Balancing Acts: A Mixed Methods Study of the Figured Worlds
of African American 7th Graders in Urban Science Classrooms

by

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Dedication

To my parents, Ernest and Winifred Cleveland, who loved me and raised me to be a survivor. I love and miss you both.

To my husband Michael, thank you for loving me through some of the best and most challenging circumstances in my life so far.

TO MY GOD – Thank You for Your love and grace, and for helping me to overcome!!!

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Chapter 1 —INTRODUCTION

Science is an important school subject that is a gateway to science, technology, engineering, and mathematics (STEM) career fields. In these fields, women and some ethnic minorities remain underrepresented relative to their male, White American, and Asian American[1] peers (Jacobs, 2005; Lewis, 2003; Oakes, Joseph, & Muir, 2004). Some explanations for this underrepresentation are that non-Asian American minority students in the United States have lower tests scores than their Asian American and White American peers on national science performance assessments (Grigg, Lauko, & Brockway, 2006), and are also less likely to take high-level science courses and less likely to choose to pursue science-related fields (Lewis, 2003; Oakes, Joseph, & Muir, 2004). Inequities in access to quality science education for students from economically, culturally, and linguistically diverse backgrounds in science explain some of these differences in outcomes (Atwater, 2000; O. Lee, 2003; Oakes et al., 2004). Other explanations are that racial minority youth develop increasingly negative attitudes toward science as youth progress through school (Hill, Atwater, & Wiggins, 1995; Simpson & Oliver, 1990), lose interest in and motivation to learn science (O. Lee & Brophy, 1996), and are required to traverse differences between their home cultures and that of science

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[1] Educational and occupational data aggregated on Asian Americans from different countries of origin suggest that although they make up less than 5% of the U. S. population, they are overrepresented in science and engineering college majors and occupations on average (National Science Board, 2008; National Science Foundation, 2009). In this dissertation, I discuss Asian Americans as an aggregated identity group, acknowledging that when these data are disaggregated by country of origin, studies have reported that not all Asian American groups are represented in the sciences; in particular, southeast Asian students from countries such as Vietnam, Laos, and Cambodia have educational and occupational outcomes similar to those of minority groups underrepresented in the sciences such as Hispanics and African Americans (Ngo & Lee, 2007; Yang, 2004).

(Aikenhead, 1996; Basu & Barton, 2007; O. Lee, 2003; Kozoll & Osborne, 2004). The research reported in this dissertation is motivated by lingering questions regarding particular ethnic/racial groups' underrepresentation in science and seeks to offer new perspectives on underrepresentation. Specifically, I focus on young people's identities and cultural models and examine the ways in which identities and culture may shape how they take up or make sense of science. In particular, I investigate how young African American students who live in a Midwestern U.S. city identify as science learners and how those identities are situated in particular cultural models that the youth hold of science, of school, being students, and of African Americans. The research questions that guided this study are:

1. What are the beliefs of African American middle-school students about the domain of science in general and about themselves in relation to science?
2. What is the relationship between students' identifications (as articulated in surveys and interviews) and their beliefs and cultural models of science?

The research questions in this study stem from my own experiences as someone who has come to adopt an identity as a science learner over time that is congruent with who I am as an African American, working-class, female who has experienced this difficulty firsthand – first as a high school student (because I had little exposure to science prior to high school), next as an engineering major in college, later working as an engineer in corporate America, and now as a social scientist in academe. This difficulty to assume an identity as a science learner and science worker had many origins including access to few cultural models related to science, science learning, *and* people like me. I also was surrounded by classed, raced, and gendered discourses from within and outside of my community that said that someone like me should have lower or at least *different* aspirations and outcomes. Moreover, I had few resources prior to high school that provided me access to the types of knowledge and dispositions valued in science. During my observations of the Black students I came in contact with, I saw that even when they had access to exemplary science programs, they seemed to struggle to assume identities as science learners. I understood that the students I worked with grew up in a different place and at a different time than I did, and had exposure to better science education and at a much earlier point in their educational process than I did, and yet their achievement scores indicated that many of them continue to struggle in school science. I wanted to interrogate what this process looked like for them.

Thus, I turned to the research literature on science education and identity enactment to learn more about innovations in the science education of young people. A large body of research has accumulated over the last two decades on development projects intended to address science underrepresentation and test score disparities. This research has used approaches shown to increase students' interest and motivation and to help students make connections between their home communities and science content. These studies have also drawn on the National Science Education Standards (National Research Council [NRC], 1996; 2001) to create large-scale implementation of curricular reforms. Such reform initiatives contextualize science content via *inquiry-based instruction* or instruction that allows teachers and students to generate questions and investigate them in ways similar to those of practicing scientists (NRC, 2001). The hands-on approaches and technologically-driven curricular innovations have resulted in increasing students' standardized test scores and their engagement in science (Geier et al., 2008, Gotwals & Songer, 2006; Hug, Krajcik, & Marx, 2005; Kahle, Meece, & Scantlebury, 2000; Songer, 2006). In addition, students from various socioeconomic backgrounds gain access to research-proven, high-quality science programs that include innovative curriculum, professional development opportunities, technological tools that help students construct science knowledge, and materials needed for curriculum enactment. Research in this vein has evaluated the effectiveness of the urban systemic reforms to determine which instructional practices and curricular conditions bring about significant changes in students' science performance, using multiple measures including pre-post test scores and students' responses from content interviews.

In addition, studies in educational and developmental psychology have attempted to understand and examine students' achievement motivation as it relates to who they perceive themselves to be as students within academic domains such as science. *Achievement motivation* refers to a student's desire to achieve in a subject area based on her evaluations of her competence in this area and the importance she places on the tasks in this subject area; individuals' ability beliefs and task values in a domain are measures of achievement motivation in a subject area and thought to drive individuals' performance and achievement-related choices such as taking advanced courses in a subject area (Wigfield & Eccles, 2000; 2002). Achievement motivation is thought to explain why some students choose to achieve and pursue activities within certain domains and not others (Eccles & Jacobs, 2000; Jacobs, 2005; Eccles, Barber, & Jozefowicz, 1999). In the domain of science, for example, individuals with high achievement motivation (as exhibited by high conceptions of their abilities as science students and high values for science tasks) would be more likely to want to enroll in higher-level science courses, engage in science-related extracurricular activities, and choose to pursue careers as in science-related fields. Many achievement motivation studies have employed large-scale survey research and are often longitudinal in nature. There are also studies that have explored differences in students' achievement motivation by gender in male-dominated fields such as math and science (Greene & DeBacker, 2004; Jacobs & Eccles, 1985; Meece, Glienke, & Burg, 2006).

Several studies in science education also document disparities, present novel instructional programs, and explore ways to provide motivating, empowering and high-quality science instruction to students from identity groups that are underrepresented in science (Barton, 1998; Brickhouse & Potter, 2001; Merino & Hammond, 1998). Unlike the science education studies reviewed above, some of these investigations have occurred in settings outside of the classroom. For example, some have investigated students' identity formation in different science environments such as at different types of high schools and in afterschool programs (Barton, 1998; Brickhouse & Potter, 2001).

The last category of science education research intended to redress issues of inequity in science learning extends the previous category of equity research, and includes studies in science education that draw on the work of Luis Moll and colleagues (Moll, Amanti, Neff, and Gonzales, 1992; Moll & Greenberg, 1990). Research in this vein has investigated students' cultural worlds or cultural knowledge and behavior that are part of their families, schools, and peer groups, including values, beliefs, and social practices well-known by individuals in a community (Phelan, Davidson, & Cao, 1991). Moll and colleagues termed the cultural knowledge that students bring to bear in classrooms from their families and communities *funds of knowledge*; they studied how funds of knowledge can be used to bridge the distance between students' home and school cultural worlds. Per this cultural perspective, science teachers can scaffold instruction using students' funds of knowledge or things students know well in their everyday lives and relating them to concepts taught in science (Bouillion & Gomez, 2001; O. Lee & Fradd, 1996; Lukyx & Lee, 2007; Rodriguez & Berryman, 2002).

One fund of knowledge that many studies have explored is *discourse* or communication that reflects students' cultural worlds (Hicks, 1995/1996). Several studies examine discourses in the subject of science; in these studies, discourses serve as funds of knowledge that help students gain access to science content and transform the spaces in which students learn science (Barton & Tan, 2009; Brown & Ryoo, 2008; Moje et al, 2004a). Research in this vein has investigated the ways that the demands of discourse enables or disables student participation and performance in the disciplinary communities constituted by science classrooms (Crawford, Kelly &, Brown, 2000; Kurth, Anderson, & Palincsar, 2002; Moje, Carrillo, Collazo, & Marx, 2001; Rahm, 2002; Rosebery, Warren, & Conant, 1992).

Gee (1990; 1996; 2008) speaks of Discourse or big "D" discourses as ways of knowing, reading, believing, and doing that reflect students' cultural worlds. I review studies that encompass both ways of discussing discourse. Research in this category proposes that discourses – both oral and written language as well as dispositions individuals take on – are instrumental in students' creation of academic identities in the subject area of science (Ballenger, 1997; Brown, Reveles, & Kelly, 2005; Rahm, 2007; Reveles & Brown, 2008); this cultural and discursive perspective also posits that the adoption of identities is part of science learning (Lee & Luykx, 2006; Reveles & Brown, 2008), or moving from identifying as a novice learner in an area to a learner with more knowledge or expertise in that area. This work is motivated by sociocultural theory that theorizes learning as shifts in identity that result from being a member of a community of practice (Lave and Wenger, 1991).

Each of these areas has made a significant contribution to developing equitable science teaching and learning practices and meaningful science curricula, and taken together, these four areas can be particularly useful in examining the relatively unexamined questions of how African American students identify as science learners, and how those identities are situated in the models of science and of science learning available in their cultural worlds. I desired to understand in particular the cultural models that drove them to act, what types of individuals they imagined scientists and science workers to be, and how they imagined science students to be.

Thus, in this dissertation study I draw upon all four research areas introduced above to explore the question of African American adolescent students' science learner identities. The present study is situated within contexts using high-quality curriculum developed in the first category of studies; measures achievement motivation, as in the second group of studies; focuses on urban African American students (an underrepresented minority group as in the equity studies); and investigates how students use various material and cultural resources to construct identities as science students as in the last group of studies. In particular, I investigate one community of underrepresented youths' identities as science learners and future science workers from a particular social location (class, gender, race, and age) by merging the analysis of survey data with the analyses of interview and short-term classroom observations. I use the term "science workers" in this dissertation to denote individuals who work in fields related to science such as technology and engineering. I also use the definition of "identities" as self-understandings, as offered by Holland, Lachicotte, Skinner, and Cain (1998). I explore the process by which students come to self-understandings as science learners. Before turning to a review of related studies of science learners' identities, cultural knowledge, and achievement motivation, I review the key constructs of identity and cultural models in more depth.

DEFINITION OF KEY CONSTRUCTS

What are identities?

Several disciplines use the terms "identity" and "identities," which would lead one to believe that definitions for these terms are widely accepted. In point of fact however, these terms have been used differently over time and are highly contested (Brubaker & Cooper, 2000). Both sociological and social psychological literatures view identities as consisting of multiple, hierarchically ordered self-representations that are constantly shifting and accessible, although they differ on how these self-representations become salient and how individuals take up these self-understandings (Hogg, Terry, & White, 1995; Stets & Burke, 2000). In general, sociological theories of identity put forth a role-focused perspective of the individual, and social identity theory of social psychology posits a group-focused perspective (Stets & Burke, 2000). In identity theory, individuals commit to “roles” or subject positions of prescribed self-representations and behaviors that are socially acceptable. Individuals also base role commitment on the number of individuals occupying that role and the strength of the ties they have with individuals in that role within a social interaction.

Context determines the salience of different roles within identity theory of sociology. Individuals rank roles according to their salience and instrumentality in a given situation. For example, if one is the only female in a room full of men, one’s gender role becomes salient. In contrast, salience in the social identity theory of social psychology relates not only to the activation of group representations by features of the context, but to the significance of group membership to the individual (Stets & Burke, 2000). In social identity theory, individuals belong to multiple groups and use the characteristics associated with their groups to self-categorize and evaluate or recognize in-group members by their prescribed norms and behaviors (Hogg et al., 1995). Group members also engage in self-enhancement, or social comparisons in which they distinguish themselves in a positive light from out-groups, about whom they hold stereotypes of behavior.

At times, there are salient aspects of the self or group related to competence in academic and social areas, or linked to one’s age, sexuality, race, and/or social class (e.g., Sellers, Smith, Shelton, Rowley, & Chavous, 1998; Wigfield & Karpathian, 1991). Racial identity, a type of social identity, is the meaning and significance individuals place on their racial group membership, which has been found to be important to students’ academic outcomes (e.g., Chavous, Bernat, Schmeelk-Cone, Caldwell, Kohn-Wood, & Zimmerman, 2003). Racial identity theorists conceive of it as either developmental or staged over time (Cross, 1971; 1991; Parham & Helms, 1981) or as measured at a particular point in time within a particular context (Chavous et al., 2003; Sellers et al., 1998). In this study, I focus on racial identity as measured at a particular point of time within a particular context per Sellers et al. (1998). Additionally, I focus on racial identity in this study in lieu of ethnic identity. Ethnic identity concerns connections to the unique social and cultural heritage of one's group (Helms, 1990). Racial identity differs from ethnic identity (cf. Phinney, 1990 for a review of studies on ethnic identity) in that it is not only associated with the level of connection an individual has to his group but also to how one acknowledges and conceives of racial group membership, perceives of others' beliefs about his racial group, and adjusts to discriminatory experiences (Sellers et al, 1998; Spencer, Noll, Stoltzfus, & Harpalani, 2001; Ward, 1990/2005). Components of racial identity have been found to be indicators of resilience, such that higher levels reflect individuals' ability to cope with stressful situations and risk factors (Sellers, Caldwell, Schmeelk-Cone, & Zimmerman, 2003). For example, students with higher levels of race centrality reported having fewer symptoms of depression and anxiety, although they had more reports of experiencing racial discrimination (Sellers et al., 2003). Youth with higher private regard had lower perceived stress (Caldwell, Zimmerman, Bernat, Sellers, & Notaro, 2002), higher self-esteem (Rowley, Sellers, Chavous, & Smith, 1998), and less depression (Sellers et al., 2006). Racial identity is also thought to signify the socialization students receive in their homes and communities related to race (Rivas & Chavous, 2007; Ward, 1990/2005).

There are other types of social identities that are salient to individuals; in this study, I focus on racial and student identities[2]. In Chapter 2, I present empirical studies on both racial and student identities in tandem. I also speak of identities in action as discussed by Holland et al. (1998), which is measured by different means; I will discuss this in the next section.

Identities in Action

Much of this identity research started as explorations of personhood or self by William James, Charles Cooley, and George H. Mead. James' contribution to identity

[2] Although the survey questions use the term "race/ethnic group," their wording connotes the definition above for racial identity.

theory was to provide the empirical basis for studying an individual's experience in the social world. James (1892/1963) discussed the self as having two parts. The first part he called "I," or the part that is consciously aware of and manages what is happening in the moment. The other part of the self, which he called "me," observes and reflects on actions. Both Cooley (1902) and Mead (1962) built on James' work, extending it to examine the links between self and society. Although these theorists explored the social aspects of self, their theories resided within the individuals, and did not incorporate the role of power in social interactions.

Holland et al. (1998) took into account both the reflective ("me") and the performative/agentic ("I") identities offered by James, and then extended by Cooley and Mead. They also borrowed the notion that humans use symbols to mediate action in their environment from Vygotsky (1929/1978) and added discursive power dynamics in the work of Bakhtin (1935/1981). Holland et al. considered that we become who we are in cultural and historical context and within social relations that are imbued with power dynamics. They offered that identities shift over time, and are perceived from the cultural knowledge, experiences, and exposures that individuals have. Additionally, these identities are imagined and also performed, as individual agents from various cultural worlds represent their self-understandings within social interactions.

My study deviates from previous work with my use of all of these lenses to understand how students' social and cultural worlds shape their identities as science learners. I seek to make a connection between cultural models and identities through exploration of students' *figured world* of science. "Figured world" is a term coined by Holland et al. (1998) to describe an imagined reality created by participants of a community to interpret and respond to everyday situations. Holland et al. described a figured world as:

> a socially and cultured realm of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others… These collective 'as-if' worlds are sociohistoric, contrived interpretations or imaginations that mediate behavior and … inform participants' outlooks. (pp. 52-53).

People negotiate and adopt *identities* or self-understandings in relation to a figured world that we come to adopt and share with others in a community. The way we identify as certain types of individuals and assume some practices and not others occurs in reference to a figured world. In other words, a figured world mediates the identities or self-understandings that we perform and the actions we ultimately take. Holland et al. (1998) termed the performative aspect of identities that we adopt within a community *positional identities*, or social positions we assume (or not) in different situations. These positional identities reflect our claims to a position or social status. Although we imagine or believe that we are a certain way, we also live in cultural worlds in which there are particular conditions, constraints, and other people with whom we share space and time, and with whom we must interact. Others recognize and evaluate our claims to different positions in social interactions. This makes it necessary for us to not only imagine or believe we are particular types of people, but to also *negotiate* our right to be recognized as particular types of people by others (Nasir & Saxe, 2003). In other words, not only do individuals have to make sense of their own perceptions and self-understandings, but they also must contend with others' ascriptions and positionings of them as certain types of people. Urrieta (2007) describes this process of identity negotiation in a figured world in the following way:

> Figured worlds are thus formed through social interaction, and in them people 'figure out' who they are in relation to those around them. …Through participation in figured worlds people can reconceptualize who they are, or shift in who they understand themselves to be, as individuals or as members of collectives. Through this figuring, individuals also come to understand their ability to craft their future participation, or agency, in and across figured worlds. (p. 120).

In this dissertation, I discuss identities (both imagined and positional/performed) that are shaped in relation to the figured world of science these students created and lived at the time of the study. These students were all part of the same urban systemic reform initiative in which they learned science by participating in the same project-based science curricula at three different schools.

Project-based science is a particular type of inquiry practice that engages students in science projects or authentic activities that mirror real-world situations over an extended time period (Krajcik et al., 1998). I posit a model of science learner identities mediated by a figured world of project-based science that has four closely-related interacting parts: the cultural models, discourses, discourse communities (or communities that share specific language, goals, and practices), and resources available to individuals. Figure 1.1 provides a depiction of this figured world. This figure suggests that students draw from a host of cultural models or generalizations related to school, science, and to themselves as African American youth, which they bring with them to school settings. In this study, I seek to examine the specific resources and cultural models that students within a particular discourse community drew from when constructing figured worlds and identities in science. In the next section, I explain each of the parts, and how they work together to mediate youths' adoption of science learner identities.

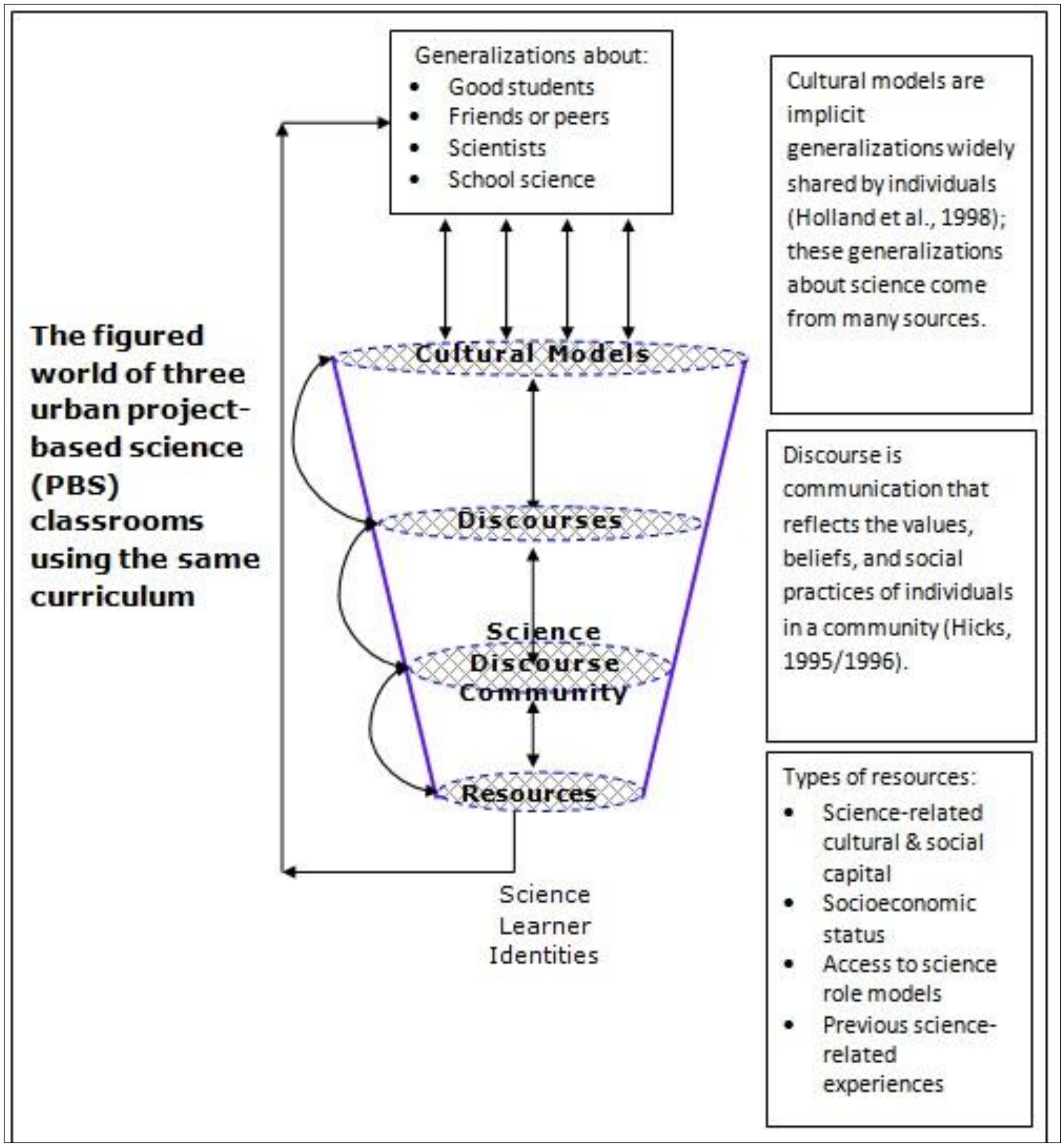

Figure 1.1 – Identity Negotiation across Three Urban Science Classrooms

Cultural Models

Cultural models are implicitly communicated generalizations that are widely shared among individuals (D'Andrade, 1987), and are important aspects of figured worlds because they describe the relationship between culture and the formation of identities (D'Andrade, 1992; Holland et al., 1998). Culture is a collection of different kinds of cultural models through which cultural knowledge is distributed (Shore, 1996). Holland et al. asserted that cultural models come from past experience, popular media and culture, norms, imagined roles and possibilities related to group membership (e.g., gender, race, age, and social class), as well as significant others' beliefs and values. Cultural models are shared and distributed among people in a community and accessible through discourse (Gee, 1999; C. Lee, 2001). They are also subject to change in interaction with others, and can be modified over time (Gee, 1999; Crawford, 2008; Lee, 2001; Price, 1987; Swidler, 1986). Some synonyms for cultural models are folk theories and cultural schemas (D'Andrade, 1987), everyday theories (Gee, 1990; 1996; 2008), cultural expectation, (C. Lee, 2001), explanations (Gee, 1999), framing models and principles of action (Gee & Green, 1998), as well as ways of knowing (C. Lee, 2003; Moje & Lewis, 2007).

Cultural models serve as tools for people to accomplish many tasks. They shape interpretations in different contexts (D'Andrade, 1992). Cultural models help us to espouse which social positions or identities we take up, and help us to evaluate ourselves and others' actions and performances of identity as "typical," "appropriate," or "normal" in a particular context (Gee, 1999). Cultural models can serve as templates or representations of possible principles and strategies for interaction and action in familiar and unfamiliar situations (Crawford, 2008; Gee, 1999; C. Lee, 2001; Swidler, 1986). Shore also suggests that cultural models can be socially distributed "in that not all members of a community will share all models or will have the same variant of a model" (p. 312) and contextually distributed "such that different versions of a model represent different functional or rhetorical perspectives" (p. 313).

Because they are schemas, cultural models are hierarchical, organize thinking and action, and can be widely applied to various situations and in different contexts. D'Andrade (1987) gave the example of the cultural model of "money" that has wide applications and is part of other cultural models. As another example, Moje & Lewis (2007) presented data showing students' talk about "*good* gangs" being peppered with references to cultural models that students in one community had of "family" and "friendship." Shore (1996) argued that cultural models and mental models or schemas do have some differences, namely that cultural models "are born, transformed through use, and eventually die out. Their continued existence is contingent, negotiated through endless social exchanges" (p. 46). He distinguished cultural models from mental models:

> Cultural models are constructed as mental representations in the same way as any mental models with the important exception that the internalization of cultural models is based on more socially constrained experiences (Shore, 1996, p. 47).

Shore indicated that negative social feedback can constrain or motivate an individual's adoption of cultural models that are widely held in society, and suggested that there is a "significant psychic cost" for individuals who have conflicts between instituted or dominant cultural models and alternative cultural models. In sum, cultural models vary across individuals, are used in different ways across groups of individuals and in different settings for myriad purposes.

As illustrated in Figure 1.1, the label "cultural models" represents the first part and the organizing frame of students' figured world of science. Students come to classrooms with multiple cultural models. However in school science, one is not only dealing with the cultural assumptions of a content area like science, its concepts and inquiry practices, but also those that students and teachers have about what it means to do schoolwork and interact in classrooms (C. Lee, 2001). Lee described how a group of urban 8th graders expressed their cultural model of school:

> They came into the class with clear epistemologies about school and school knowledge. School was a place where teachers told you what they wanted you to know and your job was to fill in blanks on worksheets or write single sentence answers that you could copy from the book. The answers were always either right or wrong and the arbiter of correctness was always the teacher. In classrooms, if you sit long enough the teacher will tell you what she wants you to know. If you are good, you will sit quietly, passively, and listen. If you are more aggressive, you will try to institute countermeasures in the form of disruptive behavior to change the agenda of the class to one more palatable to you. These students had experienced school in this way for at least 8 long years and had well-

> established ideas about what you do in school. There was a clear culture that they expected to find when they entered the classroom on the first day. The challenge for the teacher was to alter these cultural expectations, to craft a classroom culture over time and with the support of students that operated from a different set of norms (pp. 114-115).

Students used cultural models such as the one described by Lee above to determine what roles or “jobs” they and their teachers had in classrooms, and hence which identities they could assume in a classroom. Lee’s description of cultural modeling in English language arts raises similar questions about the identities students assume in science classrooms, and whether these cultural models are particular to the urban eighth graders in Lee’s study, or if they are shared by students in other settings. Additionally, this example and the example from above of Moje and Lewis (2007) also raises the questions of how non-school related cultural models influence students’ identities as science learners, questions I explore more fully by reviewing related research studies on identities in Chapter 2; these studies help us to understand the ways that cultural models influence young people’s adoption of identities as science students, in particular.

Discourses & Discourse Communities

The second part of the figured world, discourse, is communication that reflects the values, beliefs, and social practices of individuals in a community (Hicks, 1995/1996). Sometimes this communication is verbal, written, or conveyed in other ways that individuals express themselves (Lemke, 1995; Gee, 1990; 1996; 2008), such as the clothes they wear or by their use of particular vernacular. The communication of the values, beliefs, and social practices of students’ homes, neighborhoods, schools, and peer groups would constitute discourses (Gee, 1990; 1996; 2008). Additionally, people often reflect and reproduce in their talk some discourses that originate from outside of their communities, in the form of appropriated viewpoints and talk of others, both positive and negative. Subject areas like science are considered to be discourses (Crawford, Kelly, & Brown, 2000; Roth, McGinn, Woszczyna, & Boutonné, 1999), which Roth et al. (1999) define as the “all those sign forms scientists use for communicating, including language, mathematical expressions, diagrams, graphical representations, and gestures” (p. 297). All of these discourses from within and without a community can afford or constrain action, for example, if certain discourses are valued and rewarded in different settings, but not all individuals have access to those valued discourses or have yet to master them (Collins & Blot, 2003). This is the case because discourses are inherently about recognition of individuals as being certain types of people (Gee, 1990; 1996; 1999; 2008).

Gee (1996) suggested that attaining literacy in a domain is dependent on the fluent mastery of secondary discourses (both oral and written) such as those in the area of science that are new to us or different from the primary discourses of our families or home communities. For example, science uses specific terminology, which challenges individuals to attain competence with "talking science" (and, by extension, with reading and writing science) to demonstrate mastery of the discourse (Lemke, 1990), and to be recognized as gaining expertise in science. As they master secondary discourses along with the content of the subject area, students are more likely to learn to reason within multiple discourses (Michaels & O'Connor, 1990), and gain entry into secondary *discourse communities*.

Discourse communities are affinity groups in which individuals share interests or goals, ways of communicating, and use of specific terminology, tools, ideas, concepts, and ways of interpreting experience relative to the common area of interest (Lampert, 1990; Putnam & Borko, 2000; Swales, 1990). For example, some students may belong to a discourse community of individuals who are avid video game players, share similar goals related to becoming knowledgeable playing various types of games, read specific magazines to learn "cheat codes" that help them progress to advanced levels within games, and understand vernacular and specialized information related to video games. O'Brien, Moje, and Stewart (2001) wrote specifically of curricular subject areas as constituting discourse communities or disciplinary subcultures that "influence the forms of knowledge and the processes, including literacy processes, validated for accessing and using knowledge in a particular group" (p. 33). If mastery constitutes entry into discourse communities, this suggests differences in how much people gain membership in different discourse communities dependent on both mastery of the content and fluency with disciplinary discourses.

In this study, the three science teachers' classes constituted a specific discourse community that included discourses of project-based science in particular, in addition to discourses of science in general and those of students' home communities. Bounding the figured world of science to the discourse community of project-based science classrooms raises questions about the cultural models, discourses, and practices and resources available to students and about the aspects of these cultural models that were shared across classrooms.

Resources

Last, I add to Holland et al.'s (1998) theory of figured worlds the notion that access to social, cultural, economic and human resources affects the identities that individuals adopt. Bourdieu (1986) introduced a theory of resources in society using the metaphor of monetary exchange: economic, human, cultural, and social capital. People from of various social classes accumulate and transfer different combinations of these types of capital or resources from one generation to the next. Economic capital refers to material wealth, whereas human capital refers to workers with particular skills and aptitudes. Economic and human capital are relatively straightforward concepts, whereas cultural and social capital are less visible and tangible.

Cultural capital is implicitly gleaned through exposure to culturally advantageous experiences, dispositions, and environments. Bourdieu (1986) denoted three types of cultural capital: embodied (e.g., acquisition of language and dispositions), objectified (e.g., cultural goods such as books, art, and other media), and institutionalized (e.g., educational qualifications and occupational certifications). Bourdieu and Passeron (1990) discussed one form of cultural capital, linguistic capital as being important to academic success, in that "language is not simply an instrument of communications: it also provides…the capacity to decipher and manipulate complex structures, whether logical or aesthetic" (p. 73). Accumulation and appropriation of cultural capital confers advantages to individuals implicitly over time via participation in institutions – e.g., families, schools, and workplaces. Knowledge of the historical accumulation of cultural capital is important to understanding the identities that students of different racial and ethnic groups assume in instructional contexts (Ladson-Billing, 2006; Nasir & Saxe, 2003).

Coleman (1988) posited a theory of social capital, which most of the recent research on social capital builds upon (cf. Dika & Singh, 2002). Specifically, Coleman suggested that social networks provide access to social capital or the resources needed to navigate social situations such as knowledge of norms and access to information channels. He argued that relationships are necessary to build social capital; in particular, he stated that family relationships and children's access to adults in the household were important to their accumulation of social capital. Coleman's theory implied that students who come from single-parent families and those without access to valued information channels, for example, have low social capital. Bourdieu had a different theory of social capital. He argued that like cultural capital, social capital is implicitly gleaned, and directly related to the volume of social connections and social obligations that membership in valued groups affords. These connections can be built over time but can also be reproduced and inherited from one generation to the next – such that those with advantages pass those advantages on to their children.

There have been several critiques, reviews, and research studies in education (and the sociology of education) based on Bourdieu's (1986) and Coleman's (1988) conceptions of social capital (Carrington & Luke, 1997; Dika & Singh, 2002; Field, 2008; Portes, 1998). Dika and Singh (2002) argued that a limitation of Coleman's theory of social capital, and those that have followed Coleman's approach, is that these studies focus on norms individuals should follow for positive educational outcomes but do not address the reality that students have differential access to familial and institutional resources. These critiques suggested the need to focus on more than the role of familial social capital to understand other sociocultural factors that influence students' educational outcomes (Carrington & Luke, 1997; Dika & Singh, 2002), and to focus on those factors that schools *can* influence (Singh, Granville, & Dika, 2002). This research also recommended revisiting Bourdieu's theory of social capital, with its focus on the role of power and context on resources and educational outcomes.

I mainly draw on Bourdieu's notion of capital. Bourdieu theorized that differential access to capital or resources reflects and reproduces social class inequalities, creating dominant or powerful classes that have capital and non-dominant or marginalized ones that lack capital. Access to capital alone does not move individuals from one social class status to another, because social class is not just as an economic description of individuals, but “a socially constructed category,” in which “individuals’ subjective perceptions and experiences are a vital component” (Power, 2006, p. 4). In other words, social class is another way in which individuals identify that can be understood through their perceptions and experiences in addition to understanding their material conditions. Cole and Omari (2003) reviewed research that suggested the subjective experiences of African American communities related to their social class identities are also cultural, must be analyzed in conjunction with race and gender identities, and that schools are an important site of class identity formation due to the transmission of “particular meanings of class and classed-identities in students” (p. 789). In this dissertation, I want to understand the ways capital of different forms (economic, social, human, and cultural) impacted students’ negotiation of identities – including those related to social class, gender, and race. Most importantly, I want to interrogate the ways in which students’ access to capital influenced the ways they imagined and positioned themselves as science learners. The study participants were 7th grade urban, African American youth at schools representing a range of contexts. In the next chapter, I present empirical studies that illustrate the cultural models and resources at play for urban and African American youth, in particular, and how they shaped their identities as students.

In sum, there are two main goals of this dissertation study. The first is to contribute to the growing number of studies that explore the sociocultural worlds in which underrepresented groups learn science, even in classrooms participating in urban systemic science reform initiatives such that access to high-quality science is not a confounding issue. Second, I undertake this study as a step toward understanding not only the sociocultural worlds that this group of students created but also the corresponding ways they identified as science learners in relation to these cultural worlds. This has implications for their participation as future science workers. As previously outlined, the research questions that guided this study were:

1. What are the beliefs of African American middle-school students about the domain of science in general and about themselves in relation to science?
2. What is the relationship between students’ identifications (as articulated in surveys and interviews) and their beliefs and cultural models of science?

In the chapters to follow, I put forth the theoretical framework I used to approach this inquiry and present the mixed methods and analyses used to address the research questions. In Chapter 2, I put forth the theoretical and empirical framework related to students' enactments of their self-understandings or identities as urban, adolescent, Black science learners. In Chapter 3, I describe the methods used to collect and analyze the data. Chapters 4 and 5, I report the results from the analyses of survey and interview data by putting forth assertions that represent patterns across data sources. In Chapter 6, I discuss the importance and implications of the results of this study for creating opportunities to learn for students using curriculum and instruction and discuss avenues for future research stemming from this work.

Chapter 2 —THEORETICAL & EMPIRICAL PERSPECTIVES

In this chapter, I situate my research at the intersection of three different research literatures related to youths' construction of identities or self-understandings as students of a particular social location. First, I present studies on the formation of identities as students (Eccles et al., 1983; Lave & Wenger, 1991). I use this literature to understand the relationships between cognition and culture; the literature above used in conjunction with sociocultural theories takes into consideration issues inherent to learning environments such as power, and agency in addition to student identities (Lewis, Enciso, & Moje, 2007; Nasir & Hand, 2006). I then connect student and racial identity using empirical studies that explore the ways in which African American youths construct student identities (Fordham & Ogbu, 1986; Nasir, McLaughlin, & Jones, 2009; Ogbu, 1990). I then introduce science education studies on learners' adoption of identities as science students (Barton & Tan, 2009; Brown, 2004; Carlone, 2003; Kozoll & Osbourne, 2004; Rahm, 2007; Reveles & Brown, 2008). Next, I relate racial and student identities to the theoretical framework introduced in Chapter 1. Using empirical studies, I reexamine the construct of cultural models for the students in this study, who are African American adolescents attending urban schools. I also review work by John Ogbu and colleagues on African American students' cultural models of schooling (Ogbu, 1990; Ogbu & Simons, 1998), and other research that builds on this work (Fordham & Ogbu, 1986; Horvat & O'Connor, 2006; Peterson-Lewis & Bratton, 2004).

As I asserted in Chapter 1, although researchers investigating underrepresented students have made great strides in enhancing the science education of learners, a potentially missing element is a close examination of the ways in which students' figured worlds of science mediate their identities as learners of science. The conceptual framework I employ draws on research traditions in which researchers have historically used different research methods – psychologists study individual or personal identities using survey methods and structured interviews, and anthropologists and sociocultural theorists typically use observation and interview methods to study socially and culturally constructed identities. I argue in this chapter that if these methods are merged together, the resultant analyses can represent the experiences of individuals in rich and complex ways. In the sections to follow, I present empirical studies that operationalize these constructs. I then expound upon the tensions inherent in pairing these different theoretical orientations, and explore the areas in which they complement and support each other. This chapter concludes with a reminder of the specific research questions that drive this inquiry.

Studies of Identity

In this section, I present studies that discuss the ways in which identities are formed and measured for students of different social locations. Eccles (2009) discussed personal identities as those aspects of an individual that make one unique; this includes various self-understandings that individuals have from the past, at present, and for the future, as well as their personal values and goals. She also stated that social or collective identity relates to the aspects of the individual that tie one to a social group; this includes perceptions of barriers and opportunities linked to one's membership in a social group. Racial identity and student identities are types of social identities, and the ones that are the focus of this chapter. I first focus on studies of student identities from different perspectives, methodological assumptions, and techniques. I examine identities that are imagined or based on individuals' perceptions, along with studies that incorporate how individuals deal with others' perceptions of them to perform and negotiate identities. I then introduce empirical studies that marry racial and student identities in different academic domains. I last explore the differences in approaches across studies, the tensions among them, and also opportunities for these methods to inform one another in merging data collection and analysis methods.

Student Identities: Empirical Perspectives on Personal/Individual Identities

Eccles (2009) argued that students' conceptions of their ability in academic domains together with their values for academic subjects define their identities as students. Survey research has shown that measures of self-concept of ability in school subjects like math, English, and science are related to students' achievement and motivational beliefs in those domains or explain how they identify as students in those domains (Wigfield & Eccles, 2002; George, 2006; Nieswandt, 2007). For example, children who had high self-concept of ability in math tended to have higher math grades and test scores (Eccles et al., 1989), and were more likely to identify as good math students. Studies like Eccles et al. (1989) employed expectancy-value theory of *achievement motivation* to examine the relationships between expectancies (like self-concept of ability) and academic values or subjective beliefs about the domain, and their influence on academic achievement and engagement (Eccles & Wigfield, 2002; Wigfield & Eccles, 2002).

