity to author positive mathematical identities by responding to the constraints and affordances of the figured worlds in which they participate as learners and doers of mathematics with a sense of agency. Indeed, while the high achievers negotiated the unfavorable discourses of the figured worlds with a sense of agency, the low achievers appeared to adapt to these discourses with a sense of helplessness, constraining their opportunities to participate in mathematics. Regarding racial identities, the low-achieving students can learn that being in touch with one's own racial heritage should not lead to opposition but can and should be resourceful and powerful, as was the case for Karen and Caleb. The high achievers demonstrated that increasing knowledge about their heritage and being aware of the societal challenges and barriers that negatively affect the academic and mathematical participation of African American students can make students better prepared to face these obstacles. To these students, racial identity was a positive and motivating source that made them work even harder. As such, these students showed that being an African American and being successful in mathematics are not mutually exclusive occurrences. When interacting with technology to solve mathematical tasks the low-achieving students can learn from the high-achieving students the necessity to exhibit a sense of control of the technology—understanding and knowing how and when to use the tool. This sense of control, however, requires that students first take the time to carefully read the mathematical tasks presented and make sure that they fully understand the requirements of the tasks. It is this sense of control when using technology that often affords students the ability to mutually reinforce their mathematical knowledge and their graphing calculator knowledge and thereby interact with technology at higher levels of functioning.

Conclusion

This study showed that both success and failure do exist within the same figured worlds and learning communities of students. It is the individual agency that students exhibit as they participate in the figured worlds of mathematical learning that determines the kinds of identities they author. Thus, in our efforts to improve the mathematical learning and achievement of African American students, and indeed all other historically marginalized groups, it is important to inculcate into the students this sense of individual agency—the recognition that an individual has the capacity to act and make choices. It is the understanding that, in spite of the odds and the seemingly insurmountable obstacles that one may face, people have the capability to overcome these constraints if they make the appropriate choices of who they want to be.

To ensure that African American students have opportunities to learn mathematics, our challenge as mathematics educators is to find ways of providing students with opportunities to develop the sense of agency that will ensure that they author positive mathematical identities. African American students need to understand that it is not contradictory to be an African American and be successful in mathematics. African American students, and indeed all students, I believe, can navigate their way through the vast array of obstacles that they may be confronted with and become successful in mathematics.

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Appendix A
Survey Instrument

Part I (cont. on next page)

Key: **SA**: Strongly Agree **A**: Agree **N**: Neutral **D**: Disagree **SD**: Strongly Disagree

	Statement	SA	A	N	D	SD
1	I enjoy learning mathematics.					
2	Graphing calculators make mathematics fun.					
3	Doing mathematics is doing something, which I think I just can't do.					
4	I do not prefer working problems with a graphing calculator.					
5	I am good at mathematics.					
6	I feel that the use of graphing calculators has caused a decline in my basic arithmetic facts.					
7	If I had my choice this would be my last mathematics course.					
8	Mathematics is useful for solving everyday problems.					
9	Graphing calculators motivate me to do mathematics.					
10	I am looking forward to taking more mathematics courses.					
11	No matter how hard I try, I am not the type to do well in mathematics.					
12	I am able to do more interesting mathematics with graphing calculators.					
13	I feel confident in solving problems in mathematics.					
14	I find mathematics to be very boring and dull.					
15	I try math harder when I have a graphing calculator.					
16	I have a lot of self-confidence when it comes to mathematics.					

17	I understand mathematics better if I solve problems using paper and pencil.					
18	I will use mathematics in many ways as an adult.					
19	Learning mathematics involves mostly memorizing.					
20	Using graphing calculators makes me a better problem solver in mathematics.					
21	I see mathematics as a subject I will rarely use in daily life as an adult.					
22	A graphing calculator enables me to solve problems I could not solve before.					
23	Learning mathematics mostly involves exploring problems to discover patterns and make generalizations.					
24	I rely on my graphing calculator too much when solving problems.					
25	It is important to know mathematics in order to get a good job.					

Part II

Please fill in the following information:

1. Your Name____
2. Gender: (Check one) Male_________ Female________
3. How would you describe your race/ethnicity? (You can check more than one)
    - ❐ African American
    - ❐ Hispanic/Latina/o
    - ❐ American Indian/Alaskan Native
    - ❐ Asian/Pacific Islander
    - ❐ White
    - ❐ Other
4. Experience With and Use of Graphing Calculators (Check one)
    - ❐ I have the ability to work with graphing calculators Yes______No_____
    - ❐ I use the graphing calculator to do my homework Yes______No_____
    - ❐ I have my own graphing calculator which I use at home Yes______No_____
    - ❐ My teacher allows the students to use graphing calculators whenever they feel like it Yes______No_____
    - ❐ There are enough graphing calculators in my classroom for all the students Yes______No_____