Expectancies are analogous to domain-specific personal self-efficacy (Eccles & Wigfield, 2002; Eccles, 2006). Bandura (1997) conceived of personal self-efficacy as students' self-beliefs related to their own abilities as learners to achieve a certain outcome within a domain. Values are subjective beliefs about the importance of a task to the individual. Values are more enduring than expectancies, and thought to measure attitudes toward subject matter and be less subject to change (Glynn & Koballa, 2006). Graham and Taylor (2002) described the differences between expectancies and values:

> Unlike achievement-related expectancies, which largely center on beliefs about ability (*Can* I do it?), values have to do with desires and preferences (Do I *want* it?) and are more concerned with the perceived importance, attractiveness, or usefulness of achievement activities (p.122, emphasis in original).

Eccles et al (1983) put forth four values in their model of expectancy value: utility value (usefulness or instrumentality of a task towards a goal), attainment value (the personal importance to the individual to do well on a task), intrinsic value (enjoyment of a task), and cost of engaging in a particular activity or domain. In this study, I focus on two values, utility and intrinsic value. Utility value is thought to be particularly important for students as they get older due to students being increasingly motivated by external rewards as they age (Harter, 1981). Intrinsic value is tied to what students enjoy in a domain and is thought to be related to their personal interests.

Expectancy-value theory proposes that students' expectancies for success at tasks and the values they hold for succeeding at the tasks are positively related. In other words, expectancies and values influence one another, such that a student who does not have much confidence in his ability within a domain will not value achievement in that domain, thus not identifying as a good student in this domain (and vice versa). Children's past experiences, achievement goals, evaluations by those responsible for socializing them such as parents and teachers, self-assessments, and interpretations of experience influence their expectancies and values, and hence identities as students. Research has demonstrated that expectancies and values mediate performance, choice of tasks, and persistence at various tasks (Simpkins, Davis-Kean, Eccles, 2006). Wigfield and Eccles (2002) reported that children's expectancies are more closely related to performance, and that values are more closely related to choices like engaging in classroom activities.

Many expectancy-value studies have explored expectancies and values in mathematics and English (e.g., Eccles and colleagues); recent studies have measured these outcomes in science, social studies, and information technology (e.g., DeBacker & Nelson, 1999; 2000; Heafner, 2004; Mac Iver, Yong, & Washburn, 2002; Simpkins, Davis-Kean, and Eccles, 2006). A growing area of scholarship in science education uses motivational constructs similar to the expectancy-value model (George, 2006; Nieswandt, 2007; Simpson, Koballa, Oliver, and Crawley, 1994; Simpson & Oliver, 1985; 1990). In an analysis of a subsample of student participants in the Longitudinal Study of American Youth, George (2006) found that self-concept of students' ability in science had the strongest association with their attitudes toward science and the utility value of science. He noted that utility value of science was important because unless adolescents saw science as useful to their lives, they tended to lose interest in further experiences with science (e.g., taking advanced courses or pursuing science–related careers). Other variables related to these affective measures were students' perceptions of their teachers' expectations of them as science students and peers' attitudes toward science. George also found that peers' attitudes toward science were most significant during 8th grade.

Similarly, Nieswandt (2007) established that self-concept of ability was an important mediating variable associated with youth's conceptual understanding of chemistry at the end of the year. Additionally, expectancies and values for science in particular influenced the courses students chose, their academic outcomes, and their future career choices (Simpkins, Davis-Kean, & Eccles, 2006). Simpkins & Davis-Kean (2005) found that differences in self-concepts in 9^{th} grade affected adolescents' high-school course taking preferences, and that students who had higher than average science or math self-concepts took more math and physical science courses in high school.

Achievement motivation studies have typically used surveys as the primary method of data collection. I argue that many aspects of the social context are unknown to the researchers from such a quantitative measure. This may be why many researchers measure achievement motivation longitudinally, to understand changes in self-concept during a certain developmental period within a context. Although measuring achievement motivation in this way does indeed describe it as occurring in social context, the historical and cultural factors (and their interactions) that shape individuals' self-concept are not directly tangible (Rivas & Chavous, 2007). Additionally, socioculturalists may argue that one cannot control for all possible contingencies in an environment, which makes use of survey research as the sole means of inquiry inadequate for understanding aspects of self-understandings.

Another shortcoming of some achievement motivation studies is that they have focused primarily on individual academic factors and not on other aspects of learning (e.g., its social aspects). Many studies focus on individual aspects of achievement motivation such as that related to age and development. For example, several studies have examined the achievement motivations of early adolescents, whose achievement motivation decreases during the transition to middle school, and who make decisions about which careers and subject areas during this time of their development (Eccles, Lord, & Midgley, 1991; Eccles & Midgley, 1989; Hill, Atwater, & Wiggins, 1995). Similarly, a large body of research has examined the relationships between gender and expectancies and values. Some have found that girls tend to have higher grades but more negative attitudes than boys have toward math and science (Eccles, 2007; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Simpkins, Davis-Kean, & Eccles, 2006). Others have found that boys attach personal importance to doing well in science more frequently than girls do, and that stereotypical attitudes about gender and physical science begin in the elementary grades (Andre, Whigham, Hendrickson, & Chambers, 1999). Yet others have found no differences in science-related values and course-taking practices between older girls and boys, possibly because of the science course requirements for college preparation (Simpkins, et al., 2006).

Fewer studies have examined aspects of achievement motivation related to race and ethnicity and their relationship to performance in academic domains (Graham, 1994; Graham & Taylor, 2002). Many of the studies on African American students in particular have focused largely on low expectations and low conceptions of themselves as achievers (Graham, 1994). However, Mickelson (1990) suggested that the African American middle school students in her study had an achievement paradox, in that they had high values that did not always result in high achievement. Mickelson theorized that this may be due to students' awareness of the structure of educational and occupational opportunities for adults in their communities, which did not always result in them being rewarded for their efforts. Based on their review of literature on African American students' achievement, and a study on different ethnic groups' achievement values, Graham and Taylor (2002) promoted an expectancy-value model that focused on achievement values for study of African American students' achievement motivation in particular. In this model, they also included beliefs about race, class, and the structure of educational and career opportunities for adults in their communities. In math and science in particular, Singh, Granville, and Dika (2002) showed that it was fruitful for educators to focus on school-based measures such as students' academic engagement, perceptions (like expectancies and values), and students' knowledge of opportunity structure for math and science careers to understand their achievement motivation in math and science.

Some recent research that emphasized race and ethnicity in studies of students' achievement were in studies by Chavous et al. (2003) and Eccles Wong, & Peck (2006), who showed the importance of students' meanings associated with race on their achievement motivation across school subjects. In their longitudinal study of African American high school students, Chavous et al., (2003) used a cluster analysis approach to look at the relationships between racialized aspects of achievement motivation and academic outcomes. Eccles, Wong, and Peck (2006) conducted a study with African American youth that like Chavous et al., takes the recommendations of Graham and Taylor (2002) into account. They found that (1) anticipation of future discrimination caused students either to increase their engagement or to disengage academically; (2) daily experiences with discrimination were negatively associated with students' achievement motivations; (3) when students had a strong, positive, culturally connected sense of self (a component of self-concept), this reduced the negative influences of discrimination on achievement motivation. Last, Rivas and Chavous (2007) suggested that many studies of racial identity and academic achievement did not account for racial identity beliefs that were influenced by multiple interacting contexts in which students were embedded, including those related to their schools and classrooms, local community, and family socialization.

The studies on student identities reviewed thus far were based on survey research, and on students' achievement motivation in particular. There are also studies of student identities based on a range of data sources and methods of analysis. In the sections to follow, I review studies of racial and student identities from a range of disciplines using different methodological approaches.

Identities Related to African American Students in Schools: Empirical Perspectives

There are multiple reasons why students might enact and make sense of their student identities at certain times for particular purposes. In this study, I focus on the student identities of urban, African American, early adolescents, and because of this, I draw on studies that investigate the explanations for African American youths' achievement across subject areas using sociocultural and historical lenses. The first comes from Ogbu's cultural ecological theory (1990; 2008), and the second from Fordham and Ogbu's (1986) acting White hypothesis. Both argued that Blacks perceived oppression as stemming from the historical legacy of slavery (the primary cause), racial discrimination, and the current structure of opportunities (e.g., access to high-paying jobs, glass ceiling, etc.). Based on the ecology or conditions that the adults in their communities face in the job market, students generated folk theories or cultural models of "making it" and of success (O'Connor, Horvat, & Lewis, 2006). Because many students saw inequalities or that education and hard work did not always pay off for adults in their communities, the folk theories that they generated sometimes contradicted notions of the American dream, which promote hard work and education as the keys to success.

As a way to limit perceived threats to their identities as Blacks characterized by a culture of fictive kinship (a shared Black identity constituted by a sense of unity among African Americans that values egalitarianism, solidarity and sense of community) and to avoid compromising their racial identities for school success, students created oppositional cultural frameworks. These frameworks, per Fordham and Ogbu (1986), were coping behaviors that students adopted in schools to deal with others' devaluing their racial group. In other words, these folk theories were students' alternative models of success that fed their survival identities or self-understandings related to what they felt that they needed to survive within schools. For example, Fordham and Ogbu (1986) and Fordham (1996) found that students categorized as high achieving conformed to mainstream norms of achievement or what they termed, "acting White." Conversely, students categorized as underachieving adopted behaviors of avoidance or resistance of the mainstream culture's authority and norms.

Several studies and popular media articles have supported the work of Fordham and Ogbu (O'Connor, Horvat, and Lewis, 2006). Since the publication of Fordham and Ogbu's acting White hypothesis, there have been numerous articles published that have confirmed, denied or complicated the assertions they put forth (cf. Horvat & O'Connor, 2006; Ogbu, 2008; Peterson-Lewis & Bratton, 2004; Spencer et al., 2001). Galletta and Cross (2007) contested the cultural ecological theory's thesis that oppositional cultural frameworks were African American students' response to the legacy of slavery. In their historical perspective on Black achievement motivation, Galletta and Cross (2007) argued that "contemporary displays of oppositionalism and muted achievement by Black students are more readily traceable to structural elements and educational policies that define integrated schooling" (p. 16). They also proved with historical evidence that ex-slaves made significant sacrifices of their meager resources to obtain schooling for themselves and their children.

Others criticized how the cultural ecological theory and the acting White hypothesis simplified student identities of minority students by concluding that oppositional identities always lead to academic failure (Davidson, 1996). Davidson found that oppositional identities were productive in that they provided students with a means to navigate the multiple worlds in which they lived inside and outside of school. O'Connor (1997) examined the achievement of high-performing, low-income Black students from Chicago. She found that although the participants were aware of the social and economic forces that constrained the life chances of people like them, they used their knowledge of the collective struggle of Blacks historically as a motivator for their own educational outcomes. These resilient students did not have to act White to succeed in school. Furthermore, their survival identities were not oppositional, just *different from* the mainstream notions of academic success. In response to perceived and real societal constraints, these students decided to succeed in spite of the messages they ingested that told them they could not. Similarly, Ward (1990/2005) reported on the strategies of resilience exhibited by a group of academically successful Black female adolescents attending an exclusive private school, such as exhibiting leadership and maintaining supportive cultural ties through participation in Black student organizations at their predominately White institution.

O'Connor, Horvat, and Lewis (2006) discussed how much more complex the academic identities of Black American students were by pointing out some of the weaknesses of the cultural ecological theory. They argued that cultural ecological theory treated Black experience as monolithic, failing to acknowledge the heterogeneity of Black identities; it did not theorize and extract the complexities of race as a structural constraint; and it did not take into account differences in academic identities due to context. Others such as Carter (2006) complicated the lack of context and heterogeneity further using the lens of intersectionality. She discussed how Fordham and Ogbu focused solely on race and culture, and in doing so tended to "overlook an important aspect of adolescence: teenagers juggling several identities, sometimes consciously, sometimes not, as they try to balance the social constructions of their race, ethnicity, gender, and sexual identities" (p. 111).

Peterson-Lewis and Bratton (2004) offered an explanation of students' outcomes from the perspective of Black students themselves, which they called "acting Black." They presented 56 African American adolescents' (37 females and 19 males) responses to the interview question of what it meant for them to "act Black." Using content analysis, the researchers coded responses into 5 dimensions of what it meant for students to act Black: (1) academic/scholastic or education-related qualities, (2) aesthetic/stylistic or qualities related to style of dress and extracurricular/leisure activities, (3) behavioral or qualities associated with ways of acting or being not covered in the other categories, (4) dispositional or related to intentions, values, and motives, and (5) impressionistic or the image or impression projected by Blacks. There were three main patterns in the data. First, over 90% of the responses included aspects of at least three of these dimensions. Second, all of the respondents had similar notions of what it meant to "act Black." Last, only the aesthetic/stylistic dimension had somewhat positive connotations for students; their descriptions of the other four dimensions were mostly negative. Peterson-Lewis and Bratton argued that the "acting White" hypothesis of Fordham & Ogbu focused on only the academic/scholastic dimension, whereas their data showed nuances within all of the dimensions of acting Black. Peterson-Lewis and Bratton argued that these findings suggest something more problematic:

> The fact that African American youth from a wide variety of backgrounds held similar conceptualizations of the meaning of 'acting Black' suggests that all these individuals have somehow been exposed to similar perspectives on what it means to 'act Black' (p. 95).

They suggested that youth have multiple sources of exposure to negative images about Blacks, and that these findings are not the result of negative strategies as suggested in the acting White hypothesis, but due to a "crisis of group definition" (p. 97), such that there is "no positive refuge of achievement constructs that these youths may embrace as their own" (p. 98). The authors suggested the need for redefinition of what it means to act Black from the multiple socializing agents of these youth.

Like Peterson et al., Nasir et al., (2009) argued that exposure to stereotypical images of African Americans shaped the identities that African American high school students at one school deemed available to them. In addition, Nasir et al. theorized that there was a complex interplay of contextual conditions that affected the ways that the youth constructed identities. There were two levels of context that shaped students' construction of their racial identities, the 1) school (e.g., tracking and access to information about careers and college) and local context (e.g., neighborhood) and the 2) historical and media context. Students enacted identities as *street savvy* or less engaged in school but more in tuned with the life of the streets and *school oriented and socially conscious* depending on the relationships, commitments, and connections they had to others in their neighborhoods and the larger Black community, and by which academic track they were in their school. These identities had areas of overlap, including a shared use of language and cultural styles, even with differences in the ways they engaged in school.

In summary, a host of empirical studies demonstrated that students enacted survival identities in schools and some studies illustrated how those identities were enacted. One popular explanation of the academic achievement of ethnic minorities (posited by cultural ecological theory and the acting White hypothesis) was that minority students adopted behaviors that were oppositional to American mainstream notions of academic success. Per this model and the acting White hypothesis, students either assumed assimilationist (acting White) or oppositional identities to survive school contexts. However, several studies showed that minority students enacted oppositional identities that were not necessarily counterproductive but that were simply different from American mainstream models of academic success. These "oppositional" frameworks have the potential to be empowering and helpful in some minority students' navigation of school. It was argued that theories of oppositional academic frameworks like that of Ogbu and Fordham have tended to essentialize Black experience, have not taken structural constraints related to race into account, and have ignored differences in identities due to context. Last, these theories of minority academic identity have not considered how multiple identities and contexts interact to affect students' outcomes, or that Black student achievement-related behaviors may be the result of their struggling to find scholastic identities for themselves as Blacks in a world in which they are required to discard their ways of knowing and to assimilate to mainstream norms.

In the next section, I review the empirical studies of identity in the context of science classrooms. When thinking of identities in this context, one must consider what it means for students to enact student identities in science, and what the normative models of mainstream success in science are. Furthermore, one must also reflect on the possible oppositional frameworks that students adopt in science classrooms, if any oppositional frameworks are productive, if they seem to differ by context, and whether students struggle to find a place for themselves in science classrooms. I map the terrain of the field by reviewing empirical studies that interrogate identity formation in science learning contexts.

Identities in Science: Empirical Perspectives

There are several studies in science education that have posited that students' identification as people who can do science in classrooms is critical to students' engagement with and learning of science (Brickhouse, Lowery, & Schultz, 2000; Moje & Dillon, 2006; Tan & Barton, 2008). Learning science requires shifts in students' identification, according to this research, as they become familiar with the conventions and practices of their science classrooms. In other words, students are not only constructing knowledge of key science concepts in science classrooms but also constructing identities as science students and conceptions of whether they are the kind of people who can pursue science-related careers (Barton, 1998; Eisenhart, Finkel, & Marion, 1996).

Kozoll and Osborne (2004) presented case studies from interviews focused on the lives of minority-college students that identified with science in four different ways. For example, one student saw science as different from his life and ways of viewing the world, even though he used science in the migrant farming with which he supported himself. His unaddressed assumptions or cultural models about the usefulness of science in his future endeavors blocked his ability to identify with science. A second student, who was also from a migrant worker family, moved from seeing science as a separate world to seeing science as a potential part of her identity. This occurred through her participation in a science project that became meaningful to her, even with having negative preconceptions of her ability to do science, which she believed to be a difficult subject. A third case represented a Canadian-born student of Haitian descent identified as someone who did science because he had experiences outside of the norms of mainstream science that helped him to connect to science in very personal ways. Science then became a lens through which he viewed and made sense of his life both inside and outside of school. In a fourth case, another daughter of a migrant worker family was somewhere between the last two categories – she identified with science and was in the process of incorporating it into her worldview. In all four cases, students' cultural models of themselves as individuals and the way they viewed science shaped their identifications *with* science. Those who had had experiences that provided them cultural models that aligned their everyday lives to science, were better able to create identities as the types of people who did science. Indeed, many times the distance and abstraction of science results in *dis*engagement and inability to identify with science as students "decide which groups [in the science classroom that] they identify with, what kinds of persons they wish to be as a part of each group, and what is required to become those kinds of persons" (Brickhouse et al., 2000, p. 444).

Like Kozoll and Osborne, Brickhouse et al. (2000) developed case studies of science learner identities from interviews, classroom observations, and journal entries of four African American girls in a desegregated, urban, middle school (65% White, 35% Black). Their work shows the influence of others' ascriptions and gender stereotypes on girls' identifications as science learners. Brickhouse et al. found that in the contexts of their science classes, the African American girls who adhered to a "good girl" student identity were also considered by their science teachers as best in science, although these girls may not have had a particular interest in science. Per Brickhouse et al., good-girl students were quiet, high achieving students who took on the "normal" roles constructed for female students. In this case, as good students in other subjects, good-girl students used skills developed in other contexts (e.g., writing skills) as tools to complete what was asked of them in science class.

African American girls who were more outspoken or assertive, who were interested in science, but had no desire to take on the good-girl student identity fared less well in the science class studied. Jones and Shorter-Gooden (2003) reported similar positioning by Black females in their study of African American women who they found "shifted" their identities in ways to make others comfortable in their jobs, relationships, and in their homes, which sometimes included censuring and silencing themselves. However, those who had the loud-girl student identities chose not to shift by adopting good-girl student identities. Instead, they shifted by excelling when given opportunities to participate in lab activities. Their shifting in this way was positive; it also may have been due to their pushing back against the limited scope of the identities they saw as available to them as female science students in their classes. In this way, they produced oppositional identities in their classrooms. In a recent study of low-income 6th graders, Barton, Tan, & Rivet, (2008) found that girls enacted practices that allowed them to inject some of their own identities (in unsanctioned ways) into the "sanctioned" activities in their science classroom. In this way, when only certain identities and behaviors were presented as acceptable in the classroom, the girls in Barton et al.'s study, like those in the Brickhouse et al. study, found ways to bridge the distance between their everyday ways of knowing and identities as science students through oppositional identities that did not conform to the good-girl student identity.

In the Brickhouse et al. study, the science identities that the African American girls adopted in class had consequences for them after middle school, such that only one of the girls who took on the good-girl student identity tracked into honors science. The other girls tracked into mid-level science classrooms in high school. One of the girls even wound up switching to the lowest science track by the 10th grade. Because the researchers did not investigate social class differences between these girls, one is uncertain whether class could help explain the differences in the identities constructed within their science classrooms and the decisions made that affected their being tracked into science classrooms in high school.

Other researchers such as Carlone (2003) showed similar ways of identifying with science for White, upper middle-class females who excelled in regular physics. The students in Carlone's study saw science as accessible, entertaining, and as an authoritative body of knowledge (based on their experiences in that class). They took on good-girl student identities like the girls in the Brickhouse study, although there were no further restrictions to their voice. Because these girls never had the opportunity in their regular physics class to interrogate their meanings and notions of what science is and what types of people became scientists, they did not identify as people who did science. They also did not want to take further classes in science, even though they mentioned enjoying that one particular class.

Like the students in Kozoll and Osborne's study who did not identify with science, these girls saw science as distinct from their everyday lives and something that people like them (females) did not do, *but engaged only because it was useful to their future college aspirations*. Based on theories of acting White, one could conclude that White females would readily adopt mainstream models of science learning. The example of White, upper middle-class students problematizes models of student identity that privilege racial and ethnic identity or gender identity alone to show that it is not about one identity alone, but about students' social locations and the power dynamics in which they are embedded. The White female students in this study engaged in science, but did not see themselves as the types of people who did science. Their engagement possibly reflected their social class related to the expectation that females from upper middle-class backgrounds would aspire to college attendance. However, in terms of the ways they identified in relation to science, the White female students identified in similar ways as their racial minority peers.

In contrast, the ways they enacted good-girl identities differed from those of their African American counterparts. For the Black girls, being good girls also may have been about voice or lack thereof. The characteristic of voice could also be a function of social class, or a function of the intersection of both race *and* class. Taylor, Gilligan, & Sullivan (1995) found that over the course of schooling, girls across ethnic and racial classifications became silent and tended to isolate themselves. They found that many girls saw their biggest problems in school stemmed from "opening their big mouths." However, these researchers illustrated how within each racial and ethnic group they "encountered a variety of individual styles and temperaments" … "that seemed to be shaped, at least in part, by a girl's relationship to her culture and class" (p. 41).

All of these students, both minority and female, appeared to be subject to the normative gaze of White middle-class males or "an ideal from which to order and compare observations" (West, 1999, p. 75). Female and underrepresented minority performance in fields like math and science are subject to comparisons to that of White, middle class males, who are the invisible comparison group and normative cultural model of people who do science as evidenced in studies of public perceptions of scientists (e.g., Barman, 1999). These cultural models make bringing their own beliefs, theories, and perceptions to science difficult for female students, and minority students, to the extent that they may come to view science as outside of the types of people they were.

These findings suggest that *intersectionality* is an important lens when exploring science learner identities. I use the term *intersectionality* to explain how the multiple aspects of students' identities work together. Intersectionality is a term coined by Crenshaw (1994) that refers to "the interaction between gender, race, and other categories of difference in individual lives, social practices, institutional arrangements, and cultural ideologies and the outcomes of these interactions in terms of power" (Davis, 2008, p. 68). Intersectionality allows one to speak specifically to the experiences of the multiple categories that jointly comprise and define one's social location – such as in my case, being a middle-class African American female from a working-class background. In the case of science learner identities, intersections of social class, gender, and race may explain ways that young people differ in how they identify as science students.

In summary, students' social locations seemed to affect the cultural models that students adhered to and hence the identities they constructed in science learning environments. Both the Kozoll and Osborne (2004) and Carlone (2003) studies suggested that students had unexamined or unaddressed perceptions of science that act as obstacles to their identification as individuals who did science. Additionally, Brickhouse found that societal stereotypes related to gender and race influenced African American girls' participation and the identities they adopted in science class, assuming either the identity of a "good" girl or the oppositional identity of a "loud" girl, and the consequences these identities had for their future academic trajectories. Last, I contrasted the similarities in the cultural models female and minority students used to construct identities in their science classrooms as a way to demonstrate how an intersectional lens complicates the ways in which students identified as raced, classed, and gendered beings in science classrooms.

In the next section, I focus on how these conceptions of racial and student identities relate to the theoretical framework introduced in Chapter 1. As a reminder, there are four parts to the framework: cultural models, discourse, discourse communities, and resources. In the research literature, there is a rich and growing research base on the discourses and discourse communities of science (Brown, 2005; Crawford, Kelly, &

Brown, 2000; Heath, 1983; Lemke, 1990; 1995). Less studied are the cultural models and resources of students underrepresented in science. This study is situated in the discourse community of project-based science. I chose to focus on the cultural models and resources to understand more about who these young people were, with the hope that knowledge learned about these African American adolescent students' cultural models will serve as learning tools to help bridge their science and everyday worlds. I argue that this focus allows me to go beyond the assumptions that many educators hold about classrooms serving students from urban schools, African American students in particular, and within contexts of high poverty. I also engage in this research not as a way to describe the resources that they lack, but those resources they do have.

Review of Related Empirical Studies

Gee (1999) described cultural models as having three uses – to espouse social positions or identities, evaluate others (and their actions) as "appropriate/normal/typical," and to provide principles of action. In this section, I present studies that exemplify the three uses of cultural models, and the ways they may be used over time with students to help create opportunities to learn or help them to construct identities as science learners. In addition to the cultural models related to school that I previously introduced, this research has shown that students come to school with academic *and* non-academic cultural models that influence the student identities they imagine and adopt, which they form over time from exposure to popular and local culture, their families, their peers, and participation in schools. In this section, I introduce studies that examine cultural models relevant to this study.

Espousing Identities as "Doers" of Math & Science

Boaler and Greeno (2000) interviewed Advanced Placement students in a study of the figured world of mathematics classrooms. They described the differences in the identities students adopted in didactic and discussion-based classrooms based on students' talk of the ways of knowing mathematics. They did not explicitly call these ways of knowing cultural models, but their descriptions suggested that these ways of knowing were generalizations or assumptions students across schools held about mathematics. For example, students in the didactic teaching environments talked of mathematics class as ritualistic whereas students who were in the discussion-oriented classes spoke of math as an area in which they were able to be expressive and creative. Boaler and Greeno found that when students had less agency or personal efficacy in constructing identities that they desired, they were less likely to see themselves as the kind of people who did mathematics after high school. Reports of similar cultural models that students had in didactic and constructivist teaching environments were present across classrooms and in other subject areas (Rubin, 2007).

Rahm (2007) offered students' drawings of scientists as part of a summer gardening program to determine the unexamined assumptions students had about scientists. Students overwhelmingly depicted scientists as smart, yet uninteresting individuals who wore white lab coats. Students derived their stereotypical cultural models of scientists from many sources, including popular culture. Youth conceived of scientists in stereotypical ways, and expressed implicitly held views related to race, gender, and class in their discussions of their representations of scientists. These cultural models served as tools to raise students' consciousness about their beliefs about science; this research also helped students construct different cultural models and hence possibilities for their own lives and career trajectories after they conducted career-related life history interviews themselves with real scientists.

In the mathematics example from Boaler and Greeno (2000), students evaluated their ability to view themselves in future positions in mathematics based on the degree of agency within their current classrooms to incorporate creativity and critical thinking. In the science program reported by Rahm (2007), students who held implicit cultural models about science were able to change their social positions as individuals unknowledgeable about the lives of scientists, to those of individuals who had direct knowledge of multiple scientists' lives and career trajectories. These studies suggest that cultural models can be modified via changes in instructional approaches to help students shift from being individuals outside of the discipline or class activity to more active participants in disciplinary activity. These studies focus on things in the content or in the instructional environment that served as cultural models. In the next section, I review cultural models that are tied to particular milieu and understandings that are shared by groups and have also been used to change the ways in which students shift their identities from outsiders of a discipline to insiders.

Cultural Models in Action

In a study of high-school English, Carol Lee (1995) demonstrated that underachieving African American students she taught came to school with cultural models of language play from African American Vernacular English (AAVE) that could be used to help them interpret canonical literature (C. Lee, 1995). She suggested that when African American students encountered the language play in canonical literature without a cultural frame with which to approach it, they may have seen it as foreign and not worthwhile, even though they engaged in similar sophisticated language play in AAVE. Lee used signifying, or a form of AAVE discourse in which students ritually insult one another in an often witty and humorous manner (e.g., playing the dozens), to help introduce students to the language play inherent in discourses familiar to them. She then used these understandings to bring students into the reading practices or literary analysis of canonical texts and discourses that were less familiar.

In Lee's (2001) study, students used sophisticated means of analysis even when they appeared to engage in actions that may be viewed as disruptive per typical cultural models of "appropriate" school behavior. Lee spoke of this overlapping and sometimes loud form of discussion as "multiparty talk," a common element of AAVE discourse and "a routine indice [sic] of engagement" (p. 130) for African American youth. She found that it was important for her as a teacher to understand not just the content but the culture of students (including multiparty talk) in order to see when they are engaging in reasoning, even if implicitly, and how to use their errors as teachable moments. She suggested that to engage in this type of instruction, teachers also need to understand when students are raising questions – even if informally – to facilitate instruction and allow students to go down paths that may initially seem unproductive and “off-task.” The key to use of this intervention was the instructor’s (Lee’s) knowledge of the cultural model of signifying, and cultural practices such as multiparty talk that the African American students in her study shared.

Similarly, recent research has used popular culture media as a cultural frame to teach urban students analysis of canonical poems and as a way to help them become critical consumers of what they read (Duncan-Andrade and Morrell, 2000; Morrell, 2002). Duncan-Andrade and Morrell (2000) reported that students did sophisticated analysis of canonical poems when given a cultural frame as a point of entry, in this case, analyses students brought to hip-hop music lyrics were used as tools to help them approach similar analysis of classical poems. These authors argued that placing both the canonical works and hip-hop lyrics in historical perspective was an important strategy for use of this cultural frame or model, to help students understand and raise their critical consciousness of the world around them, and to critically think through events, dominant societal ideologies, and discourses that shaped their current experiences. As with Lee’s work, the significance of this intervention rested in the knowledge that these researchers had of popular culture and the youths’ use of it as a way to help them connect to similar analyses of canonical texts.

In summary, the examples from Lee (1995; 2001) and Duncan-Andrade and Morrell (2000), suggested different ways that cultural models have been used as principles of action. In both sets of studies, the researchers (who were also the instructors in these classrooms), drew from what they knew about students’ existing cultural models to help youths draw parallels to disciplinary practices used in their English classrooms. What would this look like in science classrooms? In particular, how could one draw on students’ existing cultural models to inform the roles that cultural models might play in science learning? Typically, instructional designers have made assumptions about the cultural models that students bring, and build instruction based on presuppositions of what students like and what they believe will motivate students to learn science (C.

Lee, 2003). We simply do not have enough information as it pertains to connections among dominant cultural models in science (e.g., science as inquiry, cf. Windschitl, 2002) and students' existing cultural models; therefore, further exploration is needed of students' cultural models in order to build instructional innovations that are responsive to students' cultures.

In the next section, I present other types of cultural models that co-occur with the disciplinary and classroom cultural models, those that espouse social positions or identities and help students evaluate others' claims to social positions. I assert that this third category of cultural models may interact in ways that cohere and/or compete with the disciplinary and classroom cultural models, and present examples to illustrate this.

Espousing and Evaluating Social Positions

Gee (1999) stated that cultural models are reductive, in that they often are "simplifications about the world, which leave out many complexities…" that are "useful for some purposes and not others" (p. 59). He argued that they "can do harm by implanting in thought and action unfair, dismissive, or derogatory assumptions about other people" (p. 59). In other words, the function of cultural models that sets up what is normal, also establishes what is marginal and devalued. This characteristic of cultural models makes them inherently political, or concerned with claims to identity, power, and possessions (p. 70). In this section, I review empirical studies that explore the ways in which individuals through their talk reveal cultural models related to social positions they espouse or to evaluations of the appropriateness or typicality of individuals and their actions.

In an analysis of an interview with a Latina middle school student, Gee (1999) illustrated the conflicting ways that she espoused and evaluated social positions related to a high-status career, academic achievement, and racial identities through her talk. In response to the question of why she felt there were few African American and Hispanic doctors, she stated that Whites had more education so there were more of them who became doctors. However, she then went on to say that some Hispanics were unmotivated and uninterested in attending college. She contrasted Hispanics to Whites, who she saw as smarter, more motivated, and less concerned about peer pressure. When probed further about why she thought Whites were smarter, this middle schooler suggested that White students' parents went to college, too, and passed on to their children "smartness" and the belief in the importance of college attendance. Her talk revealed both stereotypes related to race (the reductive feature of cultural models) on the one hand and very sophisticated analysis of the generational reproduction of educational advantage. In her evaluations of the type of people who were typically doctors, she espoused positions for Hispanics as atypical and negative and for Whites as typical and positive. These two cultural models coexisted, and raise the question of what their affect may have been on her own choices and self-esteem given that she herself was Hispanic. Although Gee provided no data in this excerpt about how this girl used these cultural models in her own actions, these conflicting cultural models make one wonder in what ways these cultural models may have interacted with the instructional cultural models in her classrooms if this was what she believed about people from her own ethnic group. These data also suggest that she may have seen these cultural models as things that just *were*, that were not subject to change.

Strauss (1992) presented evidence of three cultural models in the lives of working-class men based on life history interviews of five men from Rhode Island. Their talk espoused a shared, prototypical, and individualistic cultural model of American success, (D'Andrade, 1984), however, it also illustrated that this model co-existed with two other models – one of "breadwinner" and the other consisting of each man's personal experiences and relationships. These men had similar assumptions of what it meant to be a breadwinner, such as having to sacrifice time with family and friends to work long hours and do whatever was required to provide a living for their families. This breadwinner cultural model made it so that these men chose to stay in jobs that were less prestigious and less lucrative to fulfill the role of provider for their families. The men's talk in interviews indicated that the breadwinner cultural model had more influence in their everyday decisions than the dominant societal notion of success. Strauss concluded that even though the men judged themselves according to the widely-held model of American success (which affected their self-esteem), they saw the cultural model of breadwinner as a reality from which they could not escape. They believed that the welfare of their families trumped that of themselves as individuals, and seeing themselves as breadwinners motivated their actions more than that of the cultural model of American success. Strauss suggested that part of their perception of the inevitability of the breadwinner cultural model that these men never explicitly examined the assumptions underlying this gender and class-specific cultural model, although they were very aware of the assumptions of success in the more mainstream model of success.

Additionally, cultural models can also be used in analytical work of researchers as explanations of individuals' espoused identities. One popular cultural model that is used to explain minority student achievement (and the academic identities that minority students construct) is the cultural-ecological theory posited by Ogbu (1990). He defined a cultural model as "an understanding that a people have of their universe – social, physical, or both – as well as their understanding of their behavior in that universe" (Ogbu, 1990, p. 523). He also provided characteristics of the cultural model of a group: "The cultural model of a population serves its members as a guide in their interpretation of events and elements within their universe; it also serves as a guide to their expectations and actions in that universe or environment" (p. 523).

He asserted that differences in cultural models between minority groups depended on the histories of the individual minority groups, both voluntary and involuntary minorities. Per Ogbu, voluntary minorities were incorporated into a country as immigrants and involuntarily minorities were incorporated into a country by conquest or by slavery. He argued that each type of minority group had its own cultural model of schooling that differed from the other by the initial way they were incorporated into U.S. society, the ways they responded to treatment by the majority group since incorporation, "the frame of reference for comparing present status and future possibilities (i.e., a status mobility frame), a theory of getting ahead, a collective identity, a cultural frame of reference for judging appropriate behavior, and the degree of trust of White Americans and the institutions they control" (p. 529). These cultural models influenced their attitudes toward schooling and their enactment of identities and behaviors (or strategies) in response to inequitable treatment.

The main argument in Ogbu's work is that although both voluntary and involuntary minorities are subject to the same discriminatory treatment, involuntary minorities' cultural models are less sophisticated and cause them to develop less useful achievement-related strategies than their immigrant peers. Ogbu evaluated these strategies as unproductive because they resulted in involuntary minorities having less success in schools relative to voluntary minorities. Ogbu did not consider that the cultural models espoused by students were in constant revision, and were never static. Even the histories that he spoke of changed and varied in different locales; in other words, cultural models adapt to context and to changes in participants and interact with the other cultural models to which individuals adhere. For example, some of the arguments he made apply to the cultural models of Blacks in the Civil Rights era, when he conducted his initial research, and have less applicability for African Americans in postindustrial America, who have been found to interpret their worlds using cultural models related to being American, being of African descent, and of being a member of a socially-devalued group (Boykin, 1986).

Unlike the classroom cultural models in the previous section that were used to open up students' opportunities and help them construct different principles of action and hence identities as learners that teachers explicitly asserted and modeled with students, the cultural models that espoused and evaluated social positions were less explicit, were sometimes stereotypical, and perceived by individuals as static realities. In other words, they seemed to limit the opportunities and identities individuals could construct. If cultural models that espouse and evaluate social identities are held in conjunction with those of a particular domain or discipline, how do these different types of cultural models interact? What do cultural models that espouse and evaluate science learner identities look like? Do students implicitly hold stereotypical cultural models of science that they see as unchangeable? If so, what are the cultural models that students hold related to science? What other cultural models do they hold that may compete with that of science? How can science educators use these cultural models to bridge differences and create environments that help students construct identities as science learners as done in other disciplines such as English/Language Arts in the studies of C. Lee (1995; 2001) and Duncan-Andrade and Morrell (2000)? How do we help students examine the assumptions behind these cultural models of science, and help them attend to competing cultural models that may cause them to choose strategies that make them less successful according to dominant cultural models of science (although those same strategies may be useful in their everyday worlds)? In this study, I present interview and short-term observational data evidence of the cultural models held by students across schools, and later provide implications for how these cultural models as part of students' figured world of science may be fruitfully employed to help students construct identities as science learners. In the next section, I introduce the next part of students' figured worlds that I explore, the resources in the lives of this study's participants.

Resources: Empirical Examples

As stated in the theoretical framework, I focus on resources from the work of Bourdieu (1986), who suggested that the dominant class in society appropriates, accumulates, exchanges, and reproduces power in the form of different types of symbolic capital (economic, human, social, and cultural). In educational studies, Bourdieu's theory is used frequently to explain the differential outcomes of individuals outside of the societal mainstream, asserting that marginalized groups do not have the social and cultural capital needed to attain social mobility in mainstream society (Carter, 2003; Yosso, 2005). Some critiques of Bourdieu have argued that his theory employs overly deterministic notions of social structure in individuals' lives, and does not take into account their personal agency or efficacy to create change (Dika & Singh, 2002; Sewell, 1992). Yosso (2005) and Carter (2003) challenged traditional interpretations of

Bourdieu's theories and argued that there are forms of capital used in marginalized communities that go unexamined because they differ from what is valued in the dominant culture.

Recent work by Bourdieu investigated how capital worked in the lives of professional scientists, defining a form of capital held by successful practitioners. Critics of Bourdieu's work would contend that while Bourdieu's (2004) analysis helped one understand the valued capital of professional scientists, one has no information about the capital possessed by individuals who had different trajectories or were considered less successful according to mainstream notions of success. Without knowledge of the latter, one cannot understand what resources or interventions might help individuals with fewer resources possibly attain different outcomes. In this section, I review studies that examine resources in minority communities from the perspective that acknowledges differences in access and accumulation of capital needed for success in school science and outlines a growing knowledge base of the specific cultural knowledge and resources available in marginalized communities that can be tapped into to provide the capital students need to have better academic and social outcomes in subjects like science.

Cultural and Social Capital

As defined previously, cultural capital is implicitly gleaned through exposure to culturally advantageous experiences, dispositions, and environments. Accumulation and appropriation of cultural capital confers advantages to individuals implicitly over time via participation in institutions – e.g., families, schools, and workplaces. In schools, cultural capital includes the embodiment and products of valued dispositions that help students succeed in school. This includes demonstrations of content knowledge and dispositions such as "studenting" (Fenstermacher, 1986) and "procedural display" (Bloome, Puro, & Theodorou, 1989) or knowing the routines, rules, and comportment necessary to fruitfully go through the motions of classroom activity. These are dispositions that are rewarded and valued in schools. Less examined are academic dispositions such as resiliency (O'Connor, 1999; Ward, 2000) or an individual's ability to take on a positive orientation towards their achievement in the presence of perceived and actual barriers to her/his success, and aspirational capital or students' ability to hold on to their dreams even when most people would say they have no apparent reason to be hopeful based on their current reality (Yosso, 2005).

There are also studies that have examined cultural capital in schools and in families (Carter, 2003; Lareau & Horvat, 1999; Lareau, 2003). Lareau (2003) investigated the ways that parents' social class shaped their children's life experiences. She conducted observations and interviews with 12 families from a range of middle-class, working-class and poor families exploring the ways in which they structured their leisure time, used language, and navigated within various institutions. She found that there were differences in the ways the families went about these everyday practices by social class, and concluded that although the strategies and activities of working-class and poor families were different from those of middle-class families and less useful in navigating institutions, there were advantages that each gained from their particular approaches to child rearing and interacting with schools. Lareau's recommendations from this work suggested interventions could be structured to reduce the over scheduling of middle-class children, and provide more structured cultivation of working-class and poor students' time to allow them the ability to code-switch when moving between the spaces of their families and communities, and those of mainstream institutions.

Carter (2003) investigated the ways that racial identity influenced African American youth's experiences. She argued that cultural capital is context- and reference group-specific, as well as multidimensional, such that there are dominant and non-dominant forms. She referred to dominant-cultural capital in the way that Bourdieu discussed the cultural capital of the powerful group in a society that allows one to embody the dispositions of its power brokers. She defined non-dominant cultural capital as "those resources used by low status individuals to gain 'authentic' cultural status positions within their respective communities" (p. 138). Carter contended that cultural capital theorists often discuss what non-dominant groups lack in terms of cultural capital valued by the dominant class, but do not address that students in low-status groups must learn to juggle both dominant and non-dominant cultural capital in order to succeed in life. In her study of African American adolescents, she found that a focus on non-dominant cultural capital to the exclusion of dominant cultural capital made it so that youth would struggle or have challenges socioeconomically. She also found that youth who were successful strategically negotiated dominant and non-dominant social capital among family, school, community, and peer social spaces. However, Carter suggested that a student who was able to balance these forms of cultural capital had to continuously negotiate and "read the social situation to weigh the costs and benefits of his or her actions" (p. 139).

As Carter suggests, students must have the ability to not only know and understand the norms, expectations, and dispositions of both dominant and non-dominant communities, they must also then be able to leverage each in ways that allow them to navigate both dominant and non-dominant cultural spaces of school. In science classrooms in particular, dominant cultural capital relates to the knowledge students have of the content and the dispositions specific to science and scientists that schools value. Non-dominant capital includes the ways of knowing and doing that do not adhere to the dispositions required in science classrooms, including those from students' homes, communities and peer groups, including the stereotypes that many of them hold about science and science knowledge, which could be considered cultural capital that is not useful or valued in science (Rahm, 2007).

As with cultural capital, individuals glean social capital implicitly; it is derived from the number of social relationships that one has with other people and groups that are socially beneficial. For example, in the work of Lareau above, both the middle-class and working-class/poor children in her study accumulated social capital. The middle-class children did so through their connections to adults and others in the institutions sponsoring their activities; the working-class and poor students did so in their associations with peers and relatives in their leisure time. Many would see the associations of the middle-class students as superior to those of the working-class students. However, research such as that by Stanton-Salazar (Stanton-Salazar, 2001; Stanton-Salazar & Spina, 2005) has established that working-class, inner-city, Latino youth provided each other with social and emotional supports to handle the difficulties they faced when such support was not readily available from the adults in their lives. Stanton-Salazar and Spina (2005) found that participants who were embedded in peer networks that were built on principles of mutual trust as well as symmetrical understanding and reciprocity, attained resources necessary to weather emotional and social stresses; these youth, many of whom were from immigrant families, were also better able to handle the stresses of acculturation to U.S. society, particularly in schools and neighborhoods that were economically and socially marginalized. This work highlighted opportunities from which to draw the strengths of peer networks as resources for students in working-class communities.

Finally, there were studies that did not directly reference the terms cultural or social capital, or even discuss resources, but were designed in such a way that the intervention involved supplied students with resources needed to navigate or accumulate various forms of capital. For example, Jurow, Hall, and Ma (2008) asserted that an applied mathematics intervention provided students with interactions with working professionals that caused them to reconceptualize mathematical knowledge in ways atypical from normal student-teacher interactions. In their study, visiting specialists, who used mathematical models daily in their work, reviewed the growth models developed by student groups during "design reviews." Most of these reviews resulted in students either elaborating prior knowledge or articulating new knowledge via interaction with the specialists, even though the specialists had minimal coaching in advance of the event. The specialists brought expertise to the interactions that enabled them to ask students questions about what might happen if different variables in the model were changed – questions that differed from typical classroom interactions in which teachers tended to ask questions related to knowledge students already have. In this study, the specialists in conjunction with the models became resources (providing cultural and social capital) to afford engagement in the types of thinking that working specialists used in their daily practice; students made sense of the applied mathematical knowledge via the modeling activities.

Similarly, in a study of inner-city (mostly African American) students' beliefs about science and scientists in a summer gardening program, students had the opportunity to discuss at length their conceptions of science and conducted life history interviews with practicing scientists (Rahm, 2007). Prior to the interviews, students thought about the practice of science in terms of school science, which they saw as dull. Their responses in discussions showed that they had little experiential knowledge with the world of science as practiced by scientists. They also held stereotypical views of the types of people who became scientists—what they looked like and the types of people they were. Conducting interviews and visiting the workplaces of the practicing scientists, gave students social capital, allowed them to directly address the stereotypes they held, and learn about the everyday lives of scientists. Students began to see the scientists as real people who although they shared a similar curiosity about the world, they were all very different; in other words, their stereotypes were challenged and shown to be false through these activities. Many youth also came to see the work of scientists as interesting and inspirational, providing them with cultural and aspirational capital. The interactions with scientists served as a way to help students explore possibilities and understand career and life trajectories that they might not otherwise encounter.

While the previous examples discussed the use of outside experts and practitioners as resources, Shirley Brice Heath (1983) presented an example using a community's resources to help students learn a school subject. Heath engaged students from a working-class Black community by having them act as ethnographers of their community's "foodstuffs" for a science unit. They drew on the knowledge of the families in their farm-based community, and translated the knowledge collected into knowledge relevant for classroom science and vice versa. Students became quite knowledgeable about the science related to foodstuffs, became conversant in both schooled and everyday representations of the same knowledge, and motivated by the opportunity to teach others what they had learned about their community. Through this experience, youth had the ability to acquire multiple forms of capital, and the opportunity to see the non-dominant capital of their communities converted to dominant capital valued in schools.

Last, I return to the work of Bourdieu. In 2004, Bourdieu released a book detailing the ways capital played out in the professional lives of practicing scientists. He introduced the term *scientific capital* as relating to the resources valued in science such as having the appropriate knowledge and ability to recognize others as being experts in the field, and in turn, being recognized by competitors in one's field as an expert and for contributions to the field. This definition implied that "scientific capital" such as valued knowledge and social networks were necessary for one to succeed in the world of professional science. It also suggested that recognition required that one embody in their performances of identity as scientists the type of cultural capital deemed appropriate by others, including competitors; this cultural capital included ways of conducting research, writing, comporting oneself, and interacting with others in the field. In addition, having scientific capital allowed scientists in his study to gain other types of capital including economic capital. Because this dissertation focuses on middle school students, it raises many questions about the nature of scientific capital for students who may not necessarily become scientists. Some questions are: What does scientific capital look like for science *learning* if all students are expected to learn science? Does valued knowledge and recognition differ for students according to their aspirations and school contexts in K-12 schools? What cultural capital do youth need to embody in their performances of science learner identities? What types of negotiations do students make between the forms of dominant and non-dominant cultural capital in their science classrooms? How do social networks matter to scientific capital for learning?

In summary, this section aimed to present studies that suggested that students from groups outside of the mainstream do have resources, although they may not have the same currency in mainstream institutions as those of their middle-class peers. These resources help to establish for students possibilities and possible actions for "people like them." In this study, I assert that a focus on students' cultural models in conjunction with the resources that they bring from their home communities helps us understand the identities youth construct as science learners, and knowledge of these constructs could serve as bridges to students' learning.

In the next section, I put all of the pieces of students' figured worlds together, providing an example from the literature and applying the example to the formation of science learner identities. I then present the hypotheses and questions that drive this study.

A Figured World of Science and Mediation of Science Learner Identities

In this dissertation, I apply the theory from Holland et al. (1998) of aspects of a figured world to urban Black students' enactment of science learner identities. To illustrate how a figure world mediates the formation of identities, I briefly provide an example of a figured world in action from Holland and colleagues (Holland, 1992;

Holland et al., 1998)., to be able to extend this idea to the formation of science learner identities of the students in this study. Holland et al. describe the ways in which female co-eds at two different colleges made sense of their own place in the figured world of romance. These young women had cultural models or implicit and intersubjectively shared generalizations derived from their previous romantic experiences, norms of their social group and college campus of the roles individuals played in relationships and what a typical romantic relationship should look like. Their discourse or communication that reflected their beliefs, values, and social practices, conveyed their degree of expertise in romance, ways they dealt with new challenges when they arose, and what it meant to them to participate in the world of romance. Attractiveness and expertise in romantic relationships were resources young women had at their disposal in the figured world of romance. Last, women identified to different degrees with the figured world of romance, in essence taking up positions of their own identities or self-understandings in romantic relationships.

The value of Holland et al.'s theory is the examination of figured worlds as a mediator in the enactment of identity. However, their work did not acknowledge how differences in the two schools examined in their study would influence the construction of figured worlds on each campus. There were three important aspects of the figured world of romance not explored extensively in the analysis presented by Holland et al. First, the study of romance occurred at two different universities in the southeastern United States – one with lower-middle class women at a historically-Black college or university (HBCU), and the other with middle- and upper-middle class women at a predominantly White institution (PWI) – but did not take into consideration the potential differences in the figured world of romance at each school, and hence different identities as romantic partners, between women at these schools operating from potentially dissimilar cultural models and discourses.

The second point relates to the first; the analysis of resources in the figured world of romance did not explicitly explore the role of economic, cultural, and social capital in the lives of the college women studied. Students at the PWI were from middle- and upper middle-class families, whereas those from the HBCU were from lower middle-class families. This suggests that women at the PWI had higher economic capital than their peers at the HBCU. They potentially also had different types of social and cultural capital as well, given the differences in social class, that would alter the figured world of romance. Third, the young women in the Holland et al. study desired to be good at romance, even when they had yet to develop expertise, were considered to be less attractive, or had bad experiences up to that point. *This desire to adopt an identity as someone good at romance motivated their participation in the world of romance.* Even women who were not actively participating in the world of romance expressed an interest in having a healthy romantic relationship – thus attaining "expertise" in the figured world of romance. All three of these points suggest that with time (another resource), women could develop the components of the figured world necessary to adopt identities as members of the figured world of romance.

On the contrary, the desire to adopt an expert identity may not be sufficient to motivate students to increase their participation in their figured world of science of urban 7th graders, one that is different from the figured worlds of science held by others such as even pre-service teachers (Windschitl, 2002) and elementary and secondary science teachers (Bryan & Atwater, 2002). I assert that unlike the examples from the figured world of romance described by Holland et al. (1998), the cultural models, discourses, and resources necessary to become experts are not readily accessible in students' figured world of science. This is due to the figured world of science and science classrooms being influenced by access to and adoption of the cultural models, discourses, and resources of schools in general, science education, *and* science writ large. This suggests the need to understand the way these pieces work together to construct specific figured worlds, which in turn mediate the enactment of certain science learner identities and not others for students who may not aspire to be experts or to become science workers, but must become science learners in K-12 schools.

Connecting the Theories: Importance to this Study

In this chapter, I presented the empirical and theoretical perspectives of identities used to explain racial and student identities in relation to the domain of school science. What I have found through this literature review is that the different methods used to explore identities have their affordances and weaknesses. Researchers have examined student identity in achievement motivation studies using survey data, which allowed them to understand individuals in relation to a content area like science, but it did not allow them to understand the factors that shaped these individuals socially, historically and culturally. Conversely, interview and observation data have been used to capture socially and culturally-constructed aspects of identities. Examining them together gives a more complete picture. In probing youth's identities using mixed methods, I interrogate the personal, social, and cultural aspects of their experiences in science during the latter half of their 7th grade year. I also examine students' identities in the context of three science classrooms, including their self-as-science student cultural models via achievement motivation variables, racial identities, and cultural models about science, and their future educational and occupational goals. I examine youths' talk in interviews and in short-term observations to understand the types of science learner identities that they enact.

Hypotheses

In the survey analysis portion of this study, I hypothesized that students' gender would influence their interest value for science and their perceived ability in science, as gender has been associated with expectancies and values for subject matter (Meece et al., 2006). I also hypothesized that the school students attended) and their racial identity (centrality and private regard) will influence their perceived ability in science, as many studies reviewed in this chapter highlighted the importance of context and racial identity. I also measured all possible interactions, as I believed there might be an interaction between racial identity and gender on students' motivation to learn based on previous research that showed differences in minority girls' attitudes toward science (Catsambis, 1995).

I approached the qualitative work with the idea that students may have differences in exposure to experiences related to science based on differences in school contexts as well as differences in future aspirations and goals. I expected that there would be similarities in their conceptions of science based on being taught using the same curriculum and their teachers all had the same professional development training. At the commencement of this research, I believed that the contextual differences would trump any shared cultural beliefs held by students in this study. I also believed that there would be differences in the beliefs that girls and boys had about their abilities to do science currently and in the future based on research that shows gendered differences in motivations in different subject matter and in future orientations (Andre et al., 1999; Eccles et al., 1993; Greene & DeBacker, 2004). I address these lines of inquiry using the following research questions:

1. What are the beliefs of African American middle-school students about the domain of science in general and about themselves in relation to science?
2. What is the relationship between students' identifications (as articulated in surveys and interviews) and their beliefs and cultural models of science?

In summary, I merged concepts related to identities as a way to explore the aspects of science learning frequently left out of studies of students' science learning. Theories of identity enrich the individualistic and quantitatively measured nature of achievement motivation by incorporating interpretation of meanings and the social and cultural factors that shape individuals' behaviors. In the next chapter, I present details of the mixed methods design, the aims and objectives for the design, as well as introduce the study's context, data sources, data collection methods, and analytical methods.

Chapter 3 – RESEARCH & METHODOLOGY

Introduction

In this study, I combined both quantitative and qualitative data in a complementary fashion (Sale, Lohfield, & Brazil, 2002) to provide a comprehensive account of African American middle-school students' imagined and enacted science identities in three project-based science classrooms. Creswell and Plano Clark (2007) defined this type of study as mixed methods, or as a research design employed to comprehend a research problem through collecting, analyzing, and mixing both quantitative and qualitative data within a single study; mixed methods studies use philosophical assumptions that guide how to undertake the data collection, analysis, and merging of methods.

I employed a survey to measure the relationship among factors that influence students' achievement motivation, racial identity, and beliefs about science. As a complement to the survey data, I used interviews and open-ended survey items to explore students' beliefs about science, future possibilities, access to science outside of school, and about their beliefs about the identities of scientists in their own enactments of identities as science students. I used classroom observations as a way to understand the contexts under study, and for comparative analysis across data sources. In the sections to follow, I provide the design, context, and the analytical techniques utilized in this mixed methods study to address the questions that guided the research. Because this study employs mixed methods, this chapter describes the details of data collection strategies, hypotheses, research questions, instruments, and types of analyses from both qualitative and qualitative perspectives – and how I merged the two.

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Type of Design

The type of design employed in this study is a concurrent/triangulation mixed method study in which both quantitative and qualitative data were collected concurrently analyzed separately, and then merged "to best understand a research problem" (Plano Clark & Creswell, 2008, p. 376). The purpose of this design is complementarity or to use the weaknesses and strengths of qualitative and quantitative research methods to complement and offset each other (Greene, Caracelli, & Graham, 1989; Jick, 1979), and do so in a way that thoughtfully merges them, and not just reports the results of each separately (Plano Clark & Creswell, 2008). In this way, I chose the paradigms that work best to address the research questions and integrate methods in ways that serve to construct a comprehensive understanding of the phenomena studied (Rocco et al., 2003).

The challenges involved in applying a concurrent/triangulation design are multiple. Jick (1979) and Plano Clark and Creswell (2008) described the challenges in the following ways: 1) developing methods to address and reconcile divergent or unexpected results, 2) replicating the details of mixed methods studies (particularly the qualitative portion), 3) not privileging one method over the other such that one is used superficially or in a biased fashion, 4) matching the design to the purposes of the research conceptually and theoretically, and 5) managing the constraints of its application, such as time and creativity. Viadero (2005) offered that there is a limited number of individuals who are trained in a variety of approaches as the field tends to separate qualitative research from quantitative research and because of recent emphasis on randomized experimental studies in lieu of descriptive ones. As a way to address these challenges and to understand the ways in which others have approached the design and rendering of mixed methods studies, I review some examples of concurrent/triangulation designs like this one in the next section. I also provide details of the ways in which I collected and analyzed quantitative and qualitative data, and how I merged (jointly interpreted) them. Figure 3.1 below is a visual diagram of the mixed methods design used in this dissertation study.

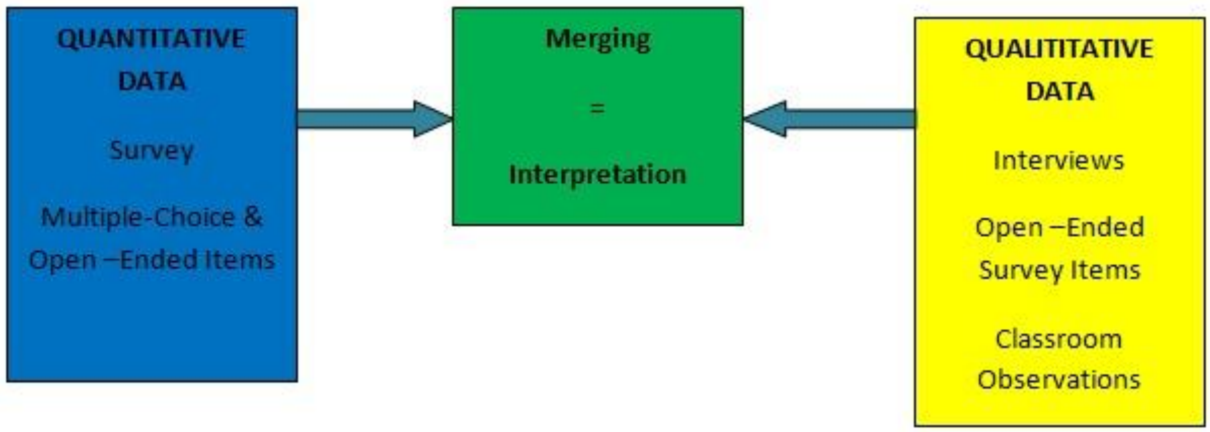

Figure 3.1 – Mixed Methods Design

Merging Qualitative and Quantitative Analyses

In chapters 4 and 5, I report the results of survey, observation, and interview analyses, as well as the results from hierarchical regression models of students' values and perceived ability in science. Examining students' self-beliefs related to science via quantitative analysis alone does not provide information about the contextual and sociocultural factors that affect students' identities and culture in relation to science, although it suggests that context was important. I merge the quantitative results with qualitative ones using the key linkages chart on the next page, Figure 3.2. Key linkages charts help one to map the main findings and the relationships among them (Erickson, 1986). In the key linkages chart, I make data-based assertions from analyses of the different data sources, and illustrate the ways each source supports the assertions.

Morse (1991) argued that triangulation in a concurrent/triangulation design as in the present study is not meant to "ascertain whether the results of two methods measuring the same concept are equivalent. The purpose of simultaneous triangulation is to obtain different but complementary data on the same topic, rather than to duplicate the results" (p. 157). Creswell and Plano Clark (2007) reported that triangulation mixed method designs employ two techniques to merge quantitative and qualitative data: data transformation or comparisons through matrices or discussion. For data transformations, qualitative data was converted to quantitative data to aid in the merging of the two types

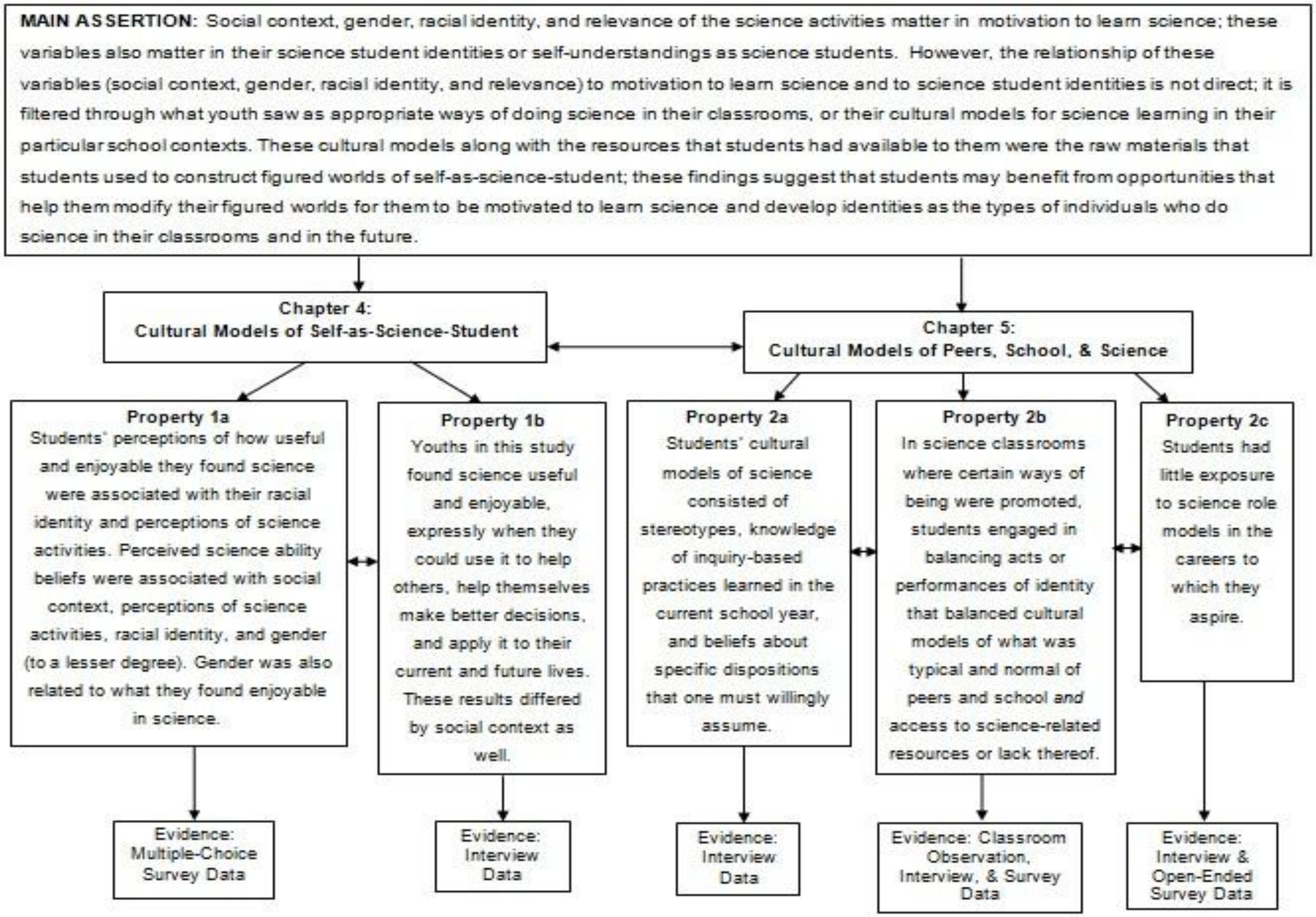

Figure 3.2 – Key Linkages Chart

of data. Researchers commonly quantify qualitative data by taking codes and counting the frequency with which they occur, and reporting them as percentages. The other technique, allows researchers to compare and contrast similarities and differences between the two types of data either visually via a matrix or written in the discussion section of the study. The role of the discussion is not to "directly merge or integrate the data; instead, the discussion highlights a comparison of the results from the two datasets" (p. 142).

In this study, I used a combination of data transformation and comparison through the use of matrices and the key linkages chart to compare survey, observation, and interview results. I also employed discussion sections in the results and final chapters to emphasize findings from the different types of analyses. In Chapter 4, I converted qualitative codes of the classes they chose as favorite and least favorite as a way to understand the frequencies in open-ended survey responses and in interview responses. I also used a matrix to examine students' intrinsic value construct measured in survey items , for example, and to explore the codes that emerged from interviews asking similar questions. In Chapter 5, I employed self-concept of ability survey data for interviewees to validate the identity categories formed using interview and classroom observation data. In the final chapter, I merged these findings via discussion to show how they work together to provide a comprehensive view of students' construction of identities across the three project-based science classrooms. In the section to follow, I present the aims and objectives of the quantitative methodology, including the hypotheses that drove the analyses.

Aims and Objectives of the Study

I administered a survey questionnaire with the aim of developing and applying a regression model of students' motivation to learn science in their project-based science classrooms. I created measures from the survey items as independent variables related to students' motivation to learn science using expectancy-value theory (Eccles et al., 1983). Expectancy-value theory posits that two types of motivational variables help to explain students' personal identities within a content area: their *expectancies* (perceived ability or self-concept of ability) in a domain like science and their *values* or subjective beliefs about how useful, enjoyable, and personally important they perceive science and scientific activities to be (Eccles, 2009).

The hypotheses that drove the survey data analysis can be summarized in the following way: Male and female students will have different levels of motivation to learn science or expectancies and values for science, as gender has been associated with students' expectancies and values within a given subject (Meece et al., 2006). I also hypothesized that the school students attended and their racial identity (centrality and private regard) will be positively related to their perceived ability in science. Centrality and private regard have been found to be protective factors for African American adolescents in the face of risk factors such as racial discrimination (Sellers, Copeland-Linder, Martin, & Lewis, 2006). Furthermore, I measured all possible interactions between independent variables, hypothesizing differences by racial identity and gender on perceived science ability based on research that has show differences in attitudes toward science by gender (Catsambis, 1995).

I approached the qualitative work with the idea that students may have differences in exposure to s science-related experiences based on differences in school contexts as well as differences in future aspirations and goals. The qualitative portion also addresses factors that the quantitative hypotheses cannot anticipate, and I raise questions that guided the qualitative research that I thought would help enrich and generate theory to explain confirming and divergent evidence found in the qualitative findings. Table 3.1 on the next page displays the study's research questions and hypotheses. Next, I discuss the context of the study, which includes information about the sample, including the schools, teachers and student participants of the study.

Table 3.1 – Research Questions & Hypotheses

Research Questions	Hypotheses/Guiding Questions	Data Collected	Data Analysis
What is the relationship between students' identifications (as articulated in surveys and interviews) and their beliefs and cultural models	1A. What is the relationship between perceived ability and values, and the identities students' adopt?	Interviews (N=56) Classroom Observations (N=21) Adolescent Literacy Motivation Survey Multiple-Choice and Open-Ended Items (N=138)	Constant Comparative Analysis (CCA; Strauss & Corbin, 1998; Strauss, 1987) Descriptive Statistics & Content Analysis
What are the beliefs of African American middle-school students about the domain of science in general and about themselves in relation to science?	2A. There will be an interaction between race and gender on students' motivation to learn science (Catsambis, 1995).	Adolescent Literacy Motivation Survey Multiple-Choice Items (N=138)	Hierarchical Multiple Regression
	2B. Racial identity, gender, and school context will be associated with students' self-concept of ability in science (Chavous et al., 2003; Eccles, Wong, & Peck,	Adolescent Literacy Motivation Survey (N=138)	Hierarchical Multiple Regression & Analysis of Variance with Post-Hoc Comparisons

Context of the Study

Schools

The schools that I chose for this study are public schools located in a Midwestern city – where the overall student population is 90.5% African American, and 72.0% of the students in this district are economically disadvantaged based on the number of students who qualify for free or reduced cost lunch in the 2005-2006 school year http://www.schoolmatters.com/. These schools were part of a 10-year old reform initiative formed through collaboration between the urban school district under study and the university. The goal of the reform was to create inquiry-driven and technology-rich curricula to address the dearth of materials with which teachers had to work. I chose these schools because I based my prior work within the context of classrooms enacting this curricula (Cleveland, 2005), and because I wanted to work with predominantly African American students in contexts where they constituted the majority of the population. I also intended to represent the range of schools serving African American students within this reform initiative, to understand differences among them. Table 3.2 provides general demographic statistics for each school and the number of students at each school. These data depict differences among these three schools, in terms of the populations served, structure, and academic outcomes. The paragraphs to follow provide descriptions of the individual context of each school.

Table 3.2– Study Demographics, 2005-2006 School Year

School Name	% African American Students	Grades Served	Total Student Enrollment	No. of Study Participants	%FRL*	% Pass MEAP[x] (Reading)
Talley	98.7	K-8	792	52	15.0	99.2
Maxwell	98.8	7-9	675	45	64.0	51.2
Linden	94.0	6-8	901	38	74.0	51.9

- [*]FRL = No. of students who qualify for free or reduced-cost lunch
- [x] Information provided for 7th graders only
- Source: http://www.schoolmatters.com

Talley Academy. Talley Academy was a public academy and school of choice, designed to serve an urban gifted/talented population. Giftedness at Talley was not measured solely by intelligence tests. Students were also evaluated as gifted in music, art, and drama. In this district, it was commonly accepted that a proportion of the students attending Talley were the children of the city’s Black professionals. Talley served 792 students in grades K-8 in the 2005-2006 school year. The students at Talley were predominantly African American (98.7%), and approximately 15% percent of the students at this school received free or reduced-price lunch in the 2005-2006 school year. Students at this school were better off financially (on average) than their peers district-wide, as the district average for economically disadvantaged students was 72% in 2005-

2006. Almost 100% of the students achieved passing rates on the reading portion of the Michigan Educational Assessment Program (MEAP) the statewide, standardized test.

Unlike many schools in this district, Talley did not struggle with student attrition and students attended school on a regular basis. During the 2005-2006 school year, Talley Academy met all requirements for Adequate Yearly Progress (AYP)[3] established in Michigan, which include accountability measures such as students' test scores and attendance. Within the science reform systemic initiative, Talley students were among the highest achievers on the unit pretests. This school received awards from local academic and civic organizations. Additionally, from 2001 to 2007, the student population grew approximately 11%. At the start of the 2007-2008 school year, Talley moved to a new building to allow for expansion of programs and enrollment.

Talley was located in a well-established, middle-class neighborhood in the 2005-2006 school year, situated in a section of the city targeted by a mayoral initiative for improved cleanliness, safety and beautification. This project was designed to improve the quality of life in six neighborhoods plagued by a changing tax base and forces that threatened neighborhood stability such as gang and drug activity. The city officials deemed this section of the city to be relatively stable economically, and targeted initiatives requiring little capital investment.

The school grounds were well kept, fenced-in, and there was a playground with swings and a sliding board for the younger students at the school. Older students gathered for lunch and recess along a fence-lined, grassy area with trees on the side of the school. The building that housed Talley Academy was a well cared for, three-story, older

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[3] Schools are graded every year and strive to achieve Adequate Yearly Progress (AYP) in language arts and mathematics. There are accountability schemes associated with Title I in which. "A school must test 95% of its students in total and in each required subgroup. The school must attain the target achievement goal in reading and mathematics or reduce the percentage of students in the non-proficient category of achievement by 10% ("safe harbor"). In addition, the school must meet or exceed the other academic indicators set by the state: graduation rate for high schools and attendance rate for elementary and middle schools. These achievement goals must be reached for each subgroup that has at least 30 students in the group." Quoted from https://oeaa.state.mi.us/ayp/faq.asp#ayp_2. When schools do not make AYP for more than one year, schools must take corrective action depending on the number of consecutive years AYP has not been achieved. Please refer to the following website for more information about the terms of accountability for Michigan schools http://www.michigan.gov/mde/0,1607,7-140-22709_22875-85932--,00.html

building. The school administrators kept the doors of the school locked, and the front office first screened then buzzed in all visitors wanting to gain entry to the building. The halls had small lockers for the elementary students at the school. There were posters about achievement and different events at the school like the academic games in which students competed across the district on their knowledge of various subject areas. Student projects from different grades covered the walls. There was a library, gym, and computer lab available to students throughout the day.

During classes, there was rarely anyone in the hallways. The atmosphere appeared to be very adult-controlled, especially as students moved from class to class. All public schools in this district required students to wear uniforms. As a reward for their hard work, there were "free dress days" throughout the year given to all students of the school (with specific guidelines for what students could wear). On any given day, there were frequent public announcements made during class about fundraisers, school trips, and extracurricular activities.

Maxwell Middle School. Maxwell served students that were generally from lower socioeconomic backgrounds, and was a school-wide Title I school[4]. Maxwell had a student population that was 98.8% African American, 64% of the students were economically disadvantaged (or 8% less students than the district average). Approximately 51% of the students had passing rates on the MEAP. Maxwell students had the lowest science content-knowledge scores on average on the science pre-test of the three schools in this study. However, they scored between Talley and Linden students on the reasoning portion of the science pretest and on the reading diagnostic given as part of this study. The administration at Maxwell used MEAP math scores from the previous year to organize classroom sections at the beginning of the year. Because there were no standardized tests given to students for science, the administrators thought math tests were good indicators of how students would perform in science. The administrators then reconfigured classroom sections in the second half of the year after receiving the fall's

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[4] "Schools with at least 40 percent poor children (or fewer, with a waiver) can operate 'schoolwide programs,' using their funding — in combination with other federal funds, if desired — to upgrade the entire school." http://www.titlei.com/whatis.htm

MEAP data, such that students who were in one section at pretest were in another section at the end of classroom observations.

At the end of the 2005-2006 school year, Maxwell was at Stage 5 status for Adequate Yearly Progress per the No Child Left Behind legislation. This translated to Maxwell not meeting Adequate Yearly Progress for 6 years, and being at the point where the administration had to implement a restructuring plan, and/or give its students the option for busing to other schools in the district. Students at Maxwell were frequently absent or cut classes. In the previous six years, Maxwell lost over 57% of its students. At the end of the 2006-2007 school year, the school district closed Maxwell and transferred its students to other local schools.

Maxwell Middle School was a comprehensive-public school located in a neighborhood adjacent to Talley's, part of the same section of the city targeted by the neighborhood improvement program. This neighborhood appeared to be in transition; on one side there were the large, well cared for homes of the middle class – and on the other the smaller homes and lot sizes of the working class. The school had a large well-kept front yard and fenced-in parking lot. The school itself was a single-story, large building with several wings – one wing for each grade (7th, 8th, and 9th). There was limited cross-grade interaction among students during school hours because of this organization by grade.

Upon entering the building, one encountered a set of metal detectors on each door, accompanied by security guards and non-teaching assistants that directed visitor and student traffic. In the central hallway there were posters that listed the honor roll (3.0 GPA or higher) and principal's list (3.5 GPA or higher) for each grade. Like Talley, there was a strict dress code. Students could wear t-shirts from extracurricular activities in lieu of the dress shirts their school uniform required. Often, I would see students with "Math Counts[5]" t-shirts on instead of their uniform shirts. The school had many facilities such as a library (which was no longer in use), a computer lab, gym, and a reading room where students went for one class a week with their subject-area teachers.

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[5] MathCounts is a nationally renowned program that provides enrichment opportunities and a competition geared toward improving middle school math achievement. http://www.mathcounts.org

The atmosphere at Maxwell was much more adolescent-controlled. Students were in the halls at all times of the day, at times running from the security guards, administrators, and non-teaching assistants. Several administrators walked the halls between and during classes to ensure students were "where they needed to be." During classes, there were public announcements about students' behavior, lack of adherence to the dress code, and standardized testing preparation and schedules.

Linden Middle School. Linden Middle School was a brand new school in 2004, only open one year at the commencement of this study. Linden was 92% African American, and 74% of its students were economically disadvantaged. This was more than the other 2 schools, and 2% higher than the district average. About 48% of the students had achieved passing rates on the reading portion of the MEAP. Students at Linden had some of the lowest science content on the science unit pretests, but scored higher than their peers did at Maxwell. They scored lower than all participants in the study did on the word recognition and main-idea measures on the reading diagnostic. Neither Maxwell nor Linden met state requirements for AYP during the focal year of the current study.

Situated in a working-class neighborhood in a section of the city targeted by the mayor for revitalization, the area around Linden was to receive more city services and non-profit and corporate investment to prevent further deterioration of what was deemed a relatively stable neighborhood. This neighborhood was on the opposite side of the city from the other two schools. The school district built the large, two-story school on a main street across from small, well-kept homes. The school had an unfenced parking lot and basketball and tennis courts open to the public. Upon entering the school, I encountered two security guards that required me to sign in and proceed directly to the office to get permission to go to the focal classroom. There was commercial artwork and pictures of students lining all of the walls of the building. The building was very clean and there were non-teaching assistants in addition to the security guards and video cameras in all of the hallways that monitored all activity. There was a large library with many computers available for whole classes and for individual students, as well as desktop computers in each classroom. A large gym and cafetorium served as the cafeteria and auditorium. Like Talley, the atmosphere was very adult-controlled. The school's website boasted many afterschool programs and initiatives for school improvement.

The Teachers

The teachers in this study all enacted the same project-based curricula and attended professional development provided by the systemic reform initiative. I previously worked with two of the teachers that were part of the study in previous research – Mrs. Alexander at Maxwell and Ms. Robinson at Talley. Mrs. Alexander participated in the reform efforts since their inception and Ms. Robinson participated for 6 years at the time of the enactment. The other teacher, Mrs. Foster, and her school, Linden, were new to me. The 2005-2006 school year was Mrs. Foster's second year participating in the reform initiative. Table 3.3 provides the characteristics of the participating teachers.

Table 3.3 – Teacher Experience

Teacher Name	School Name	Years Teaching (as of 2005-2006)	Years With the Reform
Robinson	Talley	6	6
Alexander	Maxwell	16	9
Foster	Linden	3	2

The Students

There were 138 consented participants in this study. Fifty-nine percent of the students were female, and all students were African American. Students ranged in age from 11 to 14 years old, with the average student being 12.93 years old (as of March 2006). In the survey, there were self-report measures of mother and father's education as indicators of family socioeconomic status (SES). Many students marked "I don't know" in response to both items, which made it such that a direct measure of SES was not reportable here. Although SES is a useful measure that would have helped me to describe students, it also "places people in economic groups or categories, but does not address the meaning or social enactment of these categories" (Power, 2006, p. 4). In lieu of having an SES measure in this study to describe students, I use the variable of school context in tandem with interview and observation data as a way to understand the contexts in which students attended school and the ways students' experiences depicted across data sources reflected their social class.

Role of the Researcher

At the start of the project, I observed one focal classroom at two of the three schools on about a weekly basis. The third teacher's classes started the curriculum almost two months later than the others did, and did not cover the full curriculum. I visited her classroom as often as the teacher would permit. All three teachers introduced me as someone from the group responsible for creating the curriculum they used. Although I was not directly involved in creating this curriculum, I did provide classroom support and participated in teacher professional development with two of these teachers during the larger projects' active years of data collection. At times, the teachers situated me as an expert when they would ask me technical questions about the curriculum unit and the materials in the midst of the class. Students responded to this by asking me questions about the science content or curriculum materials. At times, students in all three classrooms performed for the audio or video tape appearing to want to show me that they knew some science content or that they were conducting the hands-on activities correctly. However, I did not teach any part of the curriculum; I served only as an observer of these classrooms.

There were two important ways that I positioned myself and that teachers and students positioned me in the classrooms. After the teacher's brief introduction, I introduced myself as a graduate student from the University of Michigan, and told students about my study. In particular, I made a point to tell the students the reasons for my interests in working with them. I explained that I attended schools similar to the ones they attended in my native Philadelphia. I told them that African American students were the majority group in those schools as well.

I also told them that I had not made a decision to pursue engineering until the 10th grade when I participated in a mentoring program that paired me with an African American male who was a mechanical engineer. Up until that mentoring relationship, a career in science was out of the realm of possibility for me. Prior to that experience, I had never really thought much about science. This experience made me wonder why this was the case. I expressed to them that their participation in my study would help me to know more about the attitudes and beliefs that students their age had towards science and school in general. They would also help me to understand how to make materials better and more interesting for their younger peers.

This tended to play out in a way that positioned me as a mentor and possibly as someone from their race who they could be proud of and aspire to be like. Many students at all three schools were familiar with engineers because of their participation in a pre-college engineering project, whose mission was to increase the number of underrepresented minorities in the engineering pipeline by exposing middle-school students to hands-on activities with engineers in the field and in the classroom.

At Maxwell and Linden, students were not familiar with the idea of me being a graduate student working towards a doctorate. Students had many questions about what I was doing and why. Many also did not really understand the difference between a medical doctor and a doctor of philosophy. This required that I take time out to talk with each class section. At Talley, students actually clapped after the teacher introduced me and told them what I was doing there. Surprised at this unprompted display, I later discovered that many students at this school knew quite a bit about the process of graduate school and the types of careers and opportunities that my training afforded.

Finally, I found that students at Maxwell tried to test me to see what type of authority figure I was. This may have occurred because of the age difference between their science teacher and me or because of the challenging circumstances of the school. There were multiple examples that I can draw from to provide instances of this. Students frequently passed notes and looked at me as they did this to see if I would tell the teacher. In one instance in particular, a group of girls were talking off-task about boyfriends and things occurring socially at the school while being audio-taped. Two of the girls came to me after class to let me know that they were not the ones saying those things. I explained to them my role and that I thought it was not a good idea for them to say those private things on the tape but I would not inform the teacher because what they said was confidential.

Data Sources

Data collection occurred from mid-December 2005 to early June 2006. The study commenced with the science pretest[6], and then the classroom observations. I administered the diagnostic and surveys in February and March of 2006, respectively. Because there were three interviews with each student, I conducted them after the curriculum unit enactment. Interviews continued through early June. Table 3.4 shows the data collection schedule over the six-month period.

Table 3.4 – Data Collection Schedule

Teacher	Observations	Tests	Surveys	Interviews
Mrs. Alexander (Maxwell)	9 total, 12/05-2/06 Lessons 1, 2, 4, 6, 7, 8, 9	Science Pre12/05	Reading 1/06-2/06 Survey 3/06	31 total (11 students[7])
Ms. Robinson (Talley)	7 total, 12/05-3/06 Lessons 2, 6, 7, 8, 9, 12	Science Pre 12/05	Reading 1/06-2/06 Survey 3/06	15 total (5 students)
Mrs. Foster (Linden)	3 total, 3/06 Lessons 6, 7, 9	Science Pre 02/06	Reading 1/06-2/06 Survey 3/06	11 total (4 students[8])

<u>Sample Size</u>

For the quantitative portion of the study, I used tables in Cohen (1992) to conduct a power analysis. At a minimum, I would need 100 students, to detect findings of medium effect size. To detect larger effects I would require a sample size of 180 or above. I tried to attain approximately 180 students due to the high levels of attrition and absenteeism characteristic of some of the schools that I studied. Over 140 students

[6] I only use the science pretest and reading diagnostic to determine students to interview, because I wanted someone in each classroom that scored high relative to their peers and someone who scored low. I also used them as a way to describe students across schools.

[7] I had to sample from all five sections of Mrs. Alexander's classes in order to get the 38 students that participated. Because of this, I wanted to ensure that I got a representative sample of the students across these classes. I interviewed 2 students from each section. I lost one student after the first interview that transferred to another school.

[8] I lost one student after the second interview.

consented to participate in the study. However, only 138 students could participate in all aspects of the study. The next section includes more information on the sample size for each of the instruments used.

For the qualitative portion of the study, I employed what Patton (2002) calls maximum variation sampling to get a range of students in the systemic initiative. I chose schools by the score patterns that students in these schools have attained over several years of participation in reform initiative on the unit pretests – one each considered high, medium, and low. I selected two students from each section to interview. However, I had to sample from more class sections than originally anticipated due to a low response rate in the focal observation classrooms at Maxwell (less than 15%). At Talley, I included one more interviewee from the larger section (comprised of 48 students). Altogether I interviewed 20 students. Two interviewees dropped out before the end of the data collection period; one student transferred to another school, and the other stopped attending school toward the end of the school year.

<u>Observations</u>

The observation protocol helped to examine the opportunities that students had to engage in group activities, whole-class discussion, and reading and writing practices in science. It detailed instances of modeling inquiry practices by the teacher, and of students taking up these practices. I attempted to observe the interaction patterns of the classroom (between teachers and students and among students) to see where constraints to students' practices lay. My goal was to observe eight classroom sessions of the same lessons for all three teachers. However, this was not always possible (refer to the Proposed Observation Schedule in the Appendix A). I only observed Mrs. Foster's class at Linden three times during the enactment of this unit, due to her discomfort with the observations, and that she taught only a few parts of the unit (particularly the sections on physical and chemical properties, scientific explanations, and chemical reactions). She stopped using the curriculum after about Lesson 7, which focused on chemical reactions. I was only able to observe Mrs. Robinson's class at Talley a total of seven times. However, I observed similar lessons from all of the teachers for analysis. I recorded what was occurring at each school socially, academically, and logistically. This included general observations about the class and school climate, the number of students present, and recordings of my own thoughts after an observation. At times, I asked students about the activities in which they were participating.

My goal was to capture the enacted curriculum, the discourse styles of teachers and students, students' thoughts about what they have learned, and selected student interactions in groups. I created classroom field notes from my handwritten or typewritten notes taken during each classroom period, and elaborated the field notes using audio or videotape of classroom interactions. I elaborated field notes as close to the day of classroom observation as possible, to depict the events of the day and allow me to ask questions of students and teachers as close to the enactment as possible. I audio taped every observation using a digital tape recorder, but videotaped only selected ones. I found that videotaping distracted students and teachers. I never videotaped Mrs. Foster's class because she expressed her discomfort with videotaping. Please note, however, that I only used these data in reporting the context of the study, and for validation of patterns found in other data sources.

Survey

I used portions of the Adolescent Literacy Development (ALD) Survey (Moje et al., 2004b) to collect data about students' activities in and out of school, identity variables (self-beliefs about racial beliefs, gender, and academics), achievement motivation, and beliefs about science in particular. The full survey instrument is included as Appendix B. The ALD survey, was a two-part, large-scale survey designed to capture students in-school literacy practices and motivation to learn English, math, science, and social studies. It also examined the activities, beliefs, and literacy practices of students related to their outside of school time.

I administered the survey electronically to over 250 students using laptops for each individual student. I administered an abbreviated version of the in-school portion of the survey that had 73 items about students' attitudes about science and literacy practices within the content area of science only. Table 3.5 includes sample items from the in-school survey. The out-of-school portion of the ALD survey had 157 items that asked students questions about their activities, reading and writing practices, and identities.

Table 3.5 – Selected In-School Survey Items

Item	Scale
• How much do you LIKE doing Science? • In general, how USEFUL is what you learn in Science? • How GOOD at Science are you? • How USEFUL is what you learn in Science, compared with your other subjects at school? • Compared to other schoolwork, how IMPORTANT is it to be good at Science?	1 = not at all 7 = a lot or very GOOD, USEFUL, or IMPORTANT
• How often do you read textbooks? • How often do you read graphs, charts, and tables? • How OFTEN in Science class do you have class discussions that are meaningful to you? • How OFTEN in Science class do you see or hear examples that are interesting to you? • How OFTEN in Science class do you learn things that help you with your everyday life?	1=never, 2= once, 3= once/month, 4= every other week, 5= every week, 6= 2-3 times/week, 7= everyday
• In Science class how much do you LIKE reading books, stories, or poems? • How USEFUL is learning new Science vocabulary for helping you to UNDERSTAND Science? • How DIFFICULT do you find it to understand other Science related texts (magazines, handouts, new articles) your teacher gives you to read?	1 = not at all 7 = like or understand a lot or very good, useful, or difficult

Table 3.6 -- Selected Out of-School Survey Items 2006

Item	Scale
• hang out with friends (how often outside school last month) • family activities (watch TV, play games, go places) (how often outside school last month) • write for pleasure (how often outside school last month) • read for pleasure (how often outside school last month) • play or sing music (band, choir, play instrument) (how often outside school last month) • participate in school clubs (how often outside school last month) • Music (how often watched on TV last month) • History, science, autobiography, tech (how often watched on TV last month) • Sports (how often watched on TV last month) • Letters, notes from other people (how often read outside school last month) • Email (how often read outside school last month)	1=never, 2= once, 3= once per month, 4= every other week, 5= every week, 6= 2-3 times per week, 7= everyday
• Your friends (how much it affects what you choose to read) • your family (how much it affects what you choose to read) • how well you read (how much it affects what you choose to read) • how well you write (how much it affects what you choose to read) • how long it is (how much it affects what you choose to read) • whether you are male or female (how much it affects what you choose to read) • your race or ethnicity (how much it affects what you choose to read)	1 = not at all 7 = a lot
• What is your favorite class? • What is your least favorite class? • What kind of job would you like to have when you are 25 years old? • People can't always get the job they would most like. What job do you think you will really have when you are 25?	Open-Ended Questions

There were also open-ended questions about students' race/ethnicity, future aspirations, and favorite and least favorite books and classes. Table 3.6 includes sample items from both the out of school and open-ended portions of the survey.

Reading Diagnostic

The SARA Battery was a computerized reading diagnostic designed in conjunction with the Educational Testing Service (ETS) for the study of fluency, word, recognition and main idea among adolescent readers (Cleveland-Solomon, van de Kerkof, & Moje, 2010; Textual Tools Study Project, 2006). The diagnostic was used in this dissertation only to describe students' reading of science texts, and was not used in the regression analyses discussed in this dissertation. I only briefly summarize the diagnostic here.

The diagnostic used actual vocabulary and two texts that students in the reform project encountered in the 7th-grade science curriculum. I used the reading diagnostic as a baseline assessment given at the beginning of the study to determine how students interacted with scientific and non-scientific texts, recognized words, and with what degree of fluency they read different text types. The word recognition score was a measure of the number of words read correctly out of 37 words read. The main idea score was a mean measure of students' ability to make inferences about the main idea of the three texts. I scored the responses to the main idea questions for the three texts along with another graduate student. We utilized the rubric developed by the ALD Project (Russell, Cleveland-Solomon, Stockdill, 2008). The rubric evaluated the degree of inference and detail that students used when expressing the main idea. We maintained a raw interrater reliability of 79.3%.

I include the scores for the word recognition and combined main idea scores in Table 3.7 on the next page. On average, most students made incomplete inferences from the three texts read, and were able to recognize at least 30 of the 37 vocabulary words given. There were statistically significant differences between students at the other two schools for word recognition (t=-4.51, p<.001) and main idea (t=-2.35, p<.05). Students at Linden had the lowest scores on both measures and there was more variation in their

Table 3.7– Reading Diagnostic Scores

School	Main Idea[+] (N=59[x])	Word Recognition[+] (N=80)
Maxwell	2.04 (.611)	31.2 (3.46)
Linden	1.86 (.997)	30.3 (3.91)
Talley	2.42 (.698)	33.9 (2.26)
Average	2.25 (.735)	32.3 (3.38)

[+] Statistically significant differences exist between Talley students and those at the other two schools on word recognition ($t=-4.51$, $p<.001$) and on main idea ($t=-2.35$, $p<.05$).

[x]There were 21 students who did not respond to the open-ended items. I administered the diagnostic only once, thus I was not able to capture as many students as the pretest and survey.

responses as shown by higher standard deviations. These scores were used only in missing data analysis and to characterize the students' in the sample on various measures.

Science Pretest

I used the pretest to choose interviewees and to characterize the sample in the missing data analysis. Songer (2006) defined scientific inquiry as the knowledge and complex reasoning developed through authentic science activities and contexts. In this study, the unit pretest for the curriculum unit observed, *How Can I Make New Stuff from Old Stuff*, tested students' declarative content knowledge and complex reasoning with regard to the properties of substances, chemical reactions and conservation of mass. I scored the multiple-choice items as either correct or incorrect by SCANTRON, and the written responses along with two other research assistants using a rubric that employed Toulmin's (1958) argument theory. We attained 90% agreement using the rubric, and conferred on the other responses until we reached consensus. I used a total score from the pretest comprised of the number of correct items on the declarative content knowledge from the multiple-choice items, and the scientific inquiry reasoning from the open-ended items. Table 3.8 reports the pretest scores across the three schools, showing that students at Talley Academy performed the best on both science knowledge and inquiry reasoning items, and that students at Maxwell performed the worst on science knowledge but students at Maxwell and Linden performed similarly on the open-ended items measuring inquiry reasoning.

Table 3.8 – Science Pretest Scores

School	Science Knowledge (N=106)	Science Reasoning (N=75*)
Maxwell	3.40 (1.59)	4.08 (2.69)
Linden	5.06 (1.85)	4.05 (2.14)
Talley	6.21 (2.16)	6.57 (3.70)
Average	4.92 (2.20)	5.18 (3.28)

* There were 15 possible points from which they could score on each part of the test. There were 31 students who did not respond to the open-ended items. Most students were able to complete the first reasoning item. Many left the rest of the items blank.

Interview Protocols

I collected data via three interviews designed to get at different aspects of students' identities and their intersections. I investigated students' science cultural models that shaped their identities through questions about their perceptions of who they were as students in general, what activities comprised scientific activity, their judgments of how others viewed them as science students, and how they viewed their peers as science students. I also asked questions adapted from Stake & Mares (2005) and Stake & Nickens (2005), which try to uncover gendered cultural models through descriptions of what they believed scientists looked like, and the ways students' peer relationships and the encouragement and support they received from significant others affected their engagement in science.

I asked questions to find out how students think about educational and occupational opportunities available to them based on questions adapted from O'Connor

(1999) and Graham & Taylor (2002), which examined how students' awareness of the opportunity structure affected their aspirations and conceptions of who they can be. I attempted to elicit social class and peer- cultural models through an excerpt of Ben Carson's (1990) biography that discusses some of the issues he had growing up poor. Carson is a famous Black neurosurgeon who attended similar schools and lived in similar neighborhoods as many students in this study. I piloted questions with a student who was in the same grade as students in the survey.

Quantitative Analysis

Data Reduction: Principal Components

I employed principal components analysis as a form of data reduction, and as a way to form composite variables. Principal components analysis reduces the number of independent variables in an explanatory model to a smaller number, resulting in a more parsimonious model that combines variables that measure similar phenomena. The components created are essentially linear combinations of the unique and common underlying threads among variable constructs (Kim and Mueller, 1978). Principal components analysis assumes that variables are linear and that the components formed maximize the total variance in the group of variables. One advantage of using principal components analysis is that it allows researchers to see underlying similarities in sets of indicators. Another advantage is that principle components are more reliable than individual items.

I created the achievement motivation variables used as outcomes in the regression by creating composite variables for utility value and intrinsic value for science (reported in Table 3.9 with their reliabilities). Perceived ability in science had only two variables to combine; therefore, I report its bivariate correlation in Table 3.9. These variables originate in the Expectancy-value Theory of Eccles and colleagues (Wigfield & Eccles, 2002).

Table 3.9 – Motivation Variables

Variable	Definition	(Crohnbach's Alpha) or Pearson Correlation	Eigenvalues
Self Concept-of Ability in Science	How *good* students believe they are in science.	r=.422	N/A
Intrinsic Value of Science	How much students *like* science.	.797	2.15
Utility Value of Science	How *useful* science is to the students.	.698	1.87

A drawback of using the principal components for science in general is that there were fewer items in the survey that captured them, which means that there is less variance available to explain each construct as suggested by the eigenvalues reported in Table 3.9. By convention, principal components with eigenvalues greater than 1 are acceptable to interpret (Kline, 2005). For example, there are three items available for both intrinsic and utility value. Intrinsic value has an eigenvalue of 2.15 and utility value has an eigenvalue of 1.87. There is less explanatory power in the construct for utility value, which explains 1.87 out of 3 or 62.3% of the variance. The construct I created for intrinsic value explains 2.15 out of 3 or 71.7% of the variance. That said, I put forth the caveat that I interpret the results presented in Chapter 4 from principal components like the motivation to learn science and others with lower eigenvalues with caution.

I used dichotomous measures of gender and school attended as indicator measures of identity in this study. I acknowledge that the dummy variable for gender can provide some indication of differences between male and females in this study, but cannot describe what these differences *mean* to them. Likewise, the variable indicating the school attended by students in the 2005-2006 school year can serve to highlight the existence of contextual differences among students at the three schools, but cannot explain the complexities of these differences or what students' perceptions of them may have been. The missing data analysis in the next section provides the first glimpse of the types of interpretations that can be made using the school context variable. I also used this variable in regressions and analyses of variance. In the rest of the study, I used interview and observation data in conjunction with survey data to understand more about the three school contexts.

I also developed a factor based on students' perceptions of the frequency that they engaged in meaningful science activities based on previous research that suggests the nature of the science activities themselves influences students' intrinsic and utility value for science (Mac Iver et al., 2002). I created a component of racial/ethnic identity from a set of measures derived from theories that posit this construct as a multidimensional construct that affects the ways in which individuals are socialized to think of their racial/ethnic group (cf., Brown & Krishnakumar, 2007; Sellers et al., 1998). Principal components analysis yielded one component that reflected both Sellers et. al.'s notion of centrality (how important race group membership is to the individual) and private regard (pride in race group membership)[9]. Table 3.10 presents the meaningful activity and racial identity items that composed these component variables.

Table 3.10 – Perceptions of Science Activities and Racial Identity Variables

Variables	Items	Reliability (Crohnbach's Alpha)	Eigenvalues
Centrality & Private Regard or the Importance of & Pride in One's Racial/Ethnic Group	• How important is it for you to know about your racial/ethnic background? • How proud are you of your racial/ethnic background? • I have a strong sense of belonging to my own racial/ethnic group. • I am happy that I am a member of the racial/ethnic group I belong to.	.692	1.838
Students' Perceptions of the Frequency with which They Engaged in Meaningful Science Activities	• Frequency students felt they engaged in meaningful discussions • Learned things important to their everyday lives • Heard interesting examples in science class	.864	2.692

9 I use this variable in this analysis acknowledging that in studies like Sellers et al., centrality and private regard did not load together in factor analyses, but represent two distinct variables. This may make interpretation of my findings somewhat different than their work.

Missing Data Analysis

The nature of the school contexts in high-poverty school districts is that they are unpredictable: frequent teacher absences and use of substitutes, frequent public announcements and visits from administrators that interrupt classroom enactments, high levels of student attrition, and frequent student absence. In this study, I took several measures to maintain the integrity of the data. However, missing data were still a problem in this dataset because there were 138 consented students (a relatively small sample). For some variables, as much as 47% of the data were missing. Table 3.11 lists some of the variables in the dataset and the percentage of missing data in each.

Because of the problems with missing data, I decided to conduct missing data analysis. Missing data analysis allows one to determine whether data are missing completely at random or whether there are relationships between measures with data

Table 3.11 – Percent Missing Data by Variable

Variable	N Observed	% Missing
Word Recognition Score [a]	101	25.2%
Main Idea Score [b]	72	46.7%
Science Content Score (Pretest) [c]	106	21.5%
Science Reasoning Score (Pretest) [d]	94	30.4%
Self-Concept of Ability in Science [f]	103	23.7%
Race Centrality & Private Regard [e]	119	11.9%

a. Measure part of the SARA Reading diagnostic
b. Measure part of the SARA reading diagnostic – fewer students responded to these questions that asked students the main idea and what they found interesting and challenging in the passages
c. Science pretest multiple choice items
d. Science pretest – open-ended responses, fewer students responded to these questions
e. ALD survey out-of-school items
f. ALD survey in-school, science-related items

present and those with missing values. If data are missing completely at random, it means “there must be no relationship between missingness on a particular variable and the values of that variable” (Allison, 2002, p.4). If no systematic differences exist between populations missing data and those not missing data for a particular variable, it is possible that data were missing at random. In this section, I address the following questions: (1) How serious is the problem with the missing data? (2) What are the patterns between cases that are missing data on outcome variables and those that are not? (3) How might missing data affect the analysis of this dataset? In particular, I determine whether there were significant differences by gender and by school on the science motivation and instruction variables between early adolescents who have missing data on these measures and those who do not. I present the findings from this analysis along with discussion about the implications of the non-randomness of the missing data. I then draw conclusions from analysis about the impact of missing values on my data set.

I used none of the data in the quantitative analyses missing more than 23.7% of their values. I drew all of the dependent variables in this study from the in-school science portion of the survey and conducted the missing data analysis only on those continuous variables (self-concept of ability in science, utility value, and intrinsic value – all missing 23.7% of their values). I initiated the missing data analysis by using a method called dummy variable adjustment. This method required that I create new variables by dividing each of the continuous variables into dummy variables: missing cases and not missing cases. For example, I created a dummy variable named MISSCA in which I coded all cases missing data for self-concept of ability a “1” and those not missing data a “0.” In this way, I obtained two independent samples within self-concept of ability: missing and not missing cases.

I used cross-tabulations to compare differences between the two populations (missing and available cases on the outcome variables) by school and gender. Tables 3.12-3.15 display these results. There were no statistically significant differences in missing and not missing populations by gender. When examining missing data on science variables by school, I found statistically significant differences that indicate that data were not missing completely at random. Almost 45% of the students at Linden were missing data on these outcomes. One possible explanation for this is that one section of Linden students had a lunch period that split their science class in two. Some students may not have finished the science portion of the survey (the in-school survey), which was administered last. This can be seen in that only 103 consented students had values for science items and 119 consented students had values for the in-school survey items (refer to Table

Table 3.12 – Crosstabulation of Missing Values on Self- Science **Motivation & Instruction Variables by Gender**

Missing Values on Science Motivation & Instruction Variables	Gender		χ^2
	Males+	Females+	
Yes	23.2% (1.0)	25.9% (1.0)	.130
No	76.8% (1.0)	74.1% (1.0)	

+ Degrees of freedom are included in parenthesis.
~=p≤.10, *=p≤.05, **=p≤.01, ***=p≤.001

Table 3.13 – Crosstabulation of Missing Values on Science Motivation & Instruction Variables by Attendance at Maxwell Academy in the 2005-2006 School Year

Missing Values on Science Motivation & Instruction Variables	School		χ^2
	Non-Maxwell Academy Students+	Maxwell Academy Students+	
Yes	31.0% (1.0)	15.1% (1.0)	4.38*
No	69.0% (1.0)	84.9% (1.0)	

+ Degrees of freedom are included in parenthesis.
~=p≤.10, *=p≤.05, **=p≤.01, ***=p≤.001

Table 3.14 – Crosstabulation of Missing Values on Motivation & Instruction Variables by Attendance at Linden Middle School in the 2005-2006 School Year

Missing Values on Science Motivation & Instruction Variables	School		χ^2
	Non-Linden Middle School Students+	Linden Middle School Students+	
Yes	17.2% (1.0)	44.7% (1.0)	11.2**
No	82.8% (1.0)	55.3% (1.0)	

+ Degrees of freedom are included in parenthesis.
~=p≤.10, *=p≤.05, **=p≤.01, ***=p≤.001

Table 3.15– Crosstabulation of Missing Values on Motivation & Instruction Variables by Attendance at Talley Middle School in the 2005-2006 School Year

Missing Values on Science Motivation & Instruction Variables	School		χ^2
	Non-Talley Middle School Students+	Talley Middle School Students+	
Yes	27.5% (1.0)	19.6% (1.0)	11.2**
No	72.5% (1.0)	80.4% (1.0)	

+ Degrees of freedom are included in parenthesis.
~=p≤.10, *=p≤.05, **=p≤.01, ***=p≤.001

3.11). Although I provided two opportunities for students to take and finish the survey, some may have been absent the second time, or chose not to finish the survey.

At Talley where students had an uninterrupted block of time for science, only 15% were missing data on science-related variables. Almost 20% of the students at Maxwell were missing data on these measures, just slightly more than at Talley. Like Linden, one section at Maxwell had a split lunch period. However, I drew participants from 5 sections at Maxwell, which may explain why the number of missing cases is closer to what was seen at Talley than at Linden. There were only two sections at Linden. We used two survey administration dates to counter this, but the interrupted time block may account for why so many students at Linden were missing data on these variables.

These findings indicate that data collection differed by school, which may influence the interpretation of the results. Moreover, these data suggest that the Linden data might overstate affects because of the number of missing cases. For these reasons, Linden data must be interpreted with caution. For this reason, I attempt to use qualitative data across schools to complicate the picture of the environments of students' science learning in an effort not to bias the interpretation of data by school. I report these results in Chapters 4 and 5.

As another part of the missing data analysis, I used two-tailed t-tests (independent sample t-test) to compare the means of the continuous variables for cases missing data on the outcome variables and those for which data was available. I used two-tailed hypothesis testing in lieu of other techniques because the population standard deviations are unknown, the missing and available data represent independent samples, and because this test is approximately correct for normal distributions (Weiss, 1999).

Table 3.16 displays the results of these t-tests. There were no statistically significant differences between youth in this study who were missing data on science-related variables and those who were not in their science pretest scores and main idea scores on the reading diagnostic. There were also no differences in the types of print media they read. However, adolescents in this study who were missing data on science-related variables had lower word recognition scores (t=3.44, p<.01), lower centrality and private regard (t=2.10, p<.05), and read less popular culture communicative media such as email (t=1.67, p<.10). In other words, students that were missing data on the science motivation and instruction variables may had a harder time reading the survey items due to unfamiliarity or difficulty with the scientific vocabulary, placed less importance on and pride in their racial and ethnic group membership (centrality and private regard), and engaged less frequently with popular culture multimedia (which was marginally significant); these factors may have made students less able to participate in the computer-administered survey.

Table 3.16 – Independent Samples Test for Cases Missing Values on Science-Related Motivation and Instruction Variables

	Not Missing Data		**Missing Data**		
Variable Name	M	SD	M	SD	T
Word Recognition Score	32.3	3.38	24.4	10.3	3.44**
Centrality & Private Regard	.012	.94	-.530	1.38	2.10*
Frequency Read Pop Culture Communicative Media (e.g., email)	.063	1.00	-.350	0.86	1.67~

~p<.10, *p<.05, **p<.01, ***p<.001

However, there may be other reasons why students even when given an additional opportunity to complete the survey, may not have taken it. Some may not have been present during the second administration. For the others, I can conclude from the missing data analysis that there were some issues created during the data collection process that made it so that data were not missing at random in this study for the science motivation and instruction outcome variables. In particular, the computerized format of the survey may have posed some difficulty for students who may not have been as skilled at navigating computerized environments, and thus made it so they did not respond or participate fully. Furthermore, students who were missing data on the science motivation and instruction items had lower centrality and private regard, which may indicate that they may not have put as much emphasis on how they were perceived by others outside of their racial and ethnic group (such as those who may read and interpret their responses).

Regression Analysis Preparation

I tested the assumptions of linear regression with each model. Some of the assumptions of regression are that the (1) dependent variables have normal distributions; (2) there are relationships among the variables; (3) all variables in a regression are continuous or dichotomous and that the outcome variable is continuous; (4) there are no missing data used in the regression; and (5) residuals are homoscedastic.

To test these assumptions I reviewed the dependent variables' distributions via histograms, to determine normality and decide which variables needed transformation. I include histograms for self-concept of ability, utility value, and intrinsic value in the Appendix C. All of the dependent variables except self-concept of ability had approximately normal distributions. I used the ladder of powers (Tukey, 1977; Newton & Rudestam, 1999) to transform the self-concept of ability variable to approximate a normal distribution. The self-concept of ability variable has a negatively skewed distribution; per the ladder of powers, a negative skew can be improved by raising the variable to some power (e.g., via squaring, cubing). I transformed this variable by squaring it to obtain a more normal distribution. I then standardized each of the outcome variables for ease of comparison to the other continuous variable in the analysis.

I used correlations between variables to determine whether there were relationships among variables (as shown in Table 3.17). I created dichotomous variables out of variables measured on a Likert scale such as students' educational aspirations, to ensure I regressed only continuous and dichotomous variables. Because of the issues with missing data described in the previous section, I used pairwise case deletion to ensure that I used only those cases that had data available for all of the science motivation and instruction variables entered as dependent variables in the regression. Last, I evaluated the residuals from each regression model to ensure that the residual variance was constant or homoscedastic.

Hierarchical Multiple Regression

Hierarchical regression is theory-based, such that theory drives the choices for entering variables into the regression. In other words, each model tests a hypothesis. I chose to create hierarchical regression models to show where there were blocks of variables associated with different outcome variables. I did this in lieu of a path model or other complex quantitative models because I would need to have a larger sample size and/or effect size to incorporate more explanatory variables and relationships among them, *and* because I use qualitative data in tandem with the quantitative results to explain students' identity enactments in these classrooms.

I used theory to guide the construction of the hierarchical regression models. For instance, I used expectancy-value theory (Wigfield & Eccles, 2002) to determine the independent and dependent variables for the motivation variables of utility value, self-concept of ability, and intrinsic value. Researchers typically have used the values' variables associated with students' achievement and choices related to academic domains. In this study, I used the same independent variable for each regression model – one each for utility value, intrinsic value, and self-concept of ability. I ran hierarchical regressions on the data as a way to determine which variables helped to explain the variance in the expectancies and values explored. As the correlation matrix in Table 3.17 shows, there were correlations of high magnitude among the motivation variables.

Table 3.17 – Correlations for Regression Variables

	1	2	3	4	5	6	7	8
1. Female	1	.083	-.191	-.080	-.175	-.031	.029	-.108
2. Centrality & Private Regard*	.083	1	.256	.267	-.004	.044	.205	-.303
3. Intrinsic Value of Science *	-.191	.256	1	.624	.657	.448	.150	-.020
4. Utility Value of Science *	-.080	.267	.624	1	.624	.531	.039	.060
5. Self-Concept of Ability in Science*	-.175	-.004	.657	.497	1	.333	.229	.087
6. Perceived Frequency of Engaging Science Instruction*	-.031	.044	.448	.531	.333	1	.094	.189
7. Attendance at Talley Academy	.029	.205	.150	.039	.229	.094	1	-.432
8. Attendance at Linden Academy	-.108	-.303	-.020	.060	.087	.189	-.432	1

* All continuous variables converted to z-scores

Magnitude of Correlations (Absolute Values)
.1 -.3 small
.3- .5 medium
>.5 large

In each model, I determined the order of variable addition based on the hypothesis that there are aspects of identity such as racial identity (e.g., centrality and private regard), gender, and school attended that may have a small effect size. I hypothesized that the intersection of race and gender may positively relate to students' motivation to learn science. Several theorists who study intersectionality of race and gender beliefs in political science research use interaction terms to capture the influence of intersectionality on differences in the political beliefs between Black men and Black women, for example (e.g., Gay & Tate, 1998; Greenwood, 2008; Simien, 2005). One creates interaction terms by multiplying two variables together. Interaction terms help explain whether the effect of independent variable 1 on the outcome is different for different levels of independent variable 2. For example, I hypothesized that the effect of importance and meaning of race group membership on self-concept of ability in science may differ for African American male and female students.

In the political science work, researchers multiplied race and gender identity variables to create an interaction term. The interaction terms I created differ from those used in the political science research, in that only one of the variables used in the interaction is an identity variable. In this case, I multiplied race identity with a gender indicator variable – not a variable that specifically asks about individuals' subjective beliefs *about* their gender. For each regression model, I tested all of the possible interactions, to determine if there were interactions that I did not anticipate in addition to the racial beliefs and gender interaction I hypothesized. One determines the number of possible interactions in a regression model by the following formula: $k(k+1)/2$, where k is the number of independent variables in the model. In Chapter 4, I report the results of these analyses.

Qualitative Analysis

Content Analysis

I applied content analysis to interview and open-ended survey data in Chapter 4. Content analysis is "any technique for making inferences by objectively and systematically identifying specified characteristics of messages" (Holsti, 1969, p. 14, quoted in Bazeley, 2003). I provide one example to outline my approach to content analysis. When I analyzed students' open-ended responses about their favorite classes, I created an Excel spreadsheet with every consented students' response along with the school they attended, their gender, and their student identification number. I first went through creating variables for subject matter categories such as math, English, science, social studies, and electives. Because course titles differed across schools, I grouped reading and language arts classes with English, and courses such as civics with social studies. For classes students stated as favorite, I gave students a score of '1,' and zeroes for the classes that they did not mention. When students chose more than one class, I gave them a '1' for each. In essence, I created dichotomous variables from which I could determine descriptive statistics from frequencies; I could then use them in analyses such as regressions and analyses of variance if I so chose. There was also an open-ended item asking students why they chose a class as favorite. I went through students' responses, and wrote down codes that emerged. As with the class item I just described, I then created dichotomous variables for each reason category such as 'teacher,' or 'learned something,' such that I gave students a '1' if they stated a specific reason and a zero if they did not. This allowed me to determine which reasons were given most frequently by school attended and by gender, for example.

Constant Comparative Analysis

I employed constant comparative analysis for the analyses in Chapters 4 and 5 (CCA, Strauss, 1987; Strauss and Corbin, 1998), which Charmaz (2000) describes as "(a) comparing different people (such as their views, situations, actions, accounts, and experiences), (b) comparing data from the same individuals with themselves at different points of time, (c) comparing incident with incident, (d) comparing data with category, and (e) comparing a category with other categories" (p. 515). My goal in making comparison of individuals by categories and across data sources was to first understand then render the local meanings of students in the various data sources. I attempted to get at their meanings and examine their responses. To do this I coded the initial categories and subcategories seen across individuals using in the first stage of CCA, open coding. For example, I initially saw many patterns in students' talk in interviews related to science, scientists, and science practices (e.g., descriptions of science-like activities), definitions of being good science students vs. good students in general, future educational and occupational opportunities, and use of available resources (both social and cultural). In the next stage of coding, axial coding, I compared codes to each other, looking for areas of redundancy, consistency and inconsistency; I also had two senior graduate students experienced with qualitative research review the data to determine which types of codes emerged as a way to validate the consistency of these codes. Through this process, I was able to determine consistent codes and identify new ones before engaging in the last stage of coding, selective coding.

I reduced the initial categories down to three main categories due to some codes being redundant or subsumed within another category. These three categories were making stereotypes related to science, students' beliefs about the nature of science, and beliefs that transcend the subject of science (e.g., school in general, success, peers, everyday life, and future careers). I then tested these codes through the last stage of coding, selective coding, in which I created spreadsheets for each category, looking for instances of each across data sources. On these three spreadsheets, I recorded all of the exemplars of confirming and disconfirming data for each property or subcategory. I then wrote interpretive commentary next to each exemplar as to why it fit this pattern or not.

From the spreadsheets, I started a key linkages chart, introduced earlier in this chapter. Throughout the coding process, I developed short memos, connecting the patterns seen with relevant theoretical and empirical literature in science education and beyond. This was an iterative process, through which I revised the key linkages chart several times, sorted through data exemplars, wrote interpretive commentary, then revised or wrote new theoretical memos. In Chapters 4 and 5, I present the findings as seen in the key linkages chart.

Chapter 4 – CULTURAL MODELS OF SELF-AS-SCIENCE STUDENT

In this chapter, I used both survey and interview data to answer the first research question used to guide this research: ***What are the beliefs of African American middle-school students about the domain of science in general and about themselves in relation to science?***

The beliefs in particular that I interrogated were students' motivational beliefs within the domain of science. In survey studies of students' achievement motivation, direct relationships have been found between students' family background and previous experiences in an academic subject and their motivation to learn that subject area. In this dissertation I argue that there may be other factors, which may be less direct, related to the context in which they were learning the subject in question. Moreover, to adequately measure the influence of these factors on students' motivation, non-survey methods are required in addition to survey methods.

I present the findings in Chapters 4 and 5 that answer both research questions in the form of one main assertion, shown in Figure 4.1, which represents patterns that emerged from analysis of multiple-choice survey items, open-ended survey items, interviews, and short-term classroom observations. I address the first part of the main assertion in this chapter, and the remainder in Chapter 5, in which I also answer the second research question. Specifically, in this chapter I address my assertion that: *Social context, gender, racial identity, and relevance of the science activities matter in motivation to learn science.*

These factors matter because they are part of the cultural models of science that students hold of science and being students. As reviewed in the theoretical framework, Gee (1999) defined cultural models as views of the world or of particular activities or people that frame what counts as an appropriate performance, behavior, or attribute for a

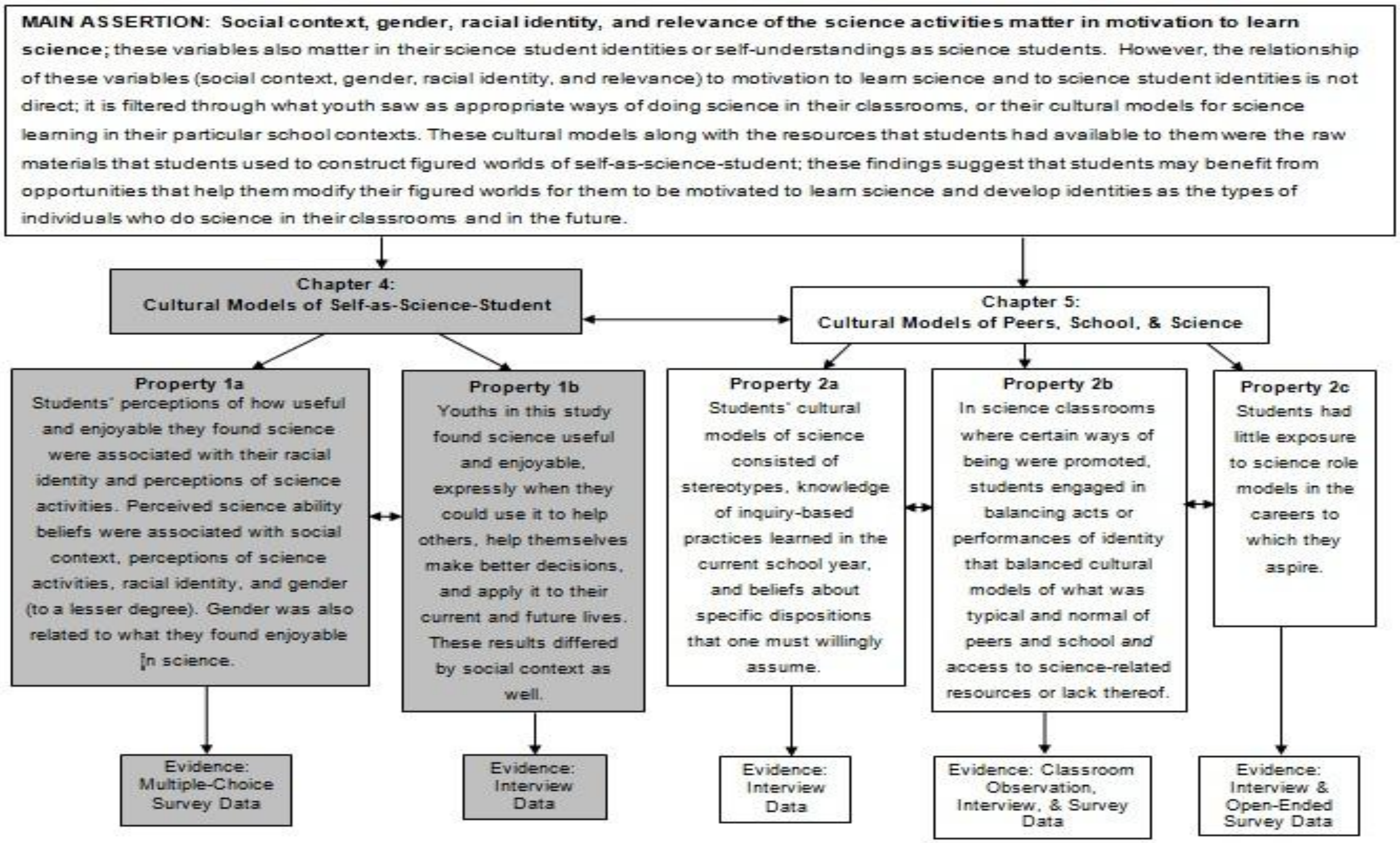

Figure 4.1– Key Linkages Chart for Chapter 4[10]

[10] The portion of the main assertion addressed in Chapter 4 is in bold text.

given activity in a given context. Cultural models help us to espouse our positions relative to others, evaluate ourselves and others as typical, appropriate, and normal, and provide examples or models that we can use to act or respond in various situations; they also these serve as motivation for various actions and behaviors (D'Andrade,1992). In the case of youths' cultural models of self-as-science student, they provided information about what was deemed appropriate for good students and, in particular, good science students. They also provided some information about what they might likely be motivated to do and imagine as possible for themselves in relation to science. Patterns related to multiple cultural models emerged from analysis of survey and interview data. Figure 4.1 displays the key linkages chart that shows the main assertion, and the ways in which the ideas within it connect to one another, and the types of data that I use to support each part of the assertion. I have divided the findings in this chapter into two sections, one in which I present survey analyses and in the other, analysis of interview data as evidence.

To warrant the first claim embedded in the assertion, that social context, gender, racial identity, and relevance of science activities matter in students' motivation for science learning, I use the results of analysis of survey items and interview data to show that each of these variables had a statistically significant relationship to the motivation outcome variables examined in the survey. To begin, I describe the outcome variables used in the regressions, and then present descriptive statistics for the independent variables used.

Description of Multiple-Choice Survey Items

Table 4.1 lists the variables that measure students' achievement motivation in science. As defined in the theoretical framework, achievement motivation refers to issues of motivation in which one's competence is at issue; two types of variables – expectancies and values – are thought to comprise students' achievement motivation and taken together, they describe youths' identities as students in a domain. In this dissertation, I use as dependent variables an expectancy measure of students' conceptions of their ability to do well in science and two measures of value or the importance students placed on science in terms how enjoyable it is (intrinsic value) and how useful it is (utility value) to learn science. I include these measures because previous research has used them as independent variables associated with students' motivations to engage and persist in skilled tasks such as English and mathematics (Wigfield & Eccles, 2000; 2002), and recently researchers have developed similar measures in science (DeBacker & Nelson, 1999; Mac Iver et al., 2002). In the next section, I report the analysis of variance by school attended and perceptions of meaningful activities on students' motivational beliefs in science, as well as regression results. For a full description of the measures used, please refer to the methods chapter.

Table 4.1 – Motivational Beliefs' Variables

Variable	Definition
Self-Concept of Ability of Science	How *good* students believe they are in science
Intrinsic Value for Science	How much students *like* science
Utility Value for Science	How *useful* science is to the students.

Descriptive Statistics for Independent Variables used in the Regression Analysis

This study's sample represents the heterogeneity of African Americans in this country. Fifteen percent of students self-reported as mixed race/ethnicity (e.g., Black and Latino), and 2% were African, as indicated on a free response question regarding race and ethnicity. More than half of the population was female (59%). Talley students comprised almost 39% of the sample and students at Linden and Maxwell comprised 27% and 34% of the sample, respectively. Almost 18% of study participants aspired to a 4-year degree, almost 16% to a masters degree, and almost 53% to a terminal degree (MD, JD, or PhD).

Table 4.2 presents the descriptive statistics for the dichotomous independent variables used in the regression models. I controlled for school attended and gender, where school attended is used as an indicator of contextual differences across schools. For continuous independent variables, I measured the significance and meaning youth placed on their racial group membership (two components of racial identity from Sellers et al. 1998 multidimensional model of racial identity). Research has shown relationships between components of racial identity and students' achievement (Chavous et al, 2003). I also included a measure of students' perceptions of their science learning environment; a similar measure has been useful in understanding the relationship between motivational variables and students' achievement outcomes (Mac Iver et al., 2002). Please refer to the Chapter 3 for more details of the variables and methods used.

Table 4.2 – Descriptive Statistics of Variables Included in the Regressions (N=101)

Variable	Mean
%Females(a)	59.3
%Males	41.7
% Attended Talley Academy(b)	38.5
%Attended Linden Middle School(b)	27.4
%Attended Maxwell Middle School(b)	34.1
% Who Aspire to a Bachelors' Degree	17.8
% Who Aspire to a Masters' Degree	15.8
% Who Aspire to a MD, JD or PhD Degree	52.5

Testing the Strength of the Relationships Among Social Context, Gender, Racial Identity, Relevance of Activities, and Motivation to Learn Science

Regression analyses revealed that students' motivation to learn science was related to school attended, gender, their perceptions about the science activities, and by their racial identity. Tables 4.6-4.8 display the regressions of students' motivation to learn science or their expectancies (perceived ability in science) and values (intrinsic and utility value). All results are reported in terms of effect sizes[11].

Perceived Ability in Science

I started by testing the hypothesis that students' perceived ability in science would be associated with gender, the school context, racial identity, and perceptions of the science activities. I also hypothesized that there would be interactions due to gender

[11] Effect sizes used: >.2 small effect, >.5 medium effect, >.8 large effect (Cohen, 1988)

and/or race and other sociocultural factors, such as school attended. These results are reported in Table 4.3. There was an interaction between independent variables on youths'

Table 4.3 – Regression Findings: Perceived Ability in Science

	(A) Main Model[12]	(B) Interaction Model[2]
Female Students(a)	-.321~	-.339~
	(.188)	(.181)
Attendance at Talley Academy (b)	.533*	.575**
	(.210)	(.203)
Attendance at Linden Middle School (b)	.321	.371
	(.280)	(.271)
Perceptions of the Frequency Engaged in	.283**	.228*
Meaningful Science Activities in School (d)	(.097)	(.096)
Centrality & Private Regard (c)	-.021	-.033
	(.104)	(.100)
Interaction: Frequency Engaged in		.299**
Meaningful Science Activities in School X		(.103)
Centrality & Private Regard		
R-Square	.193	.259
	(.925)	(.891)

(a) Males are the uncoded comparison group.
(b) Attendance at Maxwell Middle School is the uncoded comparison group.
(c) Variables standardized for ease of comparison, mean =0, standard deviation=1.

perceived science ability. The main model (without the interaction term) explained 19.3% of the variance in perceived ability in science, with a medium-sized effect indicating that students at Talley Academy (the school of choice) had science ability perceptions that were .533 standard deviations higher than those of students at Maxwell. Perceived ability in science improved by .228 standard deviations with every unit increase in youths' perceptions of the frequency with which they engaged in meaningful activities. There was also a marginally significant but negative effect of students' gender (*ES*=-.321, $p<.10$), indicating that girls in this study had lower perceived ability in science than the boys did.

[12] The standard error of the estimate is enclosed in parenthesis.

The interaction model explained 6.6% more of the variance for perceived ability in science. There was an interaction effect on students' perceived ability in science between the frequency with which students felt they engaged in meaningful science

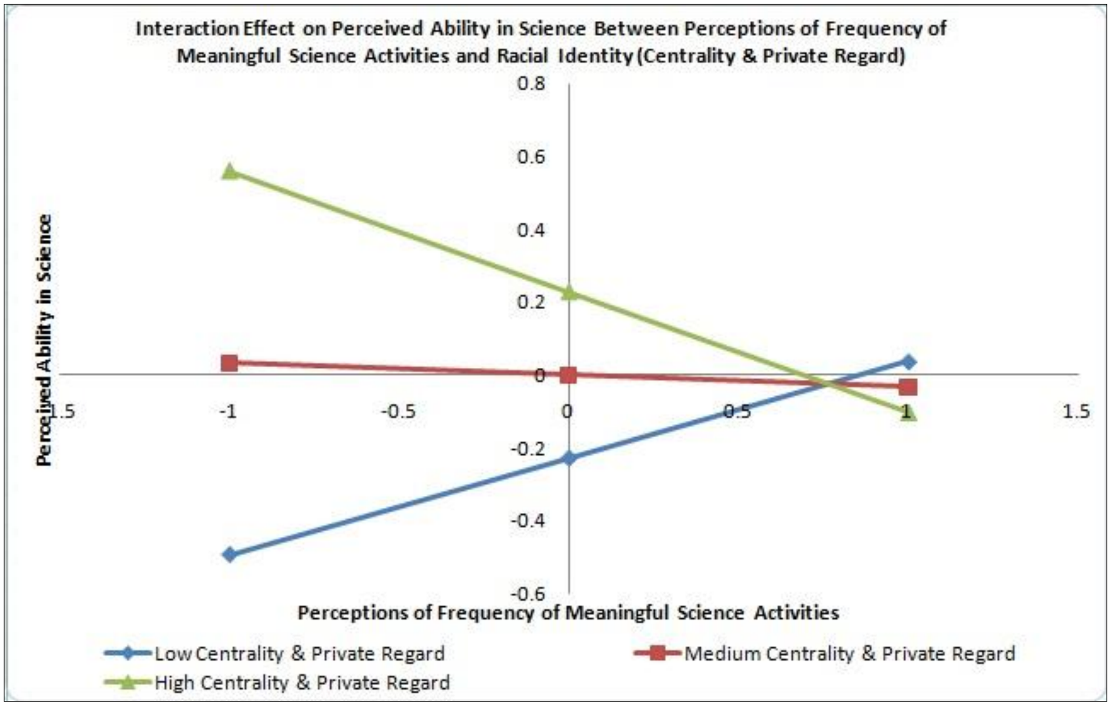

Figure 4.2 – Interaction Effect on Perceived Science Ability

activities and their racial identity (centrality and private regard). Figure 4.2 represents the magnitude and direction of the interaction on perceived ability in science between the frequency with which students felt they engaged in meaningful science activities and their racial identity. This graph illustrates that as students' perceptions that science was meaningful increased, the influence of students' centrality and private regard made less difference to their self-perceptions of ability in science. This is a particularly important finding, because centrality and private regard alone had no statistically significant relationship to perceived ability in science. I conclude from these data that if science is not meaningful for the African American students in this study, the degree of pride and importance they placed on their racial group membership was positively related to their self-perceptions as science students. This is an important finding that links to previous research on the racial identity of African American students, which has suggested that centrality and private regard can serve as protective factors or measures of resilience that mediate youths' ability to cope with risks such as racial discrimination and stressful situations (Sellers et al., 2003; Sellers et al., 2006). In this study, African American youth with higher centrality and private regard had higher perceived science ability even when they infrequently engaged in meaningful science activities. Because of the role that perceived ability has typically demonstrated in motivating academic performance within a domain (Wigfield & Eccles, 2002), the degree of exposure to meaningful science might be described as a risk factor for their development of motivation to learn science, and their subsequent academic performance in science. These data indicate that making school science more meaningful for students would increase their perceived ability in science, which may in turn have the potential influence their science achievement. These results lead me to ask additional questions. What did meaningful science look like for the students in this study? Why did the level of centrality and private regard matter to what they saw as meaningful in science?

These findings are complicated further when one also examines effects of school context in the interaction model. Students from Talley had higher perceived ability on average (*ES*=.575, $p<.01$). Even though engagement in meaningful science activities and racial identity were important, their interaction effect on students' perceptions of science ability was still smaller than that of school context. This raises important questions for further study: Why was school context such a big factor in these African American students' motivation to learn science when they had the same curriculum and reform initiative support across schools? How did school contextual conditions relate to the racial identities and the perceptions the young people in this study had about the frequency they were engaged in science activities?

To answer the question of whether racial identity and perceptions of the frequency of meaningful activity engagement in science differed by school in this study, I conducted analyses of variance with post hoc comparisons on both racial identity and youths' perceptions of science activity engagement, by school attended. Tables 4.4 - 4.6 show the results of these analyses. There were significant differences among schools by racial identity $F(2,98)=5.386$, $p<.01$, and by perceptions of the frequency of meaningful activities $F(2, 98)= 4.386$, $p<.05$. Although there were no interactions by school in this study, these data suggest that students' racial identity profiles and their perceptions of engagement in activities reflected the school attended.

Table 4.4 – Differences in Racial identity by School Attended (N=101)

Source		Sum of Squares	Df	Mean Square	F
Racial Identity	Within Groups	8.772	2	4.386	5.378**
	Between Groups	79.931	98	.816	
	Total	88.704	100		
Perceived Frequency Engaged in Meaningful Science Activities	Within Groups	7.276	2	3.638	3.905*
	Between Groups	91.297	98	.932	
	Total	98.572	100		

~p<.10, *p<.05, **p<.01, ***p<.001

Table 4.5 – Tukey HSD Comparison Racial identity by School Attended (N=101)

				95% Confidence Interval	
(I) School 1	(J) School 2	Mean Diff (I-J)	Std. Error	Lower Bound	Upper Bound
Maxwell	Linden	.633*	.255	.027	1.24
	Talley	-.172	.200	-.649	.305
Linden	Maxwell	-.633*	.255	-1.24	-.027
	Talley	-.805*	.247	-1.39	-.217
Talley	Maxwell	.172	.200	-.305	.649
	Linden	.805*	.247	.217	1.39

*p<.05

Table 4.6 – Tukey HSD Comparison Perceptions of Frequency Engaged in Meaningful Activities by School Attended (N=101)

(I) School 1	(J) School 2	Mean Diff (I-J)	Std. Error	95% Confidence Interval Lower Bound	Upper Bound
Maxwell	Linden	-.714*	.272	-1.36	-.066
	Talley	-.430	.214	-.940	.080
Linden	Maxwell	.714*	.272	.066	1.36
	Talley	.284	.264	-.344	.912
Talley	Maxwell	.430	.214	-.080	.940
	Linden	-.284	.264	-.912	.344

*p<.05

In particular, the data indicate that students at Linden had the lowest centrality and private regard or lowest resiliency in situations of risk, and students at Maxwell had the lowest perceptions of engagement in meaningful science. In other words, Linden students placed less importance on their race group membership and they had less racial pride than did students at Maxwell and Talley. Students at Maxwell perceived less frequent engagement in meaningful science activities than students at Linden did. Although Maxwell students frequently had exposure to more science instruction, they saw it as less meaningful than did students at Linden who received less of the project-based science curriculum than students at the other two schools. These findings suggests local differences in meaningful science experiences across schools, and something else – that based on the findings from the interaction, students at both Maxwell and Linden were at risk for lower motivation to learn science, specifically their perceived science ability. Maxwell students had higher race centrality and regard (which might buffer their perceptions of science ability in situations where science was less meaningful to students); and students at Linden had higher perceptions that science was meaningful, which would help them due to their lower race centrality and private regard. However, the common denominator for students in each context was the importance of perceptions of meaningfulness.

These results raise questions for future study such as: Is meaningfulness always local, and if it is, how do teachers interrogate what students find meaningful in their science classrooms? How do they then leverage this knowledge in science activities? Moreover, if this relationship between meaningfulness and racial identity existed in contexts where African American students were the majority group, what would the relationship look like for African American students in settings that were more mixed by race, or in which they constituted the minority?

Perceived Utility and Intrinsic Values for Science

I tested similar hypotheses in each regression model. Table 4.7 displays the regression results. There were no interaction effects on utility value, and no ststistically significant associations due to school context or gender. Students' perceptions of the science activities they had in school had the largest influence on how useful they saw science (ES=.517, p<.001). The measure of students' racial identity was the only other statistically significant independent variable positively associated with utility value (ES=.277, p<.01). These findings suggest that usefulness of science increased with increasing engagement in meaningful science activities and with increasing importance and pride in their racial group; these findings are congruent with those with those for perceived ability in science, suggesting that meaningful science activities and racial identity were important factors in students' motivation to learn science. This also makes sense, due to the substantial correlation between the dependent variables used in this motivation model; in this case the correlation between perceived utility value and perceived ability in science was .497.

Table 4.7 – Regression Findings: Perceived Utility Value of Science (N=101)

Variable	Main Model
Female Students	-.167
	(.166)
Attendance at Linden Middle School (b)	-.117
	(.185)
Attendance at Talley Academy (b)	.017
	(.247)
Perceptions of the Frequency Engaged in	.517***
Meaningful Science Activities in School (c)	(.086)
Centrality & Private Regard (c)	.277**
	(.092)
R-Square	.352
	(.814)

(a) Males are the uncoded comparison group.
(b) Attendance at Maxwell Middle School is the uncoded comparison group.
(c) Variables standardized for ease of comparison, mean=0, standard deviation=1.

Perceived Intrinsic Value for Science

I started with the same hypotheses as with the other two outcome variables. Table 4.8 presents the results. There were no statistically significant interaction terms. The main model explained 30.1% of the variance. There were small influences of students' perceptions of engagement in activities in their science classroom (*ES*=.439, *p*<.001), gender (*ES*=-.409, *p*<.05), and the importance and pride in their racial group (*ES*=.246, *p*<.05) on perceived intrinsic value for science. These findings are similar to those for the other two outcome variables. The perceived intrinsic value or enjoyment that students derived from science increased with more positive perceptions of the science activities and their racial identity. Large correlations existed between intrinsic value and both perceived science ability and utility value in science (*r*= .657 and .624, respectively). Unlike the other two variables, there was also a statistically significant, but negative association of gender on how enjoyable the young people in this study found science (*ES*=-.409, *p*<.05). Girls in this study had lower intrinsic value for science that the boys did. Personal identity variables (e.g., gender) have been associated with intrinsic value due to its measurement of tasks in which individuals enjoy engaging (Eccles, 2009). These findings raise questions about what meaningful activities look like, and signify that meaning or relevance is tied closely to students' race and gender in reference to intrinsic value.

Table 4.8 – Regression Findings: Perceived Intrinsic Value of Science

Variable	Main Model
Female Students (a)	-.409*
	(.175)
Attendance at Talley Academy (b)	.101
	(.195)
Attendance at Linden Middle School (b)	-.101
	(.261)
Perceptions of the Frequency Engaged in	.439***
Meaningful Science Activities in School (b)	(.090)
Centrality & Private Regard (b)	.246*
	(.097)
R-Square	.301
	(.859)

(a) Males are the uncoded comparison group.
(b) Attendance at Maxwell Middle School is the uncoded comparison group.
(c) Variables standardized for ease of comparison, mean =0, standard deviation=1.

<u>Discussion of Findings from Survey Analyses</u>

I hypothesized that gender, school context, racial identity, and students' perceptions of the frequency they engaged in meaningful activities would be associated with their motivation to learn science. School context had the largest association with perceived science ability, even across schools that had the same curricular supports. Students at Talley had higher perceived ability in science than students at Maxwell did. This may have been because students at Talley had the highest pretest scores and had more instructional time than students at the other two schools (as shown in the description of school contexts and in the missing data analysis in Chapter 3). Students at this school may have benefitted from many factors that caused them to have higher perceived ability including a stable school environment, parental and administrative support, as well as proven academic ability and positive academic experiences over time.

It may also be that the culture of Talley students was representative of what Neckerman, Carter, and Lee (1999) termed the "minority culture of mobility." Neckerman et al. defined the minority culture of mobility in similar ways as the cultural model construct used in the current study. In this model of mobility, middle-class or upwardly-mobile minorities leverage strategies and practices that help them "negotiate the competing demands of the White mainstream and minority community" (p. 949). Neckerman et al. also suggested that individuals that are working-class or poor have access to this model, depending "on social environment and personal biography" (p. 950). It is possible that students across the three schools shared this cultural model. However, Talley was a very selective school in this district, one in which students had to apply and compete against students from across the city for open slots. Having parents who were upwardly mobile may have provided Talley students educational advantages and access to the cultural model of mobility through both the resources of the school and their parents' social networks. It is also possible that if they held this cultural model of upward mobility, then they may have seen science as well as their other subjects as required for their college aspirations. In the next chapter, I discuss more about the ways that social class and mobility played out via analysis of interview and observation data.

Gender was a factor associated with students' intrinsic value for science or their enjoyment of science. Though there was no statistically significant association of gender on utility value, there were marginally significant findings for perceived science ability, and significant results for intrinsic value. The regression findings for perceived science ability and perceived intrinsic value indicated that girls in this study had lower perceived science ability and intrinsic value than the boys did. Several studies have found that girls had lower or declining attitudes toward science even when girls were active participants and had better grades than boys did (Andre et al., 1999; Catsambis, 1995; cf. Brotman & Moore, 2008 for a recent review of such studies in science education). Girls have also disidentified as the types of individuals who did science even when they admitted enjoying science (Carlone, 2003). Additionally, several studies in science education have studied the experiences of minority girls in particular, and have found that they were sometimes silenced in science classrooms (Barton, Tan, & Rivet, 2009; Brickhouse et al., 2000). More work is needed to understand what the girls in this study required for personal enjoyment of science.

In addition to school context and gender, measures of youths' perceptions of how frequently they engaged in meaningful science activities and racial identity were positively related to all three variables measuring students' motivation to learn science.

As youths' perceptions that they engaged in meaningful science activities increased, their racial identity made less difference to their self-perceptions of science ability. In addition, perceptions of meaningfulness varied by school. This suggests that at schools where students had lower race centrality and private regard, self-perceptions of students' ability could be changed through the teaching of science they found meaningful. ANOVA results showed that context was related to meaningfulness, and suggested that it would be important for teachers to determine what meaningfulness signifies for African American students in each context. The interaction between perceptions of meaningfulness and racial identity on students' perceived science ability has implications for the development of science activities for African American students in different contexts, and raises questions for further qualitative investigation such as: What did students find meaningful in science, and what would a meaningful science activity look like for students in this study? Why is "meaningfulness" tied so closely to importance and pride in students' racial group and their perceptions of their ability to do well in science? These findings imply that we should not assume that meaningfulness is the same among students of the same racial group; attention to a combination of factors could help improve students' motivation to learn science. This interaction between meaningfulness and racial identity was strong, and suggested that there were local differences in both racial identity and engagement in science activities, which must be accounted for in helping motivate students to learn science. It is not just enough to change science activities to be more interesting; educators must also understand who students are and what they believe in order to know what interesting and meaningful looks like for that particular group of students. Future work will need to understand what meaningfulness would look like for students in racially heterogeneous settings, and in settings where African American students are the racial minority.

For both utility and intrinsic value, the contribution of racial identity was smaller than that of their perceptions of science activities, but was statistically significant. Science utility value is the relative usefulness of science to current and future goals; these findings might be interpreted that students in this study needed to see the "payoff" in their learning of science for people belonging to their racial group in the short and long term. This relates to research about the achievement paradox of Black students

(Mickelson, 1990), in that they have high motivations, but lower outcomes because of their awareness of the prospects for adults in their communities. The fact that utility value was associated with both racial identity and activity engagement might also be reflective of students feeling that the science they had was not reflective of what they saw themselves doing in their everyday lives, currently or in the future (Basu & Barton, 2007).

Science intrinsic value is defined as the relative enjoyment of a science task to the individual; the fact that their perceptions of the frequency with which they engaged in meaningful science was an important independent variable in the regression model for intrinsic value indicated that students needed to understand the relevance of science to their lives in order to derive personal enjoyment from it. In essence, these multiple-choice survey results suggest a relationship between engagement in meaningful activities and students' racial identities; these findings, however, did not explain what this relationship may have been for students. In the next section, I introduce findings from interview data that complement this survey data and serve to paint a picture of what meaningfulness in science looked like for the urban African American students in this study.

I argue that the interview data will help to convey what meaningfulness or relevance meant to students, because these data explain in the students' words what things they liked and found useful about science, and provide insight into the relationship between the meaningfulness of the activities and their identities as science students. This explication of the content of students' motivation to learn science is another contribution this dissertation makes. Their perceptions of their ability in science and of what they found useful and enjoyable, paired with interview data, suggest the cultural model that may be mediating what students imagine as possible for themselves in relation to science.

What was meaningful or relevant for students in science?

Descriptions of Interview and Open-Ended Survey Questions Used

In addition to multiple-choice survey items, I looked across open-ended survey items and interview questions for patterns related to motivation for science learning. I asked questions about students' intrinsic and utility values for science. The questions are not identical to those from the multiple-choice survey, but tap into what students liked or enjoyed (intrinsic value) and found useful (utility value) about science that year. I also asked questions in the open-ended survey about which class was students favorite, tapping into what they liked about the subjects that they chose. I acknowledge that the interview questions for usefulness and enjoyment may be considered biased, in that they did not first require that students answer whether they found science useful or enjoyable. The ideal situation would be to ask the same questions in interview and survey items. However, students in this study were interviewed *after* completing surveys (refer to Table 3.5 on p. 74) in which they answered questions such as: How much do you LIKE doing Science (enjoyment)? In general, how USEFUL is what you learn in Science? How USEFUL is what you learn in Science, compared with your other subjects at school? These questions were measured on a Likert scale from not at all to a lot or very useful. This is not the ideal situation, but there is data in this study that shows that students did indeed find science useful and enjoyable on average.[13]

I summarize their responses by the findings for utility and intrinsic value in the sections to follow. I include the interview and open-ended survey questions in the textbox below. For the full text of the survey and interview protocol, see Appendices C and D. Refer to Chapter 3 for a more detailed description of the analyses employed here.

[13] Survey findings suggest that on average, youth in this study found science enjoyable and useful, and have median perceptions of their abilities to do science that are 5 out of 7 on average (as measured on a Likert scale). I include means and medians for these variables in Appendix F.

Interview Questions:

- Has there ever been a time in science class this year when you've done something that you feel is useful in your everyday life? (*Usefulness*)
- Can you tell me about a time in science class this year that you learned something that you shared with someone not in your class like a brother, sister, parent or friend? (*Examples of when science was useful*)
- And how is the work in science class different than in your other classes? (*Enjoyment*)

Interview and Open-Ended Survey Questions:

- What is your favorite class and why? (*Enjoyment*)
- What is your least favorite class and why? (*Enjoyment*)

Perceived Utility Value for Science (Usefulness)

The interview data described *what youth found useful about science*. Table 4.9 summarizes the patterns found in analyses of interviews. Fourteen of the 19 interviewees found science useful if they learned concepts that (1) helped them make informed decisions, (2) helped others make informed decisions, (3) made them feel good about themselves because they felt that science was a difficult subject, and (4) helped them toward their future aspirations. For example, one student named Ashanti who attended Talley Academy felt that the science she learned that year was useful because learning about the properties of common materials such as lye and lard helped her make healthier food choices:

TCS[14]: Now tell me about a time in science class when you've done something that you feel is useful in your everyday life?

[14] TCS is the interviewer.

Ashanti[15]: I think the day that we had the experiment with lard and soap, what lard makes up. I cooked… My grandmother, she always used to cook with lard. And I was like 'oh what is that?' I finally know what that is, and so I would always [be] like, 'why do you cook with lard?' It gives you more fat [makes you fat]. I say no because I actually know what lard is now. That was some kind of animal. It doesn't really sit right with me [to eat lard now that I know what it is]. My grandmother, she still cooks with it, but I never eat anything that she cooks. So I just… that was one of the lessons that really helped me. [Ashanti, Interview#1, Talley Academy, Lines 168-175, May 23, 2006]

Table 4.9 – What Interviewees Found Useful about Science (N=19)

Value	N	Reasons interviewees gave
Science was useful if[+]:	14	They learned things: • that helped them make informed decisions • that helped others make informed decisions • that made them feel good about themselves because science is a difficult subject • that helped them toward their future aspirations

[+] Respondents were from all three schools; there were 8 girls and 6 boys in this category.

In another example, Jeremy, a student at Maxwell Middle School shared information that he learned in science that he found useful because he was able to help others make informed decisions:

TCS: So tell me about a time in science class when you have done something that you feel is useful in your everyday life?

Jeremy: When we watched the movie about what is in Metro Park, like the chemicals, the big old gas tank things. They put it in the Metro River and stuff like that. I never knew it was in there.

TCS: Now why do you think that is useful? Like what about that is useful to your everyday life?

[15] All names included herein are pseudonyms. All students had the opportunity to choose their own. Most preferred that I choose the pseudonyms.

Jeremy: Because sometimes when I go to Metro Park, my friends would be playing around the water and stuff, and its chemicals all in the water and stuff. And it's like getting in our body, and it's making us sick.

TCS: So what about that activity made it a good way for you to learn the science?

Jeremy: Cause when she [his science teacher, Mrs. Alexander] showed us the video in science, it told us like to not play in it [the water at Metro Park] or be all in it and stuff like that. Cause it look clean but it's not.

TCS: So you tell me about a time in science class this year that there was something that you learned that you shared with someone not in your class, like a brother, sister, parent or friend?

Jeremy: I think I told my mother and my brothers about the Metro Park.

TCS: Were they surprised too?

Jeremy: Yeah cause my momma, she used to be around there too sometimes [in Metro Park]. [Jeremy, Interview #1, Maxwell Middle School, Lines 186-202, May 11, 2006]

Perceived Intrinsic Value for Science (Enjoyment)

Open-ended survey and interview data provided insight into what students liked and disliked about science. Table 4.10 below summarizes the patterns that emerged from their hand-written survey responses. Only 12% or 13 of the 108 students who wrote a response chose science as their least favorite class; most students chose math or social studies. When students did not like science; they tended to find science difficult or boring. Their reasons seemed to differ by instructional context. Two of the 4 respondents from Linden who chose science as least favorite also said that they never did experiments, while students at the other two schools did not respond in this way. In the written responses, Talley students were the only group that mentioned not liking science because of the teacher. Three of the 4 respondents at Maxwell felt that science was difficult to understand. It is important to note that students' written responses were fairly short, and students did not always explain why they found science difficult.

Table 4.10 – Reasons Students Chose Science as Least Favorite in Open-Ended Survey Responses [16] (N=13/108)

Subject	Linden[17]	Maxwell	Talley
Difficult	1	3	1
Boring	2	1	2
Don't like Science	1	--	--
Don't Like Teacher	--	--	2

The interview findings, summarized in Table 4.11, supplement and extend the survey findings, and provide some explanation for the written responses; they also raise questions about the instructional environment in which students learned science. Only 21% or 4 of the 19 interviewees said that science was their favorite subject; they described liking science because they did experiments and learned new things. None of the 4 students were from Maxwell Middle School, suggesting that there may have been some specific factors related to the instructional environment that influenced Maxwell students' enjoyment of science. Only 16% or 3 of the 19 interviewees chose science as their least favorite class; all were from Maxwell. All three also stated that they disliked science because it was difficult, and gave different reasons for why they found science difficult. One male student said that the vocabulary terms were hard for him, and one female student discussed difficulties with the teacher's admonition for students to always follow her verbal directions over those included in the curricular materials. Last, another female student from Maxwell stated why she disliked science due to its lack of certainty:

TCS: And what is your least favorite subject in school?
Andrea: Science.
TCS: And what is it about science that you don't like?
Andrea: Science is hard, and then it's like we're trying to find out a lot of stuff [in our investigations] and then you don't know if what you're trying to find out is accurate or inaccurate. So that's why it's hard for me. [Andrea, Maxwell, Interview #1, Lines 27-33, June 1, 2006]

[16] Students also sometimes provided more than one reason for choosing a class as least favorite. I coded responses using students' words as much as possible, collapsing categories that had similar meanings. I include only the 4 most common responses here.

[17] Two students from Linden stated that they did experiments infrequently in their science class. Their teacher Mrs. Foster did not enact the full curriculum unit, only teaching a few of the lessons with students.

In exploring these three interviewees' descriptions of what they disliked about science, I am not asserting that all students in the study who disliked science felt as Andrea did; on the contrary, most students in this study disliked social studies and math more than they did science. What I am suggesting is that these were some explanations to take into consideration for the improvement of the experiences in inquiry-based science classrooms. These results, particularly the responses describing what students found useful and enjoyable about science, also suggest fruitful areas of future study and concentration in terms of curriculum and instruction.

Table 4.11 – What Interviewees Found Enjoyable about Science (N=19)

Value	N	Reasons interviewees gave
Science was enjoyable if*:	4	They did experiments They learned new things
Science was not enjoyable if^:	3	Science was difficult; it was difficult because of vocabulary, teacher authority/approach, and discomfort with uncertainty of scientific data.

* None of the students were from Maxwell; there were 3 girls and 1 boy in this category.
^ All 3 students were from Maxwell.

I closely examined students' interview and survey responses about what they did not enjoy about science. I take up each of these students' responses in turn. In the first interview response, the student spoke of difficulty with the vocabulary as the reason he disliked science. Similarly, in another question in the interview asking students what made science different from other subjects, students most frequently discussed science's literacy tasks; more than half of the students who answered (six girls and five boys) mentioned that literacy tasks in science made science different than other classes including its vocabulary, and required that they use texts such as curriculum science readers to learn more about science concepts. This was an unanticipated result because students spoke unprompted of literacy tasks making science different, even though the question had no particular focus on literacy, but was more general. This has implications for part of their figured world of science that is not a focus of this dissertation –science as discourse, both oral and written – and how it influences students' experience of science. If students struggle with acquiring scientific discourse, it could potentially act as a constraint that they must negotiate in order to imagine themselves as capable of learning and doing science, and of assuming science learner identities.

The second response in which the student discussed disliking science because of the teacher's control of the classroom environment possibly relates to research that has found that adolescents required environments that provided them interpersonal support for the development of autonomy, competence, and enriching relationships with others to prevent them from losing motivation to learn (Legault, Green-Demers, and Pelletier (2006). This student replied that she disliked science even though she did well in the class. Based on her response, she may have liked science more if she had the opportunity to develop more autonomy while doing science activities.

The last response in which the student felt uncomfortable because she never felt like she arrived at a "right" answer in science, possibly communicates her lack of understanding of the tentative nature of science knowledge arrived at through inquiry practice (Lederman, Abd-El-Khalick, Bell, & Schwartz, 2002; Moss, Abrams, and Robb, 2001; Sandoval, 2005) or understanding that science knowledge is subject to change; even if it is reliable, it is never certain. These three responses highlight the need for science teachers in these classrooms to attend to the discursive demands in science classrooms (e.g., Moje et al, 2001), and to revisit concepts of inquiry practice as a way to help students acquire and understand the nature of science knowledge and complex reasoning associated with science learning (Songer, 2006).

Summary

I contended earlier in this chapter that youths' perceptions of their ability in science and of what they found useful and enjoyable, paired with interview data, suggest the cultural model that may be shaping what students imagined as possible for themselves and what they were motivated to do in relation to science. The survey results revealed that students' perceptions of the usefulness and enjoyableness of science were related to their racial identity and their perceptions of the frequency they engaged in meaningful activities. Analysis of survey data also indicated that youths' perceived science ability was associated with their school context, perceptions of the science activities, racial identity, gender, and an interaction between racial identity and perceptions of science activities. Their enjoyment of science also related to their gender, with girls enjoying science less than boys did.

In general, these multiple-choice survey results suggested a relationship between all three science motivation variables and students' perceptions of engagement in meaningful activities and their racial identities. In particular, meaningfulness was positively related to utility value and intrinsic value, or students' perceptions of how useful and enjoyable science was to them. Values have been found to have a meditational relationship to achievement-related choices such as taking higher level courses in a domain, suggesting that increasing meaningfulness would increase their values for science, and potentially their future science achievement-related choices.

There was also a strong interaction on perceived ability between perceived meaningfulness of science activities and racial identity, which indicated that increasing students' perceptions of meaningfulness of science would make race centrality and private regard (or components of racial identity) less important to their perceived ability in science. This is a key finding, because perceived ability is an important motivational variable that has a meditational relationship to academic performance in a domain. Increasing the meaningfulness of activities, then, would allow students who may be less resilient (as indicated by low race centrality and private regard) or have negative perceptions of the science they have, to increase their motivation to learn science and have the potential to influence future science achievement, which has important implications for the entry of individuals from groups typically underrepresented into the science career pipeline.

Complicating this interaction was school context, which showed that student perceptions of meaningfulness differed by school, suggesting the need to understand meaningfulness in each school/classroom context. This finding also raised questions of what meaningfulness looked like for students, and why it was tied to racial identity given that the African American students in this study attended racially homogenous schools in which they were in the racial majority. Future research is necessary to understand whether similar results would be obtained in more racially heterogeneous classrooms, and to what degree meaningfulness and racial identity would matter to Black students' motivation to learn science in a mixed-race setting.

These survey findings, however, did not explain what meaningful science looked like that would motivate students in this study to learn science. Interview data provided more insights on what students found useful and enjoyable about science. These data indicated that students saw science as useful and enjoyable when they could do experiments, and learn new things that helped them prepare for the future, feel better about themselves, and to help others. They did not enjoy science when they thought it was difficult due to literacy and contextual constraints. The survey and interview findings together portray a cultural model of the type of science students desired to have and some experienced – one in which they did experiments on their own, learned things that assisted them and others in their community in their everyday lives, and in which they could use their own interests and literacy practices to make sense of science.

The cultural model of science available to youth depicted science as difficult due to literacy demands and one in which they were passive observers, which may have shaped their motivations *and* what they saw as meaningful or relevant in science. What they experienced in science classrooms helped to produce a figured world of science learning and doing for "students like them." Students like them – urban, Black youth – wanted a science that helped them to build up themselves and their communities. These findings align with those of Peterson-Lewis and Bratton (2004), who suggested the need to help students to build positive images of what it means to be Black *and* to do well academically – in this case the findings imply the need to help Black youth in this study to build identities as science learners. Providing access to different or more consistent cultural models of science for students like them might help in this regard.

Students like them also had differences by gender and school in their self-conceptions of their ability to do well in science. Research suggests that with higher self-conceptions of ability, students have higher achievement in a domain on average (Wigfield & Eccles, 2002). Students at the school of choice, Talley, had higher perceived ability. Overall, girls in this study and students at Linden had lower perceived ability in science. These findings raise the question of the types of science learner identities that students adopt based on their beliefs about their abilities in the domain of science and the types of resources and cultural models available.

In the next chapter, I introduce data to warrant the second dimension of the main assertion about students' cultural models of *science* and the resources that allow them to enact student identities in their particular science classrooms: *Social context, gender, racial identity, and relevance of the activity also matter in youths' construction of identities or self-understandings as science students, this relationship is not direct; the identities they adopted were filtered through the cultural models they held about science, school, and their peers as well as the resources that youths had available to them. The cultural models and resources that students had available to them were the raw materials they used to construct figured worlds of themselves as science students. These findings suggest that students may benefit from opportunities that help them modify their figured worlds for them to be motivated to learn science and develop identities as the types of individuals who do science in their classrooms and in the future.*

To support this assertion, I present interview, survey, and short-term observation data that described the ways that students produced and reproduced cultural models of science and of being students. In order to develop a subject-specific cultural model of learning, it was important to understand youths' cultural models of being students in general, in addition to cultural models of science. Taken together, cultural models, resources, and motivations (personal cultural models of being science students) form the figured worlds for these Black students' that construct their self-understandings or identities as science students. The cultural models and resources available to these students shaped figured worlds that did not always include being good science workers or even good science students. These findings have implications for the types of opportunities and experiences inside and outside of school that build new or expanded figured worlds for science learning.

Chapter 5 -- CULTURAL MODELS OF SCHOOL, SCIENCE, AND PEERS

Introduction

In this chapter, I use both interview and classroom observation data to answer the second research question used to guide this research: ***What is the relationship between students' identifications (as articulated in surveys and interviews) and their beliefs and cultural models of science?*** The data presented in this chapter extend and support the main assertion put forth in Chapter 4. In Chapter 4, I presented findings regarding the relationships among social context, gender, and racial identity and students' motivation to learn science. I contend in this chapter that these variables also matter in youths' construction of identities or self-understandings as science students, but that the relationship is not direct; the identities these youth adopted were filtered through the cultural models they held about science, school, and their peers as well as the resources that youths had available to them. The cultural models and resources that students had available to them were the raw materials they used to construct figured worlds of themselves as science students; these findings suggest that students may benefit from opportunities that help them build on and expand their figured worlds for them to be motivated to learn science and develop identities as the types of individuals who do science in their classrooms and in the future.

Based on their descriptions in interviews and behaviors in classroom observations, I assert that youth constructed identities using their cultural models of what many people (including teachers, parents, and other adults) would consider a good or "ideal" student. In addition, the identities they adopted appeared to negotiate the space between good student and good friend/peer. Youth described their conceptions of good students and science students in interviews. They also categorized other students in their science classrooms in the same way, using some combination of social and academic

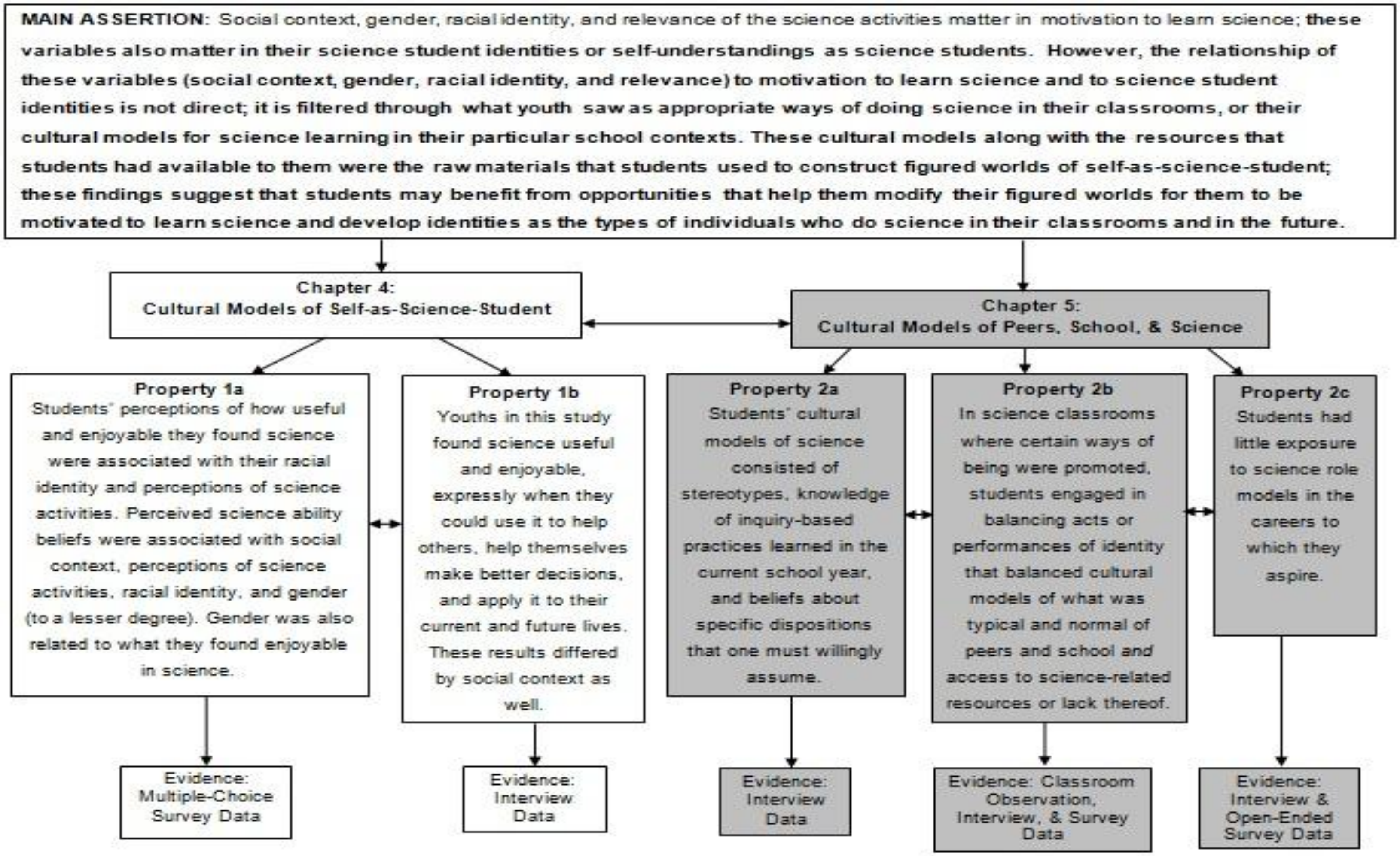

Figure 5.1 – Key Linkages Chart for Chapter 5[18]

[18] The portion of the main assertion addressed in Chapter 5 is in bold text.

criteria. Figure 5.1 depicts the assertion above and the data used to support it. In what follows, I present data that illustrate students' cultural models of school, science, and their peer worlds. From interviewees' cultural models of good students, I noted that they believed that such an individual was not only good in science, but also strived for academic excellence in all subjects. The cultural model that students communicated of an ideal student portrayed a "good" student as someone who saw it as his/her responsibility to balance social and academic worlds by separating them – academic concerns came first in school, and social concerns came after school. Survey data support that students who were in the good student category were also those with the highest perceived ability in science as well. I will show that this juxtaposition of the social and academic was seen not just in their student role in general, but also in science, and that it had clear implications for their motivation to learn science.

The identities that youth adopted pointed to their unspoken belief of the extremeness of the "ideal" students' dismissal of the social aspects of the classroom. In other words, the students interviewed in this study tended to negotiate their identities as students in the science classroom by trying to balance both established school norms *and* the cultural models sanctioned by the peer culture; classroom observations support interview data. I also saw that social status among the Black youth in each school mattered, such that students competed to be seen as embodying certain valued attributes, and this ability to attain social status served as a resource for students who were able to have both social status and academic success. These findings illustrate the ways in which both cultural models and students' negotiations of resources or their management of dominant (academic and scientific) and non-dominant (peer/home) cultural and social capital were involved in their science learner identities.

To make these patterns clear, I juxtapose students' descriptions of good students with their descriptions of themselves as students and peers, as a way to show how they employed the academic and peer-related cultural models in their classrooms – in particular, how they accepted or rejected the good student and good friend cultural models by enacting their own identities as students and peers in the context of their science classrooms. I also show how the cultural models they held of science entered into their identity negotiations, using excerpts from my field notes of short-term classroom observations and interviews to show how these identities played out in the classrooms. Finally, I compare the identity categories that I constructed using observation and interview data with those suggested by survey data of youths' perceptions of themselves as science students.

Cultural Models of Students/School and Peers

I analyzed interview questions for patterns related to good student and good-friend cultural models. These questions tapped into the unexamined assumptions students had about school, science, and about peers and peer relationships. I summarize their responses by the different cultural models that students had. See Appendices C and D for the full text of the interview protocol and Chapter 3 for a description of the analytic methods. In the sections to follow, I present the cultural models that students held of what constitutes a good student and good friend.

Good Students

In interviews, I found out some of the assumptions that students had about being good students and success in general. In the responses to questions about what it meant to for them to succeed in American society and to be good students, youth in this study used language about adherence to rules and just being good people overall. When youth spoke of the characteristics of what it meant for them to be good students in general, they stated that such individuals behaved themselves, did their work, and respected authority. Many youth in this study described good students as obedient and respectful. Good students were nice, did their class work and homework, paid attention in class, and followed directions. Good students also studied and took notes in class.

TCS: Describe what being a good student means to you?
Jeremy: Just being quiet and doing your work. And doing what you're supposed to do. [Jeremy, Maxwell, Interview #1, Lines 124-126, May 11, 2006]

Students differed in their notions of what academic achievement meant, however, along what appeared to be class lines. Four interviewees espoused mainstream (e.g., middle-class) notions of school success, and focused more on things students could do to improve their study habits and less on conformance to school rules:

TCS: And can you tell me what you believe is the best way to do well in school?
Damien: The best way is to study and set goals for yourself and then try to reach the goals, like if you get a 4.0, that means you want to do good in all your classes. And that means you want to study for all your classes and everything. [Damien, Talley, Interview#1, Lines 83-87, May 23, 2006]

Ten of the 19 students that I interviewed emphasized notions of academic achievement characterized by following the directives of adults and adherence to rules or more working-class cultural models (cf. Lareau, 2003):

TCS: Describe what being a good student means to you?
Brianna: Well it means a lot, but in some certain ways it means that you have to be obedient to whoever is talking to you or be respectful to whoever is around you and just stay out of trouble. [Brianna, Maxwell, Interview #1, Lines 120-125, May 11, 2006]

The other five students characterized good students in ways that incorporated both mainstream and working-class norms. I include an example from one Maxwell and one Talley student, respectively:

TCS: And describe what being a good student means to you?
Andrea: To me a good student means coming to school in uniform because that's our policy. Listen to the teacher, taking notes, studying and doing all your work. [Andrea, Maxwell, Interview #1 Lines 74-77, May 31, 2006]

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TCS: Now can you tell me what is the best way to do well in school?
Calvin: The best way to do well in school is to study, take good notes and listen to your teachers. [Calvin, Talley, Interview#1, Lines 68-83, May 17, 2006]

Even though youth spoke of the ideal and what they saw as the expected behavior and comportment of a good student, they explained that it was not always what they did:

TCS: What is the best way to do well in school?
Jeremy: Just to avoid like a lot of wrong stuff.
TCS: What do you mean?
Jeremy: Like skipping class or something like that… or give the teachers problems like I do. Not doing what I'm supposed to do and make it hard for them or harder on myself cause I get suspended or something like that.
TCS: Now what would you have to do to do all the good things that you say you need to do to do well in school?
Jeremy: Probably stop hanging around with some of the people I hang around.
TCS: Anything else?
Jeremy: Not really. Control my attitude. [Jeremy, Maxwell, Interview #1, Lines 84-104, May 11, 2006]

This same student in describing how others saw him as a student indicated in his response the ways he behaved in school:

TCS: How do you think other people would describe you as a student?
Jeremy: Okay, cause sometimes I can be… sometimes I won't do my work and I be talking and stuff or sometimes I can be ready to do my work and be prepared and stuff. So I'm like an even person.
TCS: You mean like somewhere in the middle?
Jeremy: Yeah. [Jeremy, Maxwell, Interview #1, Lines 128-135, May 11, 2006]

Another student spoke of the same negotiations in another way:

TCS: Now can you tell me what is the best way to do well in school?
Ashanti: The best way to do well in school is just basically pay attention. Just listen. Be respectful. Do your homework because like my mother always says, doing your homework will get you a sure A. If you don't do your homework, then that's like [an] F right there. I mean you can do well and fine on class work, but homework is basically like the main percentage of our grade. When in school, you just have to know when to play and when not to because most of the time, when you play around, you get in trouble. And that affects teacher judgment. Like when you're in between grades, and they say you play and you're between an A and

a B, they're most likely going to give you a B. But if they see that you're doing your work and focused, they're going to give you that A because they see that you're improving. You're doing what you need to do. And that's basically what it comes down to doing well in school. [Ashanti, Talley, Interview #1, Lines 78-88, May 22, 2006]

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TCS: Now how do you think other people would describe you as a student?

Ashanti: I think people would describe me as one of the smartest individuals cause I've been told that, 'Honey you're so smart,' and I always say, 'Thank you.' But I mean it's nothing for you to be cocky about, but people tell me that like I know when you play and when not to play because in class I might just pay attention, just looking at the teacher. [Ashanti, Talley, Interview #1, Lines 114-119, May 22, 2006]

Each student used comparative language that shows how each juxtaposed what they said comprises a good student, with how they believed others would describe them. One may argue that this is an artifact of the questions that were asked, but these questions were asked at different points in the interview, and in both students' responses to the question of what helped one do well in school, they each used examples of their own educational experiences. Jeremy's initial response seemed to relate to others' expectations of what made one a good student. When he discussed his own behavior, he showed how he seemed to negotiate both expected behavior of teachers and adults and what he and his peers wanted to do. Ashanti on the other hand, dealt with it another way, compromising such that she held back on her own desires until she was outside of class. This showed different ways they negotiated both the desire to adhere to social norms and deal with their own desires and wishes. Their responses also suggest that there were multiple cultural schema or cultural models against which they measured their own actions – one that was peer-driven and another that was school and/or teacher driven. Youth also tended to use comparative language to talk about tensions between good and bad things such as friends, school environs, and choices. In their responses they emphasized things that took their attention away from their class work most often.

TCS: Now what's the best way to do well in school to you?

Andre: Pay attention and ask questions.

TCS: And what things might hold you back from doing well in school
Andre: Friends.
TCS: What do you mean?
Andre: Like if you have some ghetto friends, bad friends, they probably try to distract you from your work. Therefore, you learn less. So that's about it. [Andre, Linden Interview #1, Lines 40-51, May 25, 2006]

One student named Mina spoke of being a student as the opposite of being a good friend, because of what it meant to be friends with other girls in her school environment. She mentioned that she sat by herself so that she could get her class work done and remain focused in class:

TCS: How do you think other people would describe you as a student?
Mina: Some people say I'm mean [be]cause I really don't like having friends, but I don't know. They just tell me I'm mean. I don't know why though.
TCS: When you say you don't like having friends, you mean when you said you sit by yourself so you can get your work done, is that what you mean?
Mina: Yeah, but to tell you the truth, I really only have one friend. [Be]cause it's just like people these days, especially females, they just bring so much drama. So I don't like hanging around a lot of females. [Mina, Maxwell, Interview #1, Lines 90-100, May 11, 2006]

The negotiations that students made revealed both their struggle to manage the expectations and/or demands of authority figures and friends, and their agency in determining the type of students they would be in spite of them. Here is yet another way a student parleyed this, showing that one could appease the teacher without totally alienating their peers:

TCS: Describe what a good student means to you?
Courtney: Being a good student means you don't really have to be the teacher's pet to be a good student. You can just do your work, and you don't really have to be all under the teacher to show that you're a good student. Just do your work, and your teacher will eventually sooner or later recognize that you're being a good student, and she'll congratulate you on what you're doing. [Courtney, Maxwell, Interview #1, Lines 108-113, May 24, 2006]

Peer Relationships

Students in this study had different experiences in their peer relationships across schools as well. Many students at Talley had been there for several years because it was a K-8 school. Students at Maxwell and Linden typically went to school and lived in the same neighborhood as students with whom they attended school. Often students who came to the larger middle schools like Maxwell and Linden from smaller elementary schools formed cliques with students who came from their old school. Stephanie described how groups formed at Linden:

TCS:	And what are the cliques at your school?
Stephanie:	What do you mean?
TCS:	Like what are the groups, like how do kids hang out or are there specific groups?
Stephanie:	Yes. Like if you were here last year, you would hang out with everybody who was here last year or if you came from the same school. [Stephanie, Linden, Interview #3, Lines 175-183]

Social status at all three schools was related to being known by the most people at the school, and by pressure to dress and look a certain way. This is interesting given that all three schools adhered to the district's dress code. Students spoke about the pressure to have their hair and clothing conform to the latest styles:

TCS:	Now what are the cliques at your school or groups?
Ashley:	They don't really have names, but I see like boys and girls walking in groups like every day, and they like talk about other kids and stuff like that.
TCS:	What do you mean talk about other kids?
Ashley:	Like they say like mean things like, 'uh look at her clothes or uh, look at her hair.' 'She look a mess,' and they say something about her. [Ashley, Linden, Interview #3, Lines 173-186, May 30, 2006]

At all three schools popularity or social status among youth was about being known and dressing and looking a certain way. The data across schools show that some students were able to gain social status by putting down students who did not have the proper dress or hairstyles:

TCS:	So thinking of the story you just read, how is Benny's experience with his friends and his school similar to your experience?

Andrea: Well it's like I would consider myself popular because I like know a lot of people in this school, and some of them went to elementary school with me, and some of them they like my friends, and then they cousins go here so I met them, but for like other people if people come here new, I still try and make friends with them because when you come to a new school in the beginning of the school year, it's like it's hard to get along with people. I don't try and put people down because sometimes all the stuff [clothes, material things, etc.] that other people have, I still don't have [those material things] so I can't put nobody down. [Andrea, Maxwell, Interview #3, Lines 149-163, June 2, 2006]

Although the ways students talked about peer relationships differed across contexts, the ways in which students attained social status by putting others down and/or labeling them as different were similar. Michelle described two categories of students at Talley, those who were known or those who were lame, which she describes as being disliked or being a social outcast in some way:

TCS: And what are the cliques at your school?

Michelle: We have lame, the people everybody know, and well it's just basically them two. I'm not going to say I'm a lame [now] [be]cause I'm not and it's not like popular versus lame, it's just lame versus knowing everybody. But I mean like everybody knows who I am, and I can be like, yeah I used to [be] a lame. I'm not going to say I wasn't [ever a lame] [be]cause I was when I first got here, but I'm not a lame anymore.

TCS: What makes someone a lame?

Michelle: They don't talk. They only hang around certain people all the time. Like they just hang around two or three people and that's it. Like… and like they be… like if you're ugly, you're a lame, but that doesn't make anybody a lame. Like I don't know why people call people lame. Like… that's just unnecessary. If you… like… she's ugly, she's a lame. she's short, she's a lame or stuff like that, but if you, I don't know. Like if you don't like somebody, like you're a lame. All mean and stuff. I don't know how people just classify I don't know where, but they do here. [Michelle, Talley, Interview #3, Lines 193-209, May 31, 2006]

Erika addressed the instrumentality of such behavior in her description of the atmosphere at Maxwell. She explained that social status was based on social competition to look the best (among girls) and to be able to compete for members of the opposite sex (among boys):

TCS:	Now I was just wondering is there anything you want to add about peer pressure and stuff like that at your school?
Erika:	Yeah we got a lot of peer pressure at this school because a lot of girls in this school like… it's not really hard for girls to be normal with people, not me cause I get along with everybody, but like some girls, they just got smart attitudes and stuff, and they got like… like girls in my other school [who go to Maxwell now], they used to didn't act like the way they act now. They just try to be all hard [tough] and stuff, and they try to hang around the girls that they shouldn't hang around – the girls that really don't like them. They just talk about them. They want to get them jumped [beat up by a gang of girls] and tell people like, "oh such and such said such and such about you," and get them beat up. But a lot of boys in the school they try so hard just because the rest of the boys dress nice or they get all the girls. They try so hard to be like them. They try to dress like them. They try to talk like them. They try to walk like them. And they don't look right. [Erika, Maxwell, Interview #3, Lines 268-282, June 2, 2006]

Tupac's[19] response about his peers and what they thought of him suggested that there were other things boys (and possibly girls) at this school fought -- to display a sense of solidarity with friends:

TCS:	What about other students? What will other students say about you?
Tupac:	I think they would say I'm cool. Yeah… cause I'm real. If I say I'm your friend and then you about to be jumped, and it's only two of us, but it's like 18 of them, I [will] help you. I ain't just going to stand back because I'm scared because it's 18 [of them]. [Tupac, Maxwell, Interview #1, Lines 184-188. May 10, 2006]

One of the reasons for this need for solidarity was because Tupac admitted being part of a street gang, and other students at his school were part of gangs as well:

TCS:	Now what are the cliques at your school?

[19] This student chose the pseudonym, Tupac, because he identified as a rapper, and the late Tupac Shakur (1971-1996) was his favorite.

Tupac: What you mean? Like gangs?
TCS: Yeah what are the different groups of students at your school?
Tupac: There's a whole lot of groups. Like me I'm the 65th Street[20] and my friends, mostly everybody I hang with, they 65th Street. I'm an 65th Street M.O.B., my friends they 65t\h Street Hot Boyz. Some of my friends, like one or two of them, 67th Street Hot Boyz, not even that. Just 67th Street and some of the 66th Street and some of them Blake Road. [Tupac, Maxwell, Interview #3, May 24, 2006]

Tupac was the only interviewee who admitted participation in gang activity, although two other students (one boy and one girl) from his school named some of the same groups that he did as groups in their school. None of the students from Talley mentioned gangs in school or outside of it, and only one interviewee from Linden named gangs, and he mentioned that they were not in his school:

TCS: Okay and what are the cliques or groups at your school?
Andre: You say like gangs or stuff like that.
TCS: Yeah or groups.
Andre: I can't name them but I know a bunch of them where I was going. It's like one of them called Baby M.O.B. and stuff like that. That's' about all I know.
TCS: And they don't have any here?
Andre: No.
TCS: And do you belong to any of these groups?
Andre: No. [said with emphasis]
TCS: Why do you say it like that?
Andre: My momma would kill me. [Andre, Linden, Interview #3, May 25, 2006, Lines 163-183]

Last, some students shared information about the culture of their schools, including the ways that teachers and administrators treated students. This was particularly true of students at Maxwell, whose struggles with teachers and administrators were revealed in questions in unintended ways:

TCS: Was there anything that you wanted to include based on peer pressure?
Angela: The school is peer pressure. Like when they try to make us wear uniforms, people don't wear uniforms, they try to

[20] All gang names are pseudonyms.

suspend you. My momma had wrote a note because can't nobody watch me [after school]. Everybody gone, can't stay home by myself. My grandma work. So really got nobody to watch me. So they [the school administrators] try to suspend me, but my momma wrote me a note. Ms Smith, she try to make me go back home, but my momma she said the note would be good, she wrote it for day four. But my momma can't watch me. She work downtown, she just can't hurry and come up here and pick me up. My grandma go to work at like 12:00 so she came up here, and they put me back in school. Ms. Turner did. Ms. Turner a nice person.

TCS: And that was for dress code?

Angela: Yeah and then they didn't know who… the first food fight we had. They didn't know who threw food, but they just started suspending people. I guess they asked and questioned people, and somebody said my name so I had got suspended. So it was like I was suspended for like 7 days. But went back to school any way, did my best. First report card, I had a 3.0, then I had a 2.6, then I had the same thing on my third one. Don't know what I got now. [Angela, Maxwell, Interview #3, Lines 320-344, June 1, 2006]

In essence, most students spoke about the tensions they experienced between being good students and surviving the social scene at their schools, which were sometimes extensions of their neighborhood contexts. Some of these tensions were similar across schools, and suggest shared peer culture, which may also be related to a shared racial identity as Black youth, although students at Maxwell may have had the additional factors to navigate in surviving their school context such as solidarity to neighborhood groups and issues with the school's administration.

These findings suggested that youth at all three schools attended to the cultural models of school and peers (e.g., Black youth culture) in espousing who they were as students in general. However, I contend that the data will show that those same social tensions also came up in content area classrooms, where students were already making sense of cultural models they have of the content area, being a good peer, *and* school. Cultural models of students/school, peers, and science seemed to influence the ways in which students negotiated their science learner identities in particular. I discuss this in more detail in the sections to follow and in the implications in the next chapter. In the next section, I explore the cultural models students held of science and scientists.

Cultural Models of Science and Scientists

Cultural Models of Science[21]

I asked youth in this study about specific activities that they did outside of school and whether they were science-like, and why they answered in the ways that they did. This approach allowed me to get at students' definitions of the enterprise of science and scientific activities. Students' responses to these questions revealed the ways in which they defined science in general. Their responses to these questions also indicate that just over one-third of the interviewees related science-like activities to the content from different disciplines that they learned in school and elsewhere – chemical and physical reactions, erosion, electricity, and photosynthesis among other concepts mentioned.

> TCS: Do you ever try to grow plants at home on your own?
> Calvin: No.
> TCS: Do you see that as a science like activity?
> Calvin: Yes because it's the science term called photosynthesis, and it helps the birth of plants. [Calvin, Talley, Interview #1, Lines 163-169, May, 17, 2006]

Approximately one third of the interviewees mentioned that they saw science as a way to help them learn more about the world and about how things work, in their expressions of what activities constituted scientific activities. Fourteen of the 19 respondents mentioned they either re-did experiments that they or family members learned in school or did their own experiments at home. Youth seemed excited to recount their experimentation adventures, even those who claimed that science was their least favorite school subject. When speaking of experimentation, almost half of the 19 interviewees described scientific activities as consisting of observation and problem solving by trying or testing different conditions to determine their effects:

> TCS: And do you see trying to fix and repair things as a science like activity?

[21] See Appendix D for interview questions used in this section.

Andrea: Yes because we're experimenting, like we do in science, trying to see if doing something different would make it work. [Andrea, Maxwell, Interview #1, June 1, 2006, Lines 141-143]

Their responses to the question of whether baking was a scientific activity generated descriptions that revealed that students saw science as a subject with specific practices and knowledge that are different from everyday practices. In other words, an everyday activity or phenomenon had nothing to do with science if it was not approached from a scientific disposition. One student from Maxwell provided the reason she thought baking was not a scientific activity, "well you're experimenting but you not really like, like no one trying to know where all this stuff [ingredients] come from" [Erika, Maxwell, Interview #1, Lines 64-65, May 31, 2006]. Erika is possibly referring to the curriculum unit I observed, in which students learned to identify and distinguish the properties of substances. Because she did not think about the properties of the ingredients she combined while baking, it was not a scientific activity. In this way, she painted the activity as not being scientific, and herself as not being a scientist as she engaged in it, because she was not *intentionally* interacting with the materials in ways that a scientist would.

Erika's reasoning is correct – baking is not the same thing as doing science, although it does involve scientific phenomena. The practice of baking is only considered science if someone is active experimenting with different food combinations or chemicals in the food in a controlled experiment. Using similar reasoning, another student at Maxwell mentioned that baking could be a science activity if you observed certain details while baking: "Well you could stand there and watch, say if you baking a cake, you could stand there and watch and see how it rises and things and see how long it take" [Brianna, Maxwell, Interview #1, Lines 285-286, May 11, 2006]. Inherent in her response is the same comparative language that Erika used above to explain how the everyday baking that she did was different from scientific activity, going a step further by defining the specific practices in which someone could engage to make baking scientific.

Other students distinguished baking as a non-science activity because of stereotypes they had about what constitutes activity within different school domains. Two male students and one female student from Maxwell, a school in which all 7th graders had to take home economics, mentioned that baking was a home economics activity and not a science-like activity. What is interesting about the baking question is that the unit that I observed presented baking a cake as an illustrative example to help students understand atoms within a chemical reaction. Only 5 interviewees mentioned this, two others mentioned heat and rising of the cake without direct reference to the concept of chemical reactions. The majority of students did not mention what they discussed in the unit about baking, which could have reflected their knowledge that scientific practices involve controlled experimentation while everyday practices do not.

Cultural Models of Scientists[22]

In this section, I describe youths' cultural models of scientists. The participants in this study mentioned in these interviews that they based their perceptions of scientists from a wide range of popular culture depictions of scientists including pervasive images of scientists in laboratories mixing chemicals, shows like Bill Nye, the Science Guy, and in books and magazines about science. Sixteen of the 18 students who interviewed described scientists as people who wore a typical uniform – white lab coats, goggles, and other safety equipment[23]. They thought none of the people in the pictures could be scientists because they did not wear this uniform:

> TCS: Now I noticed that you didn't think any of these people would be [a] scientist. Why is that?
>
> Andre: Because when I think of [a] scientist, I think of like lab coats, glasses and stuff like that. And these people right here didn't have none of the details of this. [Andre, Linden, Interview #2, Lines 63-67, May 22, 2006]

In addition to images from popular culture that informed students' perceptions of what scientists looked like, students had their science teachers' practices from which to draw their beliefs. For example, two of Mrs. Alexander's students stated that she was the epitome of what a scientist looked like, because she always wore a lab coat when they did experiments. I include one example here:

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[22] See Appendix D for interview questions used in this section.

[23] This is the second interview I did with students. Two students did not respond to this question.

TCS: Okay. And what would a scientist look like? If you were to think of what, you know, your opinion of what a scientist looks like, what would it be?
Brianna: Like what my teacher look like, with the white robe thing. I don't know what they look like up under it, but they had that on… yeah. [Brianna, Maxwell, Interview #2 Lines 112-117, May 16, 2006]

The reason for the number of students who answered this way may be due to the common practice of all three teachers in this study and of many teachers in this systemic initiative of wearing white lab coats when they did any science activity.

Students from all three schools held similar ideas about scientists – describing them in ways that portray scientists almost as caricatures, and possibly as quintessential "geeks." I include examples from a student at Talley and a student at Maxwell:

TCS: Now you know I'm interested in science, and I notice that you didn't think any of these people would be scientists. Why is that?
Ashanti: [Be]cause I mean they don't look like scientists. Most people see scientist as people with bifocals and lab coats and gloves and what not. None of the people in these pictures have that. [Ashanti, Talley, Interview #2, Lines 79-85, May 23, 2006]

TCS: And what do you think a scientist would look like?
Andrea: A scientist would have on the white experiment coat. They would have pens in their pocket. Well, they don't necessarily have to have it there, but that's what I think they would wear. [Andrea, Maxwell, Interview #2 Lines 53-57, June 1, 2006]

While I observed the pattern of beliefs about scientists' attire across respondents, there were preconceptions about scientists that appeared only in the talk of adolescents from Maxwell and Linden. Their responses were different than those of Talley students in that they also indicated a belief that scientists were very different from everyday people like themselves. This was not something that all students communicated directly, but through their beliefs that the people in the pictures they viewed looked normal, and could not be scientists:

TCS: All right. I noticed that you didn't think any of these people would be scientists? Why do you think that is?

Ashley: Because they look particularly like people like in everyday life, like secretaries, judges, policemen, people like that. None of them were scientists. [Ashley, Linden, Interview #2, Lines 81-85, May 22, 2006]

Like Ashley, Andrea communicated that she thought scientists were different from everyday people. Andrea not only believed that scientists have a particular "look," but she stated another belief that scientists do not "deal with" people as other professionals do:

TCS: Now you know that I'm interested in science, and I noticed that you didn't pick any of these people as scientist[s]. And I was wondering why?

Andrea: Because none of, it's not that they don't look like they're interested in science. It's just that they don't look like they deal with science.

TCS: And why do you think that is?

Andrea: I don't know. I just don't think they deal with science by the way they're dressed and how their face expressions look. It look like they do like teaching or lawyers, they like deal with people but not science. [Andrea, Maxwell, Interview #2, Lines 40-57, June 1, 2006, emphasis added]

Ashley and Andrea both set scientists apart from other professionals. Andrea elaborated how scientists are different – they were isolated from people. The two professions that Andrea chose to illustrate her point, teaching and law, were professions that involved a significant amount of interaction between the teacher or lawyer and the people that they served. Science, as Andrea conceived of it, did not have these interactions or "dealings" with people.

I observed the theme of students believing that scientists were different from everyday people in response to questions about what constitutes scientific activity. I asked students to describe activities in their everyday lives that were science like, prompting them for specific tasks such as growing plants, baking, and repairing things. In his explanation of why taking care of plants and animals is science-like, Tupac, provided another way that scientists were different from everyday people:

TCS: What do you mean [by calling this activity] science like?

Tupac: Because like a pet, a pet, [a] scientist knows what to feed a pet. So say if you were a scientist, and you walked into the shop, like yesterday me and my friends we were walking around. We walked into the pets supply store, and the

> scientist was in there looking at pets, and it was, and I forgot the name of it was. But it was some kind of pet in there. And my friend got it out of the cage, and I was like, 'what you supposed to feed that?' He's like, 'I ain't no scientist.' And the scientist next to him told him what he supposed to feed him and stuff. So I think scientists, they study it more than normal people would do. [Tupac, Maxwell, Interview #1, Lines 338-346, May 10, 2006]

Tupac explained that scientists study things more than a normal person would. A normal person may only know to feed the dog, give it water, and to walk it. A normal person, in Tupac's and his friend's estimation, would not understand the animal's needs with the level of detail that a veterinarian would. Tupac's language use established him and his friend as normal and the scientist as different from them. This is similar to the ways in which Ashley and Andrea set scientists apart from other professionals and as unlike everyday people.

<u>Discussion of Students' Cultural Models of Good Students, Peers, Science, and Scientists</u>

Overall, most students seemed to see good students as individuals who were respectful and adhered to rules. When youth spoke of the characteristics of what it meant for them to be good students in general, they stated that such individuals behaved themselves, did their work, and respected authority. These descriptions revealed classed notions of what constituted a good student. When describing themselves as students, they tended to speak of themselves differently than they spoke about the cultural model of good students. In their descriptions including their own identifications as students, they also referenced the peer culture of their schools in ways that suggested that they negotiated their student identities using both the cultural model of a good student and the cultural model for being a friend or peer in their school context. The cultural model of their peer relationships reflected the culture of urban Black youth, shared by students across schools.

Students viewed science as empirical. Through the specific example of baking, they revealed that they also saw science as using specific methods and requiring specific dispositions, whereas when they were baking at home, they did not take on such dispositions. The notions that science was empirically based and used specific methods represent two tenets from science education literature on the nature of science (Lederman,1992; Sandoval, 2005). Youths' realistic perceptions of science and science practices may be due to the exposure to inquiry-based science they had in their classrooms that mirrored the authentic practice of scientists. Students' visions of science cohered to some degree with the idea that science promotes a specific set of cultural assumptions and dispositional attributes, ways of talking, use of deductive reasoning in lieu of the inductive reasoning of commonsense knowledge, and ways of distinguishing scientific from non-scientific knowledge (Lemke, 1990; Popper, 1932/2009). This specific set of cultural assumptions in science represents dominant capital in science classrooms. And their understanding of the dispositions required for scientific endeavors may have had important implications for whether they were motivated to learn science, particularly if they did not see themselves—or people like them—as interested in taking on those dispositions.

The interview responses also suggest that a few students had stereotypical or naïve beliefs about what constitutes the content of science knowledge (e.g., students believing baking had nothing to do with science). However, all of the students in the study who responded to questions about what scientists looked like had stereotypical ideas about and the type of people who did science. They believed that scientists had a special dress code, and were not like everyday people in that they were not social and knew more than average people did. These beliefs may have potentially shaped the ways that they saw themselves as science students and how they approached science learning. These cultural models of science and scientists would be less useful or valued in science classrooms because of their inaccuracy, and they have the potential to compete with the correct cultural models students held about science. Additionally, they could potentially serve as non-dominant cultural capital depending on the ways in which students used the cultural models they held about students, peers, and science to construct identities as science students. In this chapter, I argue that students in this study juggled the dominant norms and expectations from the cultural models they held of being students and of science in addition to the expectations from cultural models of peer relationships. In the next section, I present the ways that students used the cultural models described above to construct identities as science students.

Balancing Acts: Using Cultural Models to Create Student Learner Identities

Students in this study used their cultural models of social and academic ways of knowing to espouse and enact identities. For the adolescents in this study, cultural models of social life were just as important as the academic ones. I have named these early adolescents' attempts at identity construction "balancing acts," or their balancing and negotiating the cultural models of good student (academic) and good friend (social), due to how students appeared to be balancing the academic and social demands of their science classrooms. I present evidence of merged data from interviews, classroom observations, and multiple-choice survey responses that demonstrate that these academic cultural models that students used in their identity constructions most notably reflected their unexamined assumptions about school and being a student in general, but also revealed their cultural models of science. They also reflect the degree to which students were able to leverage dominant and non-dominant cultural capital in the science classroom.

I represent in Table 5.1 the ways students identified using a continuum that reflects the identities that young people enacted in these classrooms. Good-student and good-friend identities transcended the subject of science, but the ways that they discussed the other three identities were specific to science. These three identity categories reflected a mix of characteristics of the cultural models students held of good students, peers, and science: helpers, in-between, and out-of-balance (neither good friends nor students). The good-student identity represented what students in this study characterized as ideal; it was a direct reflection of their cultural model for good students. The other identities deviated from the good student-cultural identity on social grounds. Helpers concerned themselves with their schoolwork in class and outside of it, but used their academics to gain favor socially with both teachers and students. In-between students balanced the academic and social demands of the classroom, such that they never compromised their standing academically or socially; they knew when to play and when to work in the classroom, unlike good students who did not play at all in the classroom. Students in the good-friend category, however, placed higher value on the social aspects of the classroom than on the academic, and were also a reflection of the cultural models students in this study held of good friends. Out-of-balance students were least able to find ways to balance the academic and social demands of their science classrooms. I review each category in depth in the sections to follow[24].

Table 5.1 – Balancing Acts across Science Classrooms

Category	Definition
Good Students ***(generic across subjects)***	Focus on the Academic and Less Toward the Social Demands
Helpers	Focus on Using Academic Ability to Gain Favor Socially
In-Between	Focus on Balancing Academic and Social Demands
Good Friends ***(generic across subjects)***	Focus on the Social and Less Toward Academic Demands
Out of Balance	Neither Social nor Academic Balance Attained

"Good" Students

In general, the good-student identity adhered closely to the good-student cultural model students held. Seven out of the 19 interviewees self-identified as good students, and came from all three schools. Students who adopted a good student identity believed

[24] These categories are not static; students spoke of the ways that they identified as students. I also tried to illustrate the ways individuals were positioned as certain types of students by others in their classroom, which suggests in addition to balancing cultural models of good students in school and good friends, youths were engaged in on-going and evolving constructions of science learner identities. I also use survey data to further elucidate and examine the categories that I created.

that academic achievement was important not just in science but to their future educational and occupational goals overall. In addition to a future-oriented disposition of self-improvement, students in this category appeared to be less concerned about the norms of their classroom related to the social demands of peer culture, and focused on those related to what they needed to accomplish academically. What characterized students in this category most was that regardless of their social standing, doing well academically was important to them, and the type of persons they wanted to become. They were individuals who were not going to compromise academics for their social standing:

> TCS: And what to you is the best way to do well in school?
> Andrea: The best way to do well is don't worry about the other people in school. Just do your best as far as your academics and try and get good grades and study.
> TCS: And what things might hold you back from doing well in school?
> Andrea: Things like people wanting you to do other stuff besides doing your work, and then people like asking you, 'Can I see your paper?' and stuff like that. Trying to cheat off me. I don't think they should do that and that's holding other people back because they actually fall for it sometimes. [Andrea, Maxwell, Interview #1, Lines 62-72, May 31, 2006]

Some students in this category could focus on academics because they were already popular. Other students positioned Andrea as popular; she was attractive, dressed fashionably (given the dress code she still wore the jewelry, handbags and hairstyles of the popular crowd), and she associated with people from her former middle school and the neighborhood who had high status at Maxwell. However, Andrea was a good student because like other students who claimed this category, she made distinctions about the division of labor inside the classroom and outside of it – school was for work and play was for activities outside of school. When asked how others would describe them as students, Ashanti at Talley, and Andrea at Maxwell illustrated their awareness of this distinction. Both felt the need to describe themselves as fun people outside of school:

> Ashanti: But then when I'm out of class, I'm just crazy. Just everywhere. So my work environment and then my outside

work environment is very different. [Ashanti, Talley, Interview #1, Lines 119-121, May 22, 2006]

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TCS:	And how do you think other people would describe you as a student?
Andrea:	I think they would describe me as a good student because I do my work, and I do [have] good grades. But outside of school, I'm very funny. [Andrea, Maxwell, Interview #1, Lines, 61-63, May 31, 2006]

Students who identified as good students were very confident about their abilities as students, and were similar to what Hemmings (1996) called "model students," who adhered to mainstream or middle-class notions of academic achievement and saw it as their responsibility to do well in school. This identity category reflects the cultural model of good students presented earlier, which reflected students' adherence to class-related beliefs about what it means to be a good student.

As introduced in the theoretical framework, identity work is characterized by individuals' self-understandings as well labeling and positioning by others, and others recognizing claims to an identity as valid (Gee, 1999, 2000/2001; Holland et al., 1998; Jenkins, 1996). Most of the students in this category self-identified as good students. In interviews, other students recognized students who self-identified as good students as the smartest persons in their science class. For example, Erika chooses Andrea, a girl who self-selected the good-student designation:

TCS:	Nominate someone in your science class that you most admire, respect or want to be like?
Erika:	I have to say Andrea.
TCS:	Why?
Erika:	Because she's real good in science and she likes science. She focus on it, and she get good grades in science. [Erika, Maxwell, Interview #3, Lines 233-241, June 2, 2006]

In the other categories I present next, students sometimes made claims to identities that others did not acknowledge, or were positioned by classmates into categories that they never saw themselves as belonging.

Helpers

Students interviewed did not self-select into this category, however, I created this category because helping seemed to be a valuable attribute of good *science* students based on students' descriptions in interviews and in what I observed in these classrooms. It was also a *positional* role in that circumstances or individuals positioned students into helper identities in these science classrooms. Eight of the 19 interviewees from Interview #1 referred to good science students either as helping others, or suggested that they were individuals who classmates could go to get their questions answered. Helpers were good students who either chose to help their classmates or adopted the position of helper (or not) into which their science teachers and students categorized them. Helpers were students whose peers and teachers saw them as smart and nice to classmates by helping them to do science class work or homework, as illustrated by the excerpt below from a Linden Middle School student:

TCS:	Is there someone in your science class that you think is a good science student?
Michael:	Tyler.
TCS:	And what types of things makes him a good science student?
Michael:	He listen. He very quiet. He don't hang around with bad influence people. That's it.
TCS:	And how does your teacher show you that Tyler is a good student in science?
Michael:	Cause she won't let me sit very close to him and stuff like that.
TCS:	And how do your classmates act towards him?
Michael:	Pretty nice. They like him because he *help* them. [Michael, Linden, Interview #1, Lines 78-94, May 25, 2006]

In interviews, students sometimes described the qualifications of a helper differently across schools. At Talley Academy, the school of choice where adolescents generally scored higher in science content and reading and had fewer students who received free and reduced- price lunch that the other schools (refer to Table 3.2, p. 63), students' descriptions added GPA as a characteristic of helpers.

TCS:	Is there someone in your science class that you think is a good science student?

Michelle: I think this is kind of hard. Shantal is probably a good student because she's a good student in like all our classes. Like she always gets 4.0 or 3.9.

TCS: And what types of things makes her a good science student?

Michelle: Like she listens in class. She always asks questions. She will take good notes, and she'll study. She'll study while class is going or if we have pre-period, she'll read something about science so she always does her work.

TCS: And how do your science classmates act towards Shantal?

Michelle: Like she's not the most popular girl, but everybody likes her. Like she doesn't have any enemies. She *helps* other people. [Michelle, Talley, Interview #1, Lines 98-107 and 116-118, May 17, 2006]

In addition to having good grades overall, Michelle's description implied that she did not perceive Shantal to be very social although she saw her as being nice, studious, and academically engaged in their science classroom (e.g., asking questions). This possibly reflects the cultural model that students had of scientists as non-social individuals, but these comments also serve to distinguish good science students from good students in general.

Students adopted the helper identity based on particular circumstances in the science classroom. During a class at Linden in which students edited each others' scientific explanations or "paragraphs" as the teacher termed them, one girl named Tasha engaged in the act of helping as others worked more on their own work:

> Mrs. Foster is walking around. Students who are finished show her their papers. She reminds them of what they are supposed to be doing as editors of other's papers. Most students are working quietly and by themselves.
>
> One girl Tasha is talking to another girl whose paper she is editing. She says to her, "What are you doing? The claim is the answer to the question they are asking you." Then Tasha shows the girl how she answered the question on her own paper. Tasha points out the question to her. She also shows her where the evidence is on the chart. Tasha tells the girl that all she had on her paper was the evidence. [Field notes, 3/7/06, Linden, Activity 6.1, Lines 70-77]

Tasha was a helper because not only was she a good science student, but she also helped a classmate who did not seem to get it. Tasha understood the practice of writing scientific explanations in her science class as outlined by her teacher, and helped her classmate to see where she needed to make corrections to meet the assignment criteria. She could have simply edited her classmates' paper for the extra credit Mrs. Foster assigned, and then started doing something else with her free time. Instead, she chose to help even though no one asked her to do so. She willingly adopted the role of helper in this particular situation.

Sometimes individuals did not adopt the role of helper voluntarily, but did so at the insistence of another classmate. Andrea from Maxwell discussed how classmates positioned her to help them in science class because she completed her assignments. She saw herself as a good student, but not a good *science* student per se:

> TCS: How do your classmates act towards you in your science class?
>
> Andrea: In science we always try to work together so I don't really have any problems with that, but sometimes I think I'm getting the best grade in science right now because I try to do my work even though it's hard for me, but people still come up to me and ask me like what are we supposed to do, and can I work with you because people think that it's good to work with me because I still try to do my work [even though it's hard for me]. [Andrea, Maxwell, Interview #1, Lines 90-97, May 31, 2006]

This involuntary helper role is not common just to Maxwell students. Youth at all three schools discussed how classmates got peers to help them with their work. Ashanti, herself one of the top students in her class at Talley as stated by the teacher and her fellow classmates, describes a girl who she thinks is a good science student in her classroom:

> TCS: How do your science classmates act towards Sierra?
>
> Ashanti: Classmates in the class, they call her smart too because I mean she is smart, but she's just quiet …many people, they don't talk to her in class because I mean we're not supposed to be talking, but I mean some people might ask her, "what did you get for #1?" She tell them the right answer and they copy it down because they know it's right because she's a good person, and she does her work. [Ashanti, Talley, Interview #1, Lines 151-156, May 22, 2006]

In the excerpt above, Ashanti describes incidents in which her classmates positioned Sierra to help them. Sierra gave her classmates the answers and they considered her “a good person” for doing it, although she may not have been considered the friends of the individuals she helped by giving them the answers.

Sometimes teachers involuntary positioned students into the helper role. They also used good science students to be good examples for their peers in the science classroom. From observing their science class, I saw firsthand that Shantal was a student that the science teacher, Ms. Robinson, called on frequently and referenced her comportment and answers as models for other students:

> As they were starting the journal question at the start of the class, Ms. Robinson reminds the class that Shantal gave a good definition for solubility previously and she wants them to think about it or turn back to it in their notes if they wrote it down, as a way to help them answer the third journal question. [Field Notes, Talley, 12/13/05, Activity 1.3, Lines 14-16]

An involuntary form of helping in the classroom that I saw only at Maxwell occurred when the science teacher Mrs. Alexander positioned students as “good scientists,” because they helped her model activities in the classroom. The categorizing of students as “good scientists” was a practice that Mrs. Alexander engaged in frequently. Below is an excerpt from field notes in which the teacher discussed what constituted a “good scientist” as the class prepared to conduct an experiment by first reading the procedure:

> Mrs. Alexander asks for two ‘scientists’ to volunteer to assist her with the activity.
>
> She mentions, "Scientists must be able to follow directions, so before you quickly volunteer, let's look at what we are going to do. [Students are still talking.]
>
> Mrs. Alexander raises her voice slightly, repeating, ‘Let's look at what we're going to do.’ The class settles down somewhat.
>
> She asks, ‘Who will read ‘Our Personal Safety?’’
>
> No one volunteers. The teacher commonly calls on students by their last name. She first calls on Ms. Jackson [Lisa -- Table D] to read the purpose. Lisa reads the procedure quickly and loudly. Mrs. Alexander then calls on Ms. Nelson [Benita] to read the rest of the procedure. Benita reads in a low muffled voice.
>
> Mrs. Alexander says she needs ‘a very good scientist’ and she mentions that she saw Ms. Jackson [Lisa] and Mr. Jacobs [Tony] listening closely

> while others were reading. She asks them to get goggles from the back of the room to help her with the experiment.
>
> Mrs. Alexander is sitting at the back of the room. She mentions that she has two scientists and that the rest of the class is going to watch the scientists, and observe as the scientists do the activity. [Field Notes Maxwell, 2/1/06, Activity 7.1, Lines 121-137]

Maxwell students stated in their interviews that they thought this teacher, Mrs. Alexander, was the epitome of a scientist because she wore the typical uniform of scientists. For her to position a student as a "good scientist" almost made it so in their eyes. Although the rest of the class engaged in observations of the activity, the teacher did not classify them as scientists. She positioned herself, Lisa, and Tony as scientists because they were the ones she selected to help her with the experiment ("Let's look at what *we* are going to do"). This may have contributed to the stereotypical cultural models that students had of science and individuals who did science.

Similarly, Moje (1995) in her case study of a high-school chemistry teacher's classroom reports how the teacher, Landy, positioned herself and students as part of the community of science classrooms using personal pronouns such as "we." Because Landy made this identification available to students in her class to have them become participants in a community of practice of science, students readily engaged. In Mrs. Alexander's class, only students who embodied the dispositions valued by the teacher were "scientists." Lisa and Tony in that excerpt were "very good scientists" because they were quiet and followed directions. In Mrs. Alexander's classroom, only the few people she picked could be good scientists and help demonstrate the science activities in class. As good scientists, their participation was not voluntary, and it contributed to the teacher's agenda, and possibly not their own.

As the example above shows, the teacher positioning someone as a "good scientist" was different from the ways students took up the role of helper. Good scientists also seemed to be synonymous with "obedient student" to the teacher, whereas the helper designation, as taken on by students, denoted youth helping one another without the teacher's involvement. Students sometimes were positioned in this category by other students, and if they wanted to get along with their classmates, they did so. Sometimes, as demonstrated from the excerpt from Maxwell, the teacher positioned students as helpers;

other times youth willingly assumed the identity of helper, as Tasha did when explaining how to correctly write a scientific explanation paragraph.

Students positioned in the helper category were typically, but not always, girls. Brickhouse et al. (2000) found that traditional middle school classrooms encouraged the African American girls in her study to take on “good-girl” student identities, similar to that of a helper. Per Brickhouse et al., good-girl students were quiet, good students that took on the “normal” roles constructed for female students. The possibility exists that boys read the position of helper as “feminine,” due to the degree of conformity required to enact it, as seen in other studies (e.g., Hemmings, 1996; Willis, 1977).

Of all of the categories, the helpers designation seemed to be the most content-area specific. Although one student mentioned that a helper in her science class also helped in math, I believe that this is not a coincidence; science and math are subjects that many students mention as being difficult for them. It is possible that helping was something both students and teachers saw as necessary to help youth construct identities as science learners. It is also reasonable to conclude that the cooperative nature of the activities may have lent themselves to students helping one another in informal ways.

Other research suggests that learning styles and success orientations of individuals in African American and other non-dominant communities are more communally and interdependent and less competitively-oriented (Settlage & Southerland, 2007), in which case helping would be part of a cultural model of acceptable behavior of these youths’ home culture (Boykin, 1986). Across students in this study, there appeared to be an orientation toward helping others; the data in the previous chapter pointed to students valuing science if they had the opportunity to both help themselves *and* others. Additionally, other data from the interviews shows this tendency. Even in their preferences for television shows, four students mentioned that they liked watching *Extreme Home Makeover* because they helped individuals each week. Five of the 19 students interviewed mentioned giving back to their communities in various ways as being role models or doing specific acts that will benefit the good of their community.

TCS: What does it mean to be successful to you in American society?

Cornell: It means that you give back to your community, and you help the homeless, and you got to help foster children and stuff like that.

TCS: And what would you have to do to achieve those things?

Cornell: I can help my parents more around the house. I can help in my neighborhood a job of cutting grass and helping elderly people. [Cornell, Talley, Interview #1, Lines 191-199, June 8, 2006]

The desire to give back to their communities may also reflect the minority culture of mobility offered by Neckerman et al. (1999), in which middle-class and upwardly mobile African Americans who "make it" feel the need to reach back to help lower-class Blacks as a way to show solidarity and loyalty to uplift their race.

In-Between Students

I developed the next category of "in-between" based on the description of one student who viewed herself as situated between what I described as a helper in the previous section and what she termed a "cool kid." In-between students understood mainstream notions of achievement as well as local meanings of what being adolescent Black boys or girls at their school were for them. They were students who considered themselves to be smart. Outside of school, they studied, read books, wrote for various purposes, and involved themselves in a range of activities. Some of them even mentioned being good students at their previous schools or in the previous year. Inside of school, in their 7^{th} grade year, they were in-between, which was a strategic and relational position – one in which adolescents juggled mainstream notions of a "good student," and being cool with their peers.

TCS: And how do you think other people would describe you as a student?

Courtney: Some people call me a geek and stuff like that because I'm smart and like when I do my work, they're always like, 'Oh, Courtney, oh, what's the answer? What's the answer?' And I'm like, 'Why do you always ask me?' [And they say] 'Cause you're the smartest person in the class.' [Then I say] 'Okay.' So I give them the answer, but I really don't want to be the smart person. I want to be a normal person. I

> don't want to be known as the geek in the classroom. But I'm torn down being the geek. I mean I'm in-between. I'm kind of like the geek, and I'm kind of like the cool kid. I'm in between there. I still do my work and sometimes I goof off a little bit. And sometimes you [the teacher] just may have to talk to me. But it's not as much as some of my friends. They talk, not as much as they get in trouble, but now I used to be known as the geek, but now I'm just known as the, you know… [in-between]. [Courtney, Maxwell, Interview #1, Lines 128-135, May 24, 2006]

What was most interesting in this case was that although Courtney claimed a position of an in-between student, students who positioned her as the "smartest person in the class" and someone from whom they could receive help did not recognize her in this way. However, Courtney did not want to claim the position of helper. By her own description, she was in-between, because she understood that she needed to make changes to obtain recognition as one who was both smart and cool, something that students in this study seemed to value. Bhabha (1994) discussed in-betweenness as being at the interstices of two cultures. All of the students in this study negotiated the interstices of the mainstream culture of school academics and that of urban, Black youth, and mixed the two cultural models in order to meet the demands of both. However, in-between students were cognizant of the rules of both and attended to the demands of both simultaneously.

Some students seemed to identify as in-between and embody the characteristics of in-between students in various ways. One of Courtney's classmates and a good friend of hers, Tupac, described himself as being "in the middle:"

> TCS: And how do you think other people would describe you as a student?
>
> Tupac: I think they would describe me… like, if we was on a scale, I think I would be in the middle, right, [be]cause I don't cuss out teachers. I don't do none of that. Like Ms. Douglas, do you know Ms. Douglas?
>
> TCS: No, I don't know who she is.
>
> Tupac: Oh but there's a teacher named Ms Douglas, and she cuss out the kids. She don't care, and when she started doing it to me, I don't like cuss back at her, but I say something back to her, but I don't cuss, and I don't get loud. I just say something to her, but I don't get into it like they do. They

don't care, but I don't do that, and I do my work sometimes, and sometimes I don't. But now I'm doing my work every day [since report cards came out]. So yeah, I say that I'm in the middle.

TCS: What made you change to doing your work every day?

Tupac: Cause it's the last card marking [period]. [Tupac, Maxwell, Interview #1, Lines 194-213, May 10, 2006]

For Tupac, respecting teachers by not "cussing them out" and doing his work sometimes put him "in the middle." His classmates at Maxwell recognized him in that way, too. For example, Courtney's descriptions of Tupac put him squarely in the "in-between" category:"

TCS: I would like you to nominate someone in your science class that you most admire, respect or want to be like.

Courtney: How many people can I nominate?

TCS: Well you can nominate a few people.

Courtney: Okay I nominate two. Tupac, I respect him a lot. He's like almost my best friend. He's a boy, he's a boy best friends. … Cory, he is just cool, and I respect him and I admire him, too.

TCS: And what is about them that you admire?

Courtney: I mean they're cool. I mean, yeah, they get in trouble sometimes, and they might act bad, but they still get good grades and they don't goof as much as some people do. [Courtney, Maxwell, Interview#3, Lines 273-289, June 1, 2006]

In the previous excerpts, Tupac saw himself as in the middle, and Courtney described both Tupac and Cory as cool, not as bad as some students were, *and smart*. Below is an excerpt from field notes that depicts Tupac's identity as in-between most vividly. This shows his balancing the academic and social demands of his science class, in particular. Tupac was a student that was frequently absent and did not volunteer much when he was present. Although Mrs. Alexander called on him infrequently, she called on Tupac when she wanted someone to give the right answer. In the excerpt to follow, Mrs. Alexander reviewed the daily DO NOW assignment in which students had to write down everything that they knew about substances. She had a few students volunteer their answers. Many students either did not do the assignment or did not volunteer to share their answers:

> Mrs. Alexander tells students to take two minutes to write down what their classmates have volunteered into a paragraph. Only a few students are actually working.
>
> She walks around monitoring students' progress, saying things like, 'We're writing, not talking.' Students are quiet for the most part. About two minutes later Mrs. Alexander says, 'Ten seconds.'
>
> She starts by asking several students if they want to share their paragraphs. Tim, Devon, Mr. Walker [Richard] and two other boys all decline. She gets a male student to volunteer his answer. She then asks for a young lady to share. All whom she asks decline. She walks around the classroom and asks Tupac if he would like to share.
>
> He says, "no."
>
> She then asks Tupac if *she* can read his aloud.
>
> He agrees by saying, 'Yeah.'
>
> She reads 'I understand that substances...[inaudible]. I also know that substances are made of one type of matter all the way through. And it has three properties. Properties are characteristics of substances that scientists use to describe substances, to help identify substances and to distinguish the substances from each other. And that's what I understand about a substance.'
>
> Mrs. Alexander asks if there is anything else anyone wants to add about substances. No one responds. She then moves on to explain the activity in which they will be looking at substances. [Field Notes 2/1/06 Maxwell, Activity 7.1, Lines 50-71]

In this excerpt, Tupac maintained the practice of his peers of not participating at the teachers prompting, but he did his work, and he met the teacher's need to get the right answer by allowing her to read his work aloud. Tupac was in-between because he understood the need to meet both worlds in his science classroom without compromising one for the other. In their case study of four middle-school African American girls, Brickhouse, Lowery, and Schultz (2000) found that teachers responded favorably to Chandra, an average student who was successful at negotiating both academic and social aspects of science class. Like Tupac, she was able to conform to the requirements of both worlds in a way that satisfied her standing with her teacher and classmates.

Other students' descriptions of in-between students or ones in the middle depicted them as individuals in balance both socially and academically – who knew when to work and when to play *in class*. Unlike students in the good-student category, who felt that you must relegate all play to outside of the classroom, in-between students knew that they could incorporate both even inside the classroom. These students did their work when appropriate, but could also attend to the social scene. In-between students were not always at the top of the class, but many times, they were, or their peers perceived them to be. They were often the students teachers said did not apply themselves. These students' actions were strategic in their relations with teachers and their peers; they were aware of the rules of the academic and social worlds of their classrooms and schools.

One student at Linden, who self-identified as in the middle, even mentioned admiring his science teacher. He described her as knowing when to be "business-like" and when not to be:

> TCS: I would like you to nominate someone from your science class that you most admire, respect or want to be like and then why.
>
> Andre: Ms. Foster, my teacher. She fun. She ain't like the rest of the teachers here, strictly business. She'll have fun with us but when it's time to get the work done, she…, she jump right on us. I admire her. She don't know it. [Andre, Linden, Interview #3, Lines 250-256, May 25, 2006]

This excerpt seems to reveal another instance of youth in this study describing the need to show a human side of individuals in science – as fun *and* smart. This same pattern was seen in the good-student identity, as evidenced by the ways in which Andrea and Ashanti spoke of knowing when to play – outside of school – and needing to describe how they were when they did indeed play. This need to balance academics and social life was specific to the subject area of science, a subject for which students held stereotypes about the type of people who did science. If students saw scientists as not social and not engaging in everyday endeavors, these balancing acts between the academic and social worlds of the classroom may have occurred in part due to the science-related cultural models they held. They may have also been seen as a way to enact an identity acceptable to Black youth, as showing solidarity to friends also seemed to be important to youth in this study.

<u>Good Friends</u>

The next group of students, good friends, completed their schoolwork to some degree, but did not attain the equal balance between academic and social worlds like the previous group. The social took precedence over the academic. Students often spoke of previously doing well in school and now struggling due to social pressures:

> TCS: The main character talked about his school and about trying to fit in with the other people, and what the consequences of that decision was on his life. And I'm going to ask you some questions about your school and the groups of people you hang out with. Thinking of the story you just read, how is Benny's experience with his friends and his school work similar to your own?
>
> Cornell: Like at the beginning of the year, I was high in my grades, but then when the second card marking came, I started dropping cause I was paying more attention to the basketball team here.
>
> TCS: And how is your life different from Benny's?
>
> Cornell: It's not really. I might stay out too late. I might not come home until late now. [Cornell, Talley, Interview #3, Lines 134-148, June 8, 2006]

Others seemed to be very aware of how their academics suffered:

> TCS: And nominate someone who doesn't try and receives poor grades?
>
> Michelle: I don't know about his grades, but he [Cornell] doesn't do work. Like he'll do something once. Like he'll do a report, and that will be it for the whole semester. Like you big dufus. Like he's just sits there and be stupid all the time. Just… he's just so dumb. I mean I'm not trying to be mean, but he really is. He's just really dumb. [Michelle, Talley, Interview #3, Lines 304-307, May 31, 2006]

Cornell was a young man who played sports at the school. He was a student that I did not choose originally to interview, but that I requested after interviewing Michelle, in order to get a range of students from Talley. He was someone that I never saw the science teacher chastise much, but who was always cracking jokes and being silly at the table he sat at with other male athletes in the class. As Michelle mentioned in very blunt language, Cornell had a difficult time trying to balance the academic and social worlds at Talley. In my interviews with Cornell, he stated that he thought he was a good student and that others saw him that way, too, although Michelle did not. Unfortunately, like Courtney, at least one person in the class did not recognize Cornell's claim to the position he claimed.

At Talley, the classroom dynamics were different from the other two schools. There were almost 50 students in the classroom, so the teacher kept the pace frantic to ensure that students paid attention and did not "act out." Therefore, the teacher dealt with students who were not academically oriented quickly. One common practice was to have all students hold up their homework for collection at the beginning of class (which brought attention to those who did not complete it). Another was for Mrs. Robinson to call on students who were talking or not paying attention, like Cornell:

> Ms. Robinson starts to review the daily journal topic by reading the question aloud: 'In a chemical reaction the number of atoms/molecules stay the same? True/False?
>
> She calls on Jessica, who says, 'false.' Ms Robinson asks how many people agree with Jessica. Few students raise their hands. Jessica then changes her answer aloud.
>
> She then calls on Cornell, who was talking with a neighbor. He pauses, then says, 'um... false?' [Several students laugh.] Ms. Robinson says, 'No, true. Pay attention.' [Field Notes, Talley, 2/1/06, Activity 8.1, Lines 30-35]

Students who were in the good-friends category understood the good-student cultural model, but their actual behavior deviated from it such that it appeared that social and academic cultural models were in conflict:

TCS:	And describe what being a good student means to you?
Erika:	To come to school every day with your supplies, be on time in class and be quiet and listen to the teacher and do all the work he or she say.
TCS:	And how do you think other people would describe you as a student?
Erika:	Not a really good student. [Be]cause I be late to my class sometimes, and I do come with my supplies, but not all the time do I listen, cause I sit and talk sometimes. [Erika, Maxwell, Interview #1, Lines 69-79, May 31, 2006]

Erika mentioned in her interview that the transition from elementary to middle school prompted her to change from a more academically to socially-oriented student. Erika discussed the difference between this school and her last school:

TCS:	And why do you think you make different grades here than you did there?
Erika:	Because probably because I don't really do my work and I would just rather sit down and talk in class and hang

around my friends. [Erika, Maxwell, Interview #3, Lines 161-173, June 2, 2006]

Erika was a student who was popular at Maxwell by her own admission because she was able to wear the clothes that everyone thought were "tight," or cool, and she hung with others who were also in high-status groups at Maxwell. However, Erika was one of the students who mentioned in her interviews her struggle with the dominant-cultural capital of classes such as English and science that required specific ways of speaking and writing. It was possible that her choice to engage socially over academically related to her lack of efficacy as a student in the science classroom or to outside of school issues. In the excerpt below, she spoke of difficulty with science vocabulary:

TCS: And how is the work in science class different than in your other classes?

Erika: Because we be studying stuff like air and all that type of stuff, and it be confusing [be]cause we be using big old [words], we don't know what she be talking about half the time. Like if we miss some weeks of school and we come back, she don't even be telling us what she be talking about, and I just [be] looking at her like I don't even know what she talking about. [Erika, Maxwell, Interview #1, Lines 94-100, May 31, 2006]

Students in this category seemed to accomplish adherence to social norms differently depending on their gender. In the next two examples, students depicted gendered ways of attaining balance between the academic and social worlds of their science classrooms:

TCS: Is there someone in your science class that you think is a good science student?

Tupac: Yeah, Martin.

Martin: What types of things makes him a good science student?

Tupac: Well he is [a good science student] and he not [a good science student] because he don't do his work, but he don't talk. He don't talk to nobody. He do his work sometimes. He don't… the teacher never holler no more about unless… the only time she call him is like when got like… like if somebody calls to the school for him or if she needs to tell him something, she asks him where the paper is… he didn't do it, or something like that.

TCS: Now how do your science classmates act towards this boy Martin?

Tupac: They don't call him no geek or nothing … They all cool with him. Yeah. Cause sometimes, he quiet, but sometimes he hang, you know, he do what the other kids, the wrong crowd, he do that. And he'll cap on people and he'll go 20 seconds. [Tupac, Maxwell, Interview #1, Lines 202-216 and 225-230, May 10, 2006]

Tupac saw Martin as both a good science student because he was quiet and a bad science student because he negotiated his placement as an outsider by sometimes engaging in the same behaviors as classmates Tupac labeled "the wrong crowd." This included activities such as "cappin'" or a game of "the dozens" in which an individual is crowned the winner because he/she said the most derogatory jokes about another individual (or better, his mother). This is a linguistic practice particular to Black English that has distinct rules such that, "the insult must be funny and original (or a new twist on an old line). And, most important, it must not be literally true because, then, it is no longer a game" (Smitherman, 1997, p. 13). Martin also engaged in a practice called "20 seconds" where a group of boys locked him in the bathroom and beat him up for 20 seconds (if he lasted 20 seconds without crying, he won; I learned about this activity from Tupac). I learned from another interview that Martin did well at their previous school and in classes other than science. It appeared that he felt the need to show solidarity with the other boys in science class. The question is why? What was it about science or the environment in particular that caused boys at Maxwell to react in this way? One answer may be that the "20 seconds" ritual described above is some type of a gang initiation (Best & Hutchison, 1996), which can occur for either gender (Moje, 2000). This is definitely a possibility, as three interviewees from Maxwell mentioned that some students in the school belonged to gangs, (which may be why Tupac witnessed the incident with Martin above).

Some reasons for enactment of good-friend identities came from the girls in this study. They seemed to enact good-friend identities for two reasons. The first was seen in the excerpt with Erika, who was not able to understand the norms of the disciplinary demands of science vocabulary, and chose to engage in the social scene in which she already had social status. The other I present in the excerpt below. Some girls chose not to engage in classroom activities in science because such participation was incongruent with their notions of appropriate activities for females or their gendered cultural models. The excerpt below shows how a table of girls at Maxwell decided whether to engage in an activity in which the teacher calls on them to be "scientists:"

> T has to quiet class w/ a count, "5… 4… 3…" T announces that she will pick the table that has the most complete procedure to do the experiment. She picks Table A with Shantae, Porshe, Denisha, and Ari. [I go over to this table and ask students if it is ok to tape record their activities. They say yes. I ask for all their names and tell them I will listen to the recordings later.] The teacher takes their activity sheet and tells the girls not to throw away their sheets because they will have to revise their procedures.
>
> Mrs. Alexander has Shantae go to the supply cabinet to get four sets of goggles and test tubes. Mrs. Alexander warns her to be careful and to put the test tubes in a rack. Most students watch as she does this. The teacher has Shantae go up to the front and pour oil and water in the test tubes (putting oil and water in two test tubes each). The teacher then asks how many test tubes and how much water they should put in the test tubes. Porshe yells out, '4' and then'75%.'
>
> Mrs. Alexander tells students to pay attention to the procedure so they can make changes to theirs, particularly how many test tubes they need. Shantae then takes everything back to the table. All four girls pick up goggles, but Ari can't get them on her head. Mrs. Alexander tells her to get another pair. She gets a pair from the back of the room, and then says she does not want to put them on because she does not want to mess up her hair by putting on the strap. A male student calls out, 'It's already messed up!' Each of the girls begins to prompt the others to put on the goggles and they are arguing about putting them on. Porsche tells Shantae to put on the goggles. Mrs. Alexander says, 'Maybe this table won't be doing the experiment.'
>
> This goes on for at least two minutes. None of the other girls at the table put on goggles. They were saying things like, 'You put them on. No, you put them on!' I had the audiotape on the table as the girls started the activity. Ari says, 'I am not about to put them dirty things on my face." Porsche tells Shantae that they should do what they are supposed to be doing because they are being recorded. Shantae starts reading from the procedure as she tells the other girls that she is not doing anything.
>
> Mrs. Alexander has Shantae take the goggles to the back of the room. The teacher then commences to demonstrate the activity for students at the front of the room. [Field Notes, Maxwell, 1/5/06, Activity 2.1, Lines 57-62, and 68-88]

One of the major practices of this classroom was that "good scientists" participated by wearing the proper equipment and engaging in the demonstrations of science activities obediently. These girls chose to do neither. This excerpt from Maxwell showed how the girls initially agreed to participate, but then chose not to when one of them pointed out that the strap would mess up her hair and that the goggles were dirty. In doing this, Ari signaled that she was a girl who cared about maintaining her appearance and as such, would not engage in this activity. Again, it appears that social and academic cultural models were in conflict. The girls chose the social over the academic. In turn, Mrs. Alexander did not challenge their adherence to a stereotypically gendered identity in lieu of that of scientists. This may be because of her adherence to safety rules, or more likely due to needing to get through the activity, which she then demonstrated for the class.

Out-of-Balance

The last group of students was only marginally part of classroom interactions, academic and social. Like the helper identity, students in this category generally were positioned by others, or chose actions that appeared to be unfruitful in either their academic or social worlds. They often did not do class work and/or did not put forth effort when they did the work in class.

TCS: Nominate someone in your science class who doesn't try hard and receives poor grades.

Andre: Someone who don't try hard and receives bad grades… Matthew. He play around a lot. He really don't say nothing but he don't do his work either. He always have his head down. That's about it. [Andre, Linden, Interview #3, Lines 300-304, May 25, 2006]

For some students, the reasons they disengaged had to do with their lack of efficacy in certain academic tasks such as reading and writing. One student at Linden named Michael, put his head down or did not engage during reading and writing tasks in his classes, as he did during the reading diagnostic given as part of this study. He stated that he liked math and felt confident in his ability to do math problems. He did not mind science because there were fewer reading assignments than in Language Arts, and there were hands-on activities. However, he mentioned that his peers made it difficult for him to engage in activities in class:

TCS:	How does participating in academic games differ than participating in activities at school?
Michael:	Because you don't have to read… or like say get the question, then you say you don't get it [the answer], then everybody start laughing.
TCS:	You mean in class that happens?
Michael:	Yes.
TCS:	Whereas in academic games does that happen?
Michael:	You've got friends to help you. Like if you don't get it, they just be right there to say what you got to do and stuff like that.
TCS:	So it's like a lot of help and support from people in the academic games.
Michael:	Without making fun of you. [Michael, Linden, Interview #2, Lines 388-406, May 22, 2006]

Michael engaged in academic games, an elective at Linden, because it was a non-threatening environment in which he could risk being wrong and not understanding everything in ways that he could not in class; it was also an environment where friends helped one another. In his classes, he did not have the same safe environment. He chose not to give his classmates the opportunity to laugh at him. During the times I was in Michael's science class, I saw him not focused and not involved in classroom activity. In an earlier excerpt, Michael shared that Mrs. Foster did not let someone he considered a good student sit near people who were "bad influences;" he mentioned that she did not let them sit near him, either.

Out-of-balance students got into trouble frequently with their teachers and sometimes with other students. Many of the male students in the study spoke of good students as being respectful of teachers in ways that the girls did not mention, and spoke of behaviors that sometimes got them into trouble such as cussing at teachers, not giving teachers "problems," and not applying themselves. However, I include an example of a female student who I know had issues in class from observations of the science class at Maxwell. Mrs. Alexander moved her from one science class section to another because of the issues she had getting along with the other students. She was positioned as a social outcast, and chose not to engage academically. Unfortunately, most of the time, they were not issues within her control:

> The teacher prompts students to begin working and the majority start working. Girls at Table A, the table closest to window near the front where Shantae and Porsche sit, tease Benita who has on uniform pants that are not long enough for her. Porsche asks Benita why she is wearing capris in the winter.
>
> I walk around talking with students at tables D and G about what they are writing, and they seem to be confused. At Table D, some the students think that they will be mixing salt in oil and water instead of mixing fat and soap to see if they are soluble in oil and in water. The girls at table G also say they are confused. After I help the girls with what they need to start the task, Robin and Alana work together. The other girl, Benita, does not do anything right away. She raises her hand and asks Mrs. Alexander for another sheet of paper. Even after she gets a new sheet of paper, she continues to work in isolation, not writing anything on her paper as the other two girls work together. [Field Notes, Maxwell, 1/4/06 Activity 2.1, Lines 30-32, 161-168]

It was possible that there were issues from their homes, neighborhoods, from other subject area classrooms or school experiences that caused out-of-balance students to struggle. In this case, the condition of Benita's too-short pants possibly exposed her family's financial difficulties, and marked her as being of lower social status than the girls who teased her. Benita struggled to engage both academically and socially. It is important to note, however, that even though they were not involved in the teasing episode with the group of popular girls at Table A, the other two girls at the table with Benita chose not work with her to complete the assignment. In other words, no one challenged the way in which the girls at Table A marked Benita as less than – not even Mrs. Alexander (who I am not sure heard the exchange). On the other hand, Benita's disengagement from both academic and social interactions was possibly as much a rejection of a social world that mocked a situation over which she had no control, as it was a rejection of class work characterized by collaborative activities (with students who mocked her). That her work was contingent upon cooperative work with others made the construction of an identity as a science learner unlikely for Benita in this instance.

The excerpts shared above illustrate the complexities of the cultural models that converged in these science classrooms, and affected the interaction patterns of students.

They also highlight that the teacher could not control for or anticipate what ways the convergence(s) occurred or the identities created by perceived differences in social status (or other markers of difference such as reading ability) of students in her science class. The project-based curriculum called for cooperative inquiry of phenomena. However, the project-based curriculum alone was not sufficient to assist teachers like Mrs. Alexander in grappling with a situation like Benita's in which group work was untenable based on social relations in the classroom. The interactions required for participation in these science classrooms entailed a certain level of trust among members; students like Michael and Benita did not trust their classmates, and may have struggled in constructing identities as science learners because of this. In her review of studies of students' need for belongingness and acceptance in school communities, Osterman (2000) found that "students who feel accepted and secure are more likely to evidence autonomy and self-regulation" whereas "students who experience rejection often exhibit an unwillingness or inability to conform to norms and appear less able to act independently (p. 330)." Without having a space in which they could be accepted for being themselves—a struggling reader and a student without the material resources of her peers—Benita and Michael were not able to negotiate identities as science learners without assistance.

Balancing Acts and Science

The interview and observation data from this study illustrated that students were struggling to balance academic and social cultural models in these classrooms. One might ask, what does this have to do with science? When comparing interviewees by survey data measuring their self-perceptions of their science abilities, I found data that helped support that these balancing acts are indicative of science classrooms in particular. Figure 5.2 is a graph of the 14 out of the 19 interviewees with data available on their perceived ability in science. I added lines in the graph to indicate interviewees' identities from the qualitative data.[25] I included the first letter of the school name in parenthesis. In general, students' identities from the interview and observation data corresponded with the

[25] Because the helper identity was a positional one, it is not represented in graph.

continuum of perceived science ability from the survey data (shown in Figure 5.2), until one gets to the in-between category. Looking at the graph, the values of perceived science ability are lower and shift direction in the in-between category. It should be noted that no Talley interviewees were represented in the lower values of perceived ability in science. Most Maxwell students constituted the lower portion of continuum. I only had survey data for one of the four Linden interviewees.

Students in the good-student identity category – Ashley from Linden, Mina from Maxwell, and Ashanti, Calvin, and Damien from Talley– had the highest perceived-science ability of all interviewees, and some of the highest levels of all participants in the study.

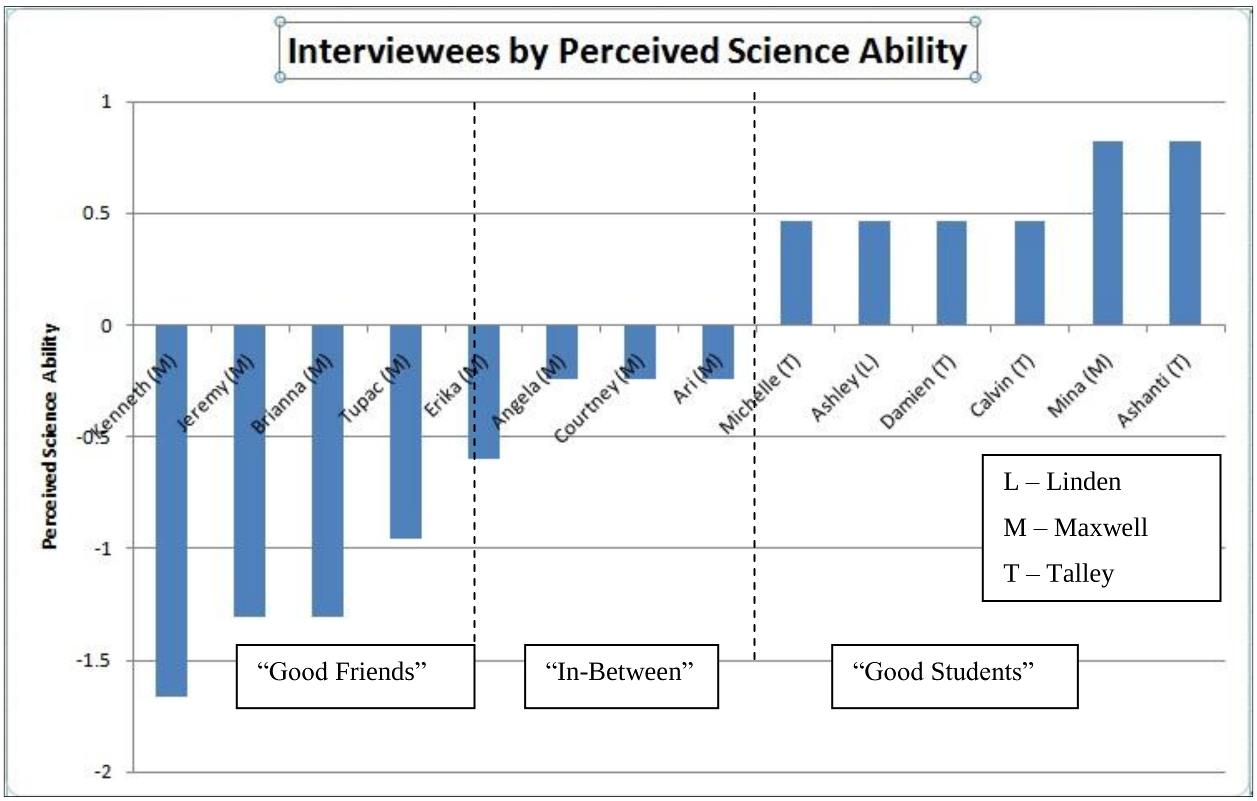

Figure 5.2 – Interviewees by Survey Data on Perceived Science Ability

Although Michelle (Talley) and Ashley (Linden) had the same level of perceived-science ability, Michelle's responses in interviews put her squarely as a student that was in-between. Michelle was a student at Talley, the school whose students had the highest perceived science ability (on average) in this study. It is possible that even though interview data depicted her as in-between, she still had relatively high perceptions of her ability in science in comparison to other students in this study. Conversely, Ashley, who had the lowest perceived ability of the students in the good-student identity category, attended Linden, a school whose students had lower perceptions of their ability in science. Courtney, a student at Maxwell, from whom I derived the term in-between, had a self-concept of ability in the center of the distribution of interviewees' perceived ability. Another Maxwell student, Ari did as well; she was the student who refused to put on her goggles in a fieldnote excerpt shared previously.

In their interviews, Tupac and Jeremy (Maxwell) stated that they were "in the middle," which may be an accurate statement at their school, however, compared to other interviewees across schools, their responses would not be in the middle. Although Tupac is closer to the middle than Jeremy, they have some of the lowest self-perceptions of science ability in the group. Erika, a Maxwell student who did not see herself as a good student, and one who struggled in science, had higher perceptions in her ability to do well in science than both Jeremy and Tupac. Jeremy had perceived ability that was the same as Brianna's. Brianna was a Maxwell student that could be categorized as out-of-balance based on her interview responses. Brianna was the only interviewee in the out-of-balance category for whom I had responses to this item.

These balancing acts in science looked different for interviewees depending on school context and youths' gender. It is also possible that students enacted student identities in general, but in science, they adopted identities depending on their cultural models of science *and* of their peers in their school context. This difference may reflect that balancing acts may have looked different at Maxwell in that they were more social than students from the other two schools, possibly because of the science instruction they received, the environment of the school, or due to cultural models youth held about being students, about science, and peer culture.

Survey data for participants in the study on average also showed that girls had lower perceived science ability than boys did. These data may provide disconfirming data for students such as Tupac and Jeremy and their claims to in-between identities, but these data confirm gender differences in each category (as was observed in the observation and interview data as well). Boys had lower perceptions of their ability in each category, particularly among those at the lower end of the perceived-ability spectrum. Maxwell boys who were interviewed had lower conceptions of their ability in science than girls in the same identity category. As I mentioned in the previous section, it appeared that girls and boys in the same category constructed identities in different ways; Figure 5.2 confirms this at least for those students at the lower end of the spectrum. This difference in perceived ability by gender may be due to the cultural models that students in this study held about science and good friends. If boys at Maxwell believed that being a good friend was incompatible with their cultural models for science and scientists and good students, they may have felt that they could not do well in science. At Maxwell in particular, the teacher positioned students as helpers – a position in which girls were often positioned. This identity may have been seen by some of the male students to be a less desirable science learner identity.

<u>Discussion: Balancing Acts</u>

Students' talk from interviews and in my notes from classroom observations revealed the ways in which individuals categorized themselves and positioned others in reference to the categories of good student and good friend. The categories represented the range of identities that students assumed *and* the degree of effectiveness in balancing the forms of cultural capital needed to navigate the social and academic worlds of their science classrooms. Students categorized themselves and positioned others, and sometimes assumed identities others ascribed to them in their science classrooms. These negotiations were made possible due to the figured world of science to which students in this study appeared to adhere, one in which an adolescent could be a good student, but also maintain social and cultural links to peers.

Although students attended very different schools, their beliefs and identities in relation to science were similar, indicating that they shared cultural models, discourses (as evidenced by their talk in observations and interviews), and resources related to science, even with contextual differences across schools. Their figured world included the dispositions, associations with others, and knowledge of school and class norms as well as broader social norms and mediated their ability to navigate the terrain of their classrooms. The actions, dispositions, and knowledge that constituted good student identities were the most fruitful in the science classrooms in terms of enacting identities closer to the cultural model of good students, and appeared to constrain the social status that students could attain. In Ms. Robinson's classroom for example, students had to be alert and engaged for fear of the teacher embarrassing them for non-conformance to desired classroom behaviors. In Mrs. Alexander's class, students had to be obedient and observant for the teacher to allow them to participate as good scientists in the classroom. Because of the distance between the types of people they were socially as urban Black youth and who they could be academically, students created a figured world that helped them devise hybrid ways to "be" in science that allowed them to maintain balance between their academic and their social selves – *relative to their specific school contexts*. These balancing acts were strategic and reflected youths' negotiations of the competing cultural models in the classroom, and their facility with understanding when and how to use dominant and non-dominant cultural capital in the classroom.

Their figured world of school science also established participants' valued roles and norms. Although students may have espoused on identity, this did not mean others in the classroom acknowledged or validated their claims. This was because identity negotiation in their figured world of science was complicated by students' interactions with teachers and peers in these science classrooms, which were somewhat different across schools. Youth were sometimes positioned into identities by others in their classrooms that they would not readily assume if given the choice. Examples were given that showed that although some readily adopted helper identities, others were positioned by teachers and peers into this identity category. The same is true of the out-of-balance category.

Identity negotiation of balance in their figured world of science looked different across identity categories. Good students focused on the academic in school and the social after school, and adhered to middle-class norms of success and achievement. Helpers had confidence in their abilities as students in general and in science in particular, and helping others sometimes gained them favor with their peers and with their teachers. In-between students did reasonably well in science, and were also deemed cool their friends in their classes. Carter (2005) refers to the navigational characteristic exemplified by in-between students' choices and posturing in school. She labels such students "cultural straddlers," because of their awareness of the types of valued behaviors that were useful in their peer groups and in the school context, and when and where to enact them. Per the figured world students had of science, those who were in-between were the most successful at leveraging academic/scientific, and social resources.

There were also two groups of students who did not fare as well in these classrooms academically – those in the good friends and out-of-balance categories. Students in the good-friend category may have had a hard time adapting to the academic demands of middle schools. They found that the demands of science did not fit with their cultural models of what it meant for them to be a certain type of Black girl or boy or felt they desired to be more socially than academically engaged. The factors that affected out-of-balance students' outcomes seemed to originate outside of the classroom, or earlier in their academic careers. Out-of-balance students seemed to be the least adept at attaining balance between the dominant and non-dominant cultural capital, or least able to use the figured world of science to mediate their construction of identities as science learners.

Survey data of students' perceived ability in science seemed to validate the identities developed from analysis of interview and observation data and seemed to suggest differences by school and gender similar to those seen in the qualitative data. First, the survey data highlight the ways in which the same identity categories differed across school contexts, as students adopted identities relative to their peers at their specific school. For example, students at Maxwell performed identities that looked more socially-oriented than those at Talley, in particular. Students at Talley had higher self-perceptions of ability in science than students from Maxwell and Linden in the same category. This may be due to the challenging circumstances at Maxwell, both academically (a school that was slated for closure), and socially (one in which students had to survive a troubled peer culture), and because students at Linden had lower perceived science ability than students at the other schools.

Second, I also observed what seemed to be gendered identities that students adopted and others ascribed to them (in observation and interview data), particularly the way students compensated for lack of academic or social position in the classroom. Girls helped or were social, and boys acted in ways acceptable in their classroom contexts such as being smart and "cool," an "athlete," or by showing they had could "hang" with the toughest of the boys. The boys' reactions may have been due to them holding cultural models of scientists as individuals who were "soft," and not interested in stereotypically male pursuits and concerns, such as sports and interactions with girls. This seemed particularly the case at Maxwell, which may have been due to the young men not wanting to assume the feminized helper position into which their teacher positioned students. These data suggest that cultural models of what was appropriate for someone of their race and gender drove students' motivational beliefs (e.g., their perceived ability in science), and hence the identities that they assumed.

These positionings and identities created from their figured world of science also seemed to differ by youths' beliefs in their abilities as science students and their access to social and cultural resources. Students who were good students or in-between, were confident in their abilities as students, and were sometimes strategic in their performances of identities or the ways they took up social positions. Good students were also often positioned as helpers even if this was not an identity they claimed or adopted voluntarily. Helpers had fewer social connections, but used their knowledge of science, and their teachers' and peers' need for help to adopt social positions in their classrooms. In-between students used their social connections with teachers and with students and their knowledge of the content and dispositions valued by both worlds to navigate their science classrooms. Good friends used their knowledge of peer cultural models to feel more efficacious in classrooms where they felt less academically engaged. Students who were out-of-balance seemed less able to navigate due to a lack of knowledge, grades/success in the content area, ability to take on valued dispositions (academically or socially), and/or to build associations with teachers and students that cohered with the roles established in the figured world of their science classrooms.

These findings also suggest that there were differences in cultural capital, as evidenced in their access to and acquisition of cultural models (both dispositional and knowledge-based) that would allow them to see science as a subject in which real people like them engaged in school and in the future. This begs the question: What can teachers do to build upon some of the cultural models that students have related to science? How might they facilitate students' negotiations of competing cultural models in order to mediate students' constructions of identities as science learners?

One term that describes what some of the out-of balance students appeared to lack is social capital. In his review of literature on social capital, Field (2008) explored the "dark side" of social capital (also briefly discussed by Bourdieu), in which individuals who had social capital used it to advance their position while simultaneously undermining the social status of others outside of their network. This undermining activity creates mistrust among individuals, and leads to further inequalities between those with social status and those without it. In this study, out-of-balance students in particular seemed to be targeted by others who were attempting to gain social status. Students in the out-of-balance category appeared to have had low trust of their peers, due to lower social status in the figured world of their science classrooms, which in turn limited their ability to assume identities as science learners.

Some students were better able to negotiate identities as science learners because they had the necessary social capital due to their social status and due to their knowledge of valued of the competing cultural models and when and how to use them. Field (2008) suggested that those who have higher cultural capital also tend to have higher social capital because they "are generally engaged with other people, and… their connections tend to be with people who are themselves well connected" (p. 83). Helpers in these classrooms had some social capital because they had knowledge that others in the community needed that they could share as a way into the social world of the science classroom. They also understood what science teachers required, and conformed to teacher expectations (which allowed them to do well academically). In-between students understood the norms and had information valuable in both the academic and social worlds of their classroom; because they had good relationships with individuals academically and socially, they were in a position to have access to additional information through these connections to individuals. Youth who excelled socially and not academically had social capital necessary to succeed in the social domain, but maybe not in the academic one. The same was true for those who excelled academically, but not necessarily socially.

As these excerpts of science classroom observations and interviews illustrated, even when students knew the right things to do academically, they may not have because of the competing cultural models of their classroom context. In reform-based science classrooms where students are required to work together cooperatively in groups (like the ones in this study), educators may need to think about ways to help students navigate the real demands of peer culture in addition to the academic demands inherent in the science curriculum. In the next section, I discuss other resources students in this study had available to them in the form of cultural and social capital that may help explain why some students were more successful than others in their negotiations of science learner identities, and inform the ways teachers could potentially leverage youths' figured worlds in their development of science activities.

Science-Related Knowledge, Connections, and Dispositions Available to Students

The interviews provided other information about things students enjoyed outside of school that may serve as resources in that they could inform curricular and instructional interventions. Students in this study enjoyed engaging in activities that gave them access to real-life applications or examples. For example, 10 of the 18 students interviewed during the second round of interviews chose to watch mysteries and crime show dramas (as at least 1 of 3 of shows they watch) that were related to problem-solving and inquiry thought to be critical to science learning such as *Law and Order* and *CSI*. Below are some of their reasons for choosing these shows. They often chose these shows over popular teen shows such as *106th and Park* on Black Entertainment Television (BET).

TCS: So now I'm going to show you some pictures of popular TV shows, and I would like you to look at these different shows, and tell me if you could choose any of these, which one you would choose to watch first?
Ashley: I would choose to watch CSI.
TCS: Why would you choose CSI first?
Ashley: Because it's very interesting. It's like a drama. It's like investigations and everything and that excites me.
TCS: And is this something you watch on a regular basis?
Ashley: Yes, I do.

TCS: And what would you watch second?
Ashley: I would watch second, I would watch Law and Order.
TCS: And why do you like that show?
Ashley: Because it's like tells like murders and stuff like that and dramas, and it's like very, what is it called? It like gives you hints and stuff that makes you want to watch it more. And it's like when you watch it, you just get hooked onto it. And very interesting. [Ashley Interview #1, Lines 91-115, May 25, 2006]

In the open-ended survey responses to questions about their favorite books (N=128), 76% of the 7th-graders had a favorite book that they shared in the written response, 10% had no favorite book, and 14% did not respond. Twenty-four percent of the students chose books by African American authors, and 11% chose mystery and adventure novels. In general students chose books that took on "real" topics in which people discussed everyday struggles, dilemmas, and issues common to children, teens, families, and African Americans; they also chose biographies, books relating to careers in which they were interested, and mystery and adventure books. Enclosed are a few examples of what respondents to the open-ended survey who were also interviewees wrote:

> My favorite book is the boxcar kids It is very interesting book It is about a mystery and I love mystery book they excite me That's why It is my favorite book. [Ashley, Linden, Open-ended survey response, March 2006].
>
> My favorite book is BANG! By Sharon G. Flake. I like this book because it is a novel by my favorite author and captures African American life in the ghetto. [Ashanti, Talley, Open-ended survey response, March 2006]
>
> The Call of the Wild, is my favorite book. It is my favorite book because it talks about how 1 dog had to adjust to a new area and a whole new life. He also went through a lot of struggles and reminds me of myself. [Damien, Talley, Open-ended survey response, March 2006]

Students' interests in this section cohere with the argument of Nespor (1997) who suggests that school has a powerful competitor for students' attention: popular culture. Nespor gives a description of popular culture's allure to children:

> This competitor, 'popular culture,' has some advantages over school culture. It is more widely disseminated and easily transportable; it is tied more directly to kids' core concerns… [P]opular culture is open to

> appropriation and use by kids interacting with peers, while school-based representations still often presume interactional systems containing both kids and adults (Nespor, 1997, pp. 163-164).

Taken together, the results from the previous chapter and this chapter suggest a figured world of science in which youth in this study were interested in a science that helped people, allowed them to be “themselves,” that used inquiry, and addressed real issues in their lives. These findings raise an important question: In what ways can science educators help students engage in science in ways that allows them to learn about the world through experiences that draw on what they seemed to enjoy about the intrigue, realism, and authenticity of these television shows and books – the everyday struggles, dilemmas, and issues of interest to children, teens, families, and African Americans? How do we help them see science as a living endeavor that not only provides them with knowledge, but allows them build knowledge that actually helps everyday people like them? How might their desire to work together and help one another be fostered in ways that position more students as science learners?

<u>Students’ Beliefs about Future Jobs and Possibilities</u>

The section discusses students’ aspirations, as well as their knowledge of and perceptions about careers and possibilities available to them. Table 5.2 includes the types of future jobs that students said they would like to have at age 25. I found that students provided a range of the responses, with most requiring a college education (66%). Most students aspired to careers in medicine (23%), followed by law (19%) and professional sports (18%). A number of students chose skilled trades such as hair dressing and working in the automotive industry (16%). Thirteen percent chose careers in the entertainment industry such as acting and singing. Approximately 26% of the participants aspired to careers related to science all but two of the students who chose science-related careers chose careers in medicine.

Table 5.2 – Desired Future Careers (N=128)

Job Category	Frequency
Medicine	23%
Law	19%
Professional Sports	18%
Skilled Trades	16%
Entertainment (actor, singer, comedian)	13%
Jobs Requiring College Education	66%
Science-Related Jobs (Includes Medical Careers)	26%
No Response	13%

Students beliefs about what it takes to succeed in American society suggest that while students seemed to have dreams that resembled the American dream, they also they were aware of the obstacles with which older adolescents and adults in their communities struggled.

TCS: What does it mean to be successful in American society to you?
Angela: It means to be successful like you have a job that pays you well. Then… where you smart go to college and get your degree and know a lot of things about what you're trying to go for.
TCS: And what types of things might hold you back from being successful in the way that you talk about?
Angela: Me not finishing school, doing drugs and stuff like that. [Angela, Maxwell, Interview #1, Lines 214-223, May 26, 2006]

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TCS: What does it mean to be successful in American society?
Mina: It just means to follow your goals and do as well as you can.
TCS: And what do you mean by follow your goals and do as well as you can.
What would you have to do to achieve your goals and do as well as you can?
Mina: If you really want to be what you say you want to be, just work as hard as you can.
TCS: Are there any things that may hold you back from doing that?
Mina: Like family problems or like financial struggles or yeah that's it.
TCS: And how might they hold you back?

Mina: It's like you really want to be an entrepreneur for instance, you could and you don't have money to do it or your family's in a little problem, you wouldn't be able to succeed in doing that. [Mina, Maxwell, Interview #1, Lines 232-250, May 26, 2006]

When asked what they would have to do to attain the careers they desired, 12 out of the 19 students interviewed had some general ideas about the skills and education needed for these jobs. Students seemed to have realistic notions of what they would need to accomplish their goals. I include two such responses below:

TCS: And what would you have to do to be able to achieve your goal of being an architect?
Charles: Know math and drafting and go to college.
TCS: And what will hold you back from achieving this goal?
Charles: Not getting an education. [Charles, Interview #1, Maxwell, Lines 244-251, May 11, 2006]

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TCS: And what would you have to do to be able to achieve your goal of being a veterinarian?
Calvin: Well I heard if you want to be in any type of medical school or things, you have to have six or more years of college so [I] have to study and learn. [Calvin, Interview #1, Talley, Lines 239-250, May 17, 2006]

Five students responded in ways that demonstrated that they thought attaining higher education was extremely important, but they also referenced behaviors seen as acceptable at the middle school level as necessary to reach their goal – attendance, paying attention, self-control, and doing your work. The behaviors cited were all things that could reap rewards in college and in the workplace, but they may not be the things that people who attain these positions might say was most important to their success:

TCS: And what would you have to do to be able to achieve this goal [of becoming a lawyer or working in a law firm]?
Michelle: I would have to be able to be a good student, buckle down and concentrate when I'm at school and learn to take life as it comes because something might go wrong while you in college, and you like, 'Oh I just want to drop out.' Like you can't just drop out. So when I'm in college, I want to learn, I want to be able to be a good student so I can learn, get my degree and probably go back to college to get a masters degree or something. *But if I want to work in a law firm, I have to be able to be a good student, and I have to be able*

> *to listen and just be a good person.* [Michelle, Interview #1, Talley, Lines 259-266, emphasis added, May 17, 2006]

In the excerpt above, Michelle discussed very real issues with which one contends in reaching for their goals, as grades are very important in a competitive job market. However, she also ended her response by discussing things that she valued and that helped her do well in middle school – *being a good person*:

> TCS: And describe what being a good student means to you?
>
> Michelle: A good student would be to know how to get things done right, get things done in a good way and to be able to like be positive about everything. And if you're not positive and if you can't do anything, like if you have a project to do and you do it at the very last minute, like if you're a procrastinator, you can't be a procrastinator while you're at school. So you just have to be a good person. *If you're not a good person, you can't be a good student.* [Michelle, Talley Academy, Lines 74-80, May 17, 2006]

Seven students including Michelle showed this same pattern – they said very similar things about what they needed to achieve their desired goals. What is interesting is that this is not a random pattern or a factor of question order. I asked the career questions at the very end of the interview, and questions about what it means to be a good student near the beginning. Their responses possibly indicate the ways they made sense of future attainments from their current identities as middle-school students.

Models of Attainment/Role Models

The previous section showed that students had some naïve ideas about the career fields that they aspired to, which suggests that they may have few models of attainment or people in their lives or individuals who they know personally in these fields. Ten students of the 19 interviewed mentioned not knowing individuals who did the types of jobs they desired. They tended to mention things they read or saw on television as providing information about their dream jobs. For example, one student from Talley discussed learning about the Fortune 500 job she wanted from television.

Eight of the nineteen students interviewed personally knew individuals with the jobs to which they aspired. Some of these individuals were family members. Others were friends of the family, or adults they knew from school. Two students mentioned not talking to these individuals about the types of jobs they held. Three others participated in activities related to their future careers after school or over the summer – interestingly one student each from Linden, Maxwell, and Talley. I include an example each of students whose model of attainment came from their families or from family friends:

TCS: And do you know someone who is doing the type of job that you want to have someday [a pediatrician]?
Erika: Yes.
TCS: And what types of things have you learned from this person about the job you want to have?
Erika: They like, my step momma, well god momma, she like her job. She love kids so, and she likes to work with babies. And I like to play with babies.
TCS: So you learn from her or by just watching her you know that she loves kids and things like that. Does she ever tell you anything about her job?
Erika: No. [Erika, Interview #1, Maxwell, Lines 222-238, May 31, 2006]

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TCS: Do you know someone who is doing the type of job that you want to have some day?
Calvin: My uncle used to be a veterinarian. Now he works somewhere else.
TCS: And what did you learn from him about the job you want to have?
Calvin: I think it was a year ago where he took me to his job and he just… they had a dog who needed severe surgery, and he did it, and the dog was okay. So that made me want to go into veterinarian. [Calvin, Interview #1, Talley Academy, Lines 254-263, May 17, 2006]

These exemplars provide information about the differences in experiences that students had even when they had access to models of attainment. This did not differ across schools. Each of the students in these excerpts had access to individuals in their desired field. However, they did not always talk to those individuals about their jobs, or have experiences like Calvin’s above in which they actually had the opportunity to see individuals at work.

Self-Schema Related to Opportunities: I Will Do That Job, Maybe…

The interview responses led me to wonder about students' aspirations *and* their feelings about them, and to do additional analyses of survey data. In this section, I explore the idea of how schema related to opportunities affected students' job aspirations (based on responses from the open-ended survey). In earlier sections I wrote about schema in terms of cultural schema or cultural models, and how students used them to construct identities as science learners. *Self*-schema are mental structures that organize and store information about the self, which one can later retrieve to help make inferences, decisions, and take action based on previously established patterns of self-knowledge (Markus, 1977). When asked what they really thought they could be at age 25 (priming self-schema about what they could actually be given what they know about opportunities for people like themselves), 31% of respondents changed their written responses from their original aspirations (e.g., doctors, lawyers, professional ball players, etc.) to less prestigious jobs that required less education. For example, one student changed from wanting to be a doctor to being a nurse like his mother. Another changed her response from being a lawyer, to working in a law firm. I coded students' adjustments on the survey items from more to less prestigious job choices as *more practical* and from less prestigious to more prestigious as *less practical*.

Table 5.3 presents the results broken down by school. Students at Talley were most susceptible to lowering their aspirations with the self-schema question (37%), *they were also about twice as likely to raise* their aspirations than their peers at the other two schools. More students at Linden kept the same high aspirations even with the self-schema priming question (8% more than Maxwell students, and 15% more than Talley students). Fewer students at Maxwell changed their answers in terms of practicality. However, it should be noted that a higher proportion of students from Maxwell did not respond to this item in comparison to the other two schools. These findings differ by school, with youth at Talley being the most affected by negative occupational-schema questions, and the students at Linden being affected the least. These findings suggest that students' self-knowledge about their future selves was vulnerable to negative schema. Why were students at Talley so negatively impacted? It may have been the case students whose identities were more closely tied to their academic and occupational goals were the most affected. It may also be due to research that suggests that gifted African American students, who have advanced cognitive ability above their peers may also have other differences in their social, emotional and physical development, which may serve to make them more sensitive to such schema (Lindstrom & Van Sant, 1986; Rodgers, 2008).

Table 5.3 – Response to Self-Schema Items on Future Jobs (N=128)

Job Choice	Maxwell	Linden	Talley
Lowered	23%	29%	37%
Raised	5%	6%	12%
Same	36%	44%	29%
More Practical	2%	12%	15%
Less Practical	7%	12%	17%
No response	25%	12%	15%

Discussion of Dispositions, Knowledge, and Connections

Youth in this study had high aspirations overall. However, few had connections to individuals who had attained the careers they aspired to (including scientists). These results also indicate that youths' stereotypical ideas about scientists seen earlier may come from lack of exposure to individuals in their everyday lives who were working in the careers to which they aspired, or a lack of social capital. These findings also signify that students needed ways to help them have realistic beliefs about who does science and what it looks like for them to do it (e.g., the types of knowledge and dispositions that are useful to succeed).

Their responses also suggested that there were societal and school norms that they understood and aspired to meet on some level, but they negotiated the parameters of those norms in different ways – revealing their agency in the process. These negotiations suggest that students have competing cultural models and goals for their futures that they must learn to reconcile in fruitful ways. Additionally, the schema-related items suggest that there were differences across schools related to which careers students deemed possible and practical. These occupational schema made students at Talley more likely to lower their aspirations when schema related to obstacles to their success were triggered. This may have been due to social context differences as suggested by the number of students who were economically disadvantaged or received free and reduced cost lunch at each school. As reported in Table 3.2 in Chapter 3, 74% of the youth at Linden were economically disadvantaged compared to 64% of the students at Maxwell, and 15% of the students at Talley. Talley students' vulnerability to schema may also be due to the fact that many were considered gifted, and research has shown that African American gifted students tend to not only be more advanced cognitively than their peers, but may also be more sensitive to social and cultural stimuli and situations. In the previous chapter, the data suggested that students at Maxwell and Linden required more attention to meaningfulness in order for them to succeed. This data suggests that students at Talley also need attention, but in a different place – to their beliefs related to success and what making it or not making it may mean for them.

The findings in this chapter lead me to ask the following question: What do available resources—i.e., social capital--have to do with science learning? Bourdieu's (2004) notion of *scientific capital* offers a possible interpretation. S*cientific capital* relates to valued knowledge (including comportment of scientists and science content knowledge) and social networks necessary for one to succeed in the world of professional science. Because this dissertation focused on the science education of middle-school students, I asked what scientific capital might look like for science *learning* if all students are expected to learn science. If all students are expected to learn science, and some have difficulties constructing identities as science learners as some students in this study appeared to, then scientific capital would seem to be related to students' understanding scientists as real people – not just understanding their practices and thinking. This relates back to the figured worlds that students created that included cultural models and resources useful for science learning, and suggests that if they have difficulties forming fruitful science learner identities, it may be due to insufficient exposures to the cultural models and resources (dispositions, knowledge and social networks) of scientists. Having access to role models and expansive cultural models of possibility based on real people and experiences allows one to directly observe the dispositions of individuals and to get personal and relational information about an area of interest. Without such interactions, people make assumptions based on what information is available to them—those sometimes based on persistent stereotypes or two-dimensional models. The resulting figured worlds include cultural models of possibility that are not personal or relational, making it difficult for individuals to see a place for themselves in an area of interest, such as science. To be able to help students consider and take on different dispositions like those they recognize as scientific, it is necessary to expose both teachers *and* students to individuals who have scientific capital and expansive cultural models in science.

Summary

In this chapter, I asserted that social context, gender, and racial identity mattered in youths' construction of identities or self-understandings as science students, and that the relationship is not direct; the identities they adopted were mediated by their figured world of science or the through the cultural models they held about science, school, and their peers as well as the resources that youths had available to them. Students had what seemed to be competing cultural models that they used to construct identities as science students. These cultural models depicted what was typical of good students, good friends/peers, and science, and reflected differences by gender and social class, as well as indications of solidarity to their peer and racial groups. Students negotiated these cultural models to espouse identities as science learners. These espoused identities showed how much students balanced dominant (academic and scientific) and non-dominant cultural capital (related to the peer culture); those who were most able to construct fruitful academic identities also seemed to display the most social capital. Those who could balance both social and academic demands seemed to be the most admired by their peers in this study because they exhibited behaviors and identities valued in their figured world of science – a marker of cultural capital.

In the previous chapter, differences among the three contexts were seen in students' racial identity and perceptions of meaningfulness of school science. Interview data suggested that there were differences in the ways in which students enacted the same identities across contexts, with Maxwell students appearing more socially-oriented even in the more academic categories than their peers at the other two schools. This may be due to the challenging circumstances at this school academically based on the school failing to meet NCLB criteria for a number of years, and socially with gang-related activities and concerns. Conversely, Talley students, who had the highest perceived ability of all students in the study, tended to look more academic when espousing identities in the same categories as students at Maxwell and Linden. Linden students, who had some of the same neighborhood concerns as Maxwell students (as shown in interview data), may have been protected from some of those contextual challenges at school due to the school being newly built and staffed.

I also presented data that showed the other forms of capital or resources available to students. Students had interests and knowledge of inquiry from their everyday lives that teachers could leverage in instruction and activity design. They had high aspirations, and wanted to succeed, but also were aware of the challenges that many in their communities faced. Students in this study had little access to knowledge, dispositions, and associations with individuals in the careers they aspired to, including science that would provide them with cultural and social capital necessary to pursue their desired career paths. In sum, the cultural models and resources that students had available to them were part and parcel of the figured worlds that they used to construct identities as science students; these findings suggest that students may benefit from opportunities that help them modify their figured worlds for them to be motivated to learn science and develop identities as the types of individuals who do science in their classrooms and in the future. Some consideration must be given to how educators create transformative environments that change cultural models available to students and help them to leverage these cultural models in ways that help them construct more fruitful science learner identities. I discuss this along with other implications in the next chapter.

Chapter 6 – IMPLICATIONS AND CONCLUSIONS

This study revealed that variables such as social context, racial identity, gender, and relevance of activities mattered in students' motivation to learn science. I analyzed survey, classroom observation, and interview data as a way to render the figured world of science from the perspective of Black youth during the last six months of their 7th-grade year. These data suggest the need to create opportunities to learn science that help young people build on, expand, and, in some cases, shift their existing scientific cultural models, as cultural models motivate students' actions. These findings also suggest that teachers and curriculum developers should address competing cultural models that exist in school spaces to empower these Black youth to adopt fruitful identities as science learners – ones that will enable youth to build figured worlds that provide access to pathways into science and science-related career pipelines.

Three principles put forth in the National Science Standards (NSES; NRC, 1996) provide support for the importance of these findings. The first is that all students should have the opportunity to learn science. The second is that students learn science through active participation. The third is that "[s]chool science reflects the intellectual and cultural traditions that characterize the practice of contemporary science" (p. 19). The findings from this study suggest that although progress has been made in providing opportunities for students from different backgrounds to learn via inquiry-based science curriculum, there is additional work needed to help students connect to the intellectual and cultural practices of science so that they can make them their own, not just in classrooms for the short term, but also in the long-term. The latter is important if we want to achieve the goal of increasing the number of individuals from underrepresented populations who excel, are critically literate in science, and who enter into the science career pipeline. Without attention to this third objective of connecting to the culture and thought processes of science and scientists through exposure to more expansive cultural models, it seems unlikely that science educators will achieve the first two objectives (science for all students and active participation).

I embarked upon this study of African American 7th-grade students to examine the factors that influenced their motivation to learn science. I hypothesized the importance of students' gender and race to their motivation to learn science. I also hypothesized that there was a relationship between their motivational beliefs about science and their constructions of identities as science learners. I used the following research questions to guide the study's inquiry:

- What are the beliefs of African American middle-school students about the domain of science in general and about themselves in relation to science?
- What is the relationship between students' identifications (as articulated in surveys and interviews) and their beliefs and cultural models of science?

In this chapter, I first summarize the findings from Chapters 4 and 5 where I examined students' motivation to learn science and the cultural models and resources students used to construct identities as science students. I will then tie the results to the literature in a discussion of the identity development of minority youth as people who did science. I then discuss the implications of what we can learn from this study for students historically underrepresented in science, related to science education curriculum, instruction, and teacher education as well as suggest avenues for future research.

Summary of Motivation to Learn Science

In Chapter 4, I presented the results of tests of means, cross tabulations, analyses of variance, and hierarchical regression models to illustrate relationships among variables and offer possible explanations for students' motivation to learn science as represented by their perceived ability in science and their utility (usefulness) and intrinsic (enjoyment/interest) values for science. I hypothesized that motivation to learn science would be associated with youths' gender, school attended, racial identity, and perceptions of the frequency with which they engaged in meaningful science activities. I also hypothesized that there would be interactions between independent variables associated with students' motivation to learn. I tested these hypotheses using regressions. I provided excerpts from interviews and open-ended survey items to compare what students discussed as enjoyable and useful to what the survey findings suggested.

Gender was a factor associated with students' intrinsic value for science or their enjoyment of science, indicating that girls in this study had lower intrinsic value than the boys did. There was also a marginally significant result on gender; girls in this study had lower self-perceptions of their science ability on average than boys did. Measures of their racial identity and perceptions of the frequency with which they engaged in meaningful science activities were related to all three variables for students' motivation to learn science. For both utility and intrinsic value, the contribution of racial identity was smaller than that of their perceptions of science activities, but was statistically significant.

There was a strong interaction between the youths' perceptions of meaningful science activities (in this case discussions, examples, and things that helped them in their everyday lives) and racial identity on students' perceived ability in science. This result indicated that as students' perceptions that science was meaningful increased, their race centrality and private regard was less important to their perceived science ability. This interaction finding was complicated by school context, which suggested that students had different experiences of meaningfulness across schools, even with the same curriculum. Students at Maxwell had lower perceptions of engaging in meaningful science than Linden students, even though they received more project-based science curriculum. Furthermore, students at the three schools differed in their levels of race centrality and private regard, with students at Linden having the lowest race centrality and private regard. These interaction results indicated that meaningfulness is the key to both students at Maxwell and at Linden having increased perceptions of their ability to do science.

These multiple-choice survey results suggest a relationship between engagement in meaningful activities and students' racial identities, however, did not explain what this relationship may have been for students. I introduced findings from interview data to complement the survey data and to paint a picture of what meaningfulness in science looked like for the urban African American adolescents in this study. The interview data suggested that youth in this study were motivated to learn science that was meaningful in their navigation of the situations and challenges (e.g., making decisions) in their everyday lives and for others in the communities in which they lived. I have argued in this dissertation that the interview data helped to convey what was meaningful or relevant to students, because these data explained in the students own words what things they liked and found useful about science, and provided insight into the relationship between the meaningfulness of the activities and their identities as science students. The interview data make another contribution: explicating what the content of students' motivation to learn science looks like. Together, the motivational data from the survey and interviews depict a cultural model of what students might likely be motivated to do and imagine as possible for them in relation to science.

What makes the findings of this study a contribution to the field is the link between youths' racial identities and how much students felt they were engaged in meaningful activity in their science classrooms uncovered in the regression results. This suggests that meaningfulness is related to students' beliefs about themselves as members of their racial group. Others have linked meaningfulness to gender and linguistic differences in empirical studies in science education, but have not examined specifically the role of racial identity in science. Although the interview data do not interrogate race specifically, they explore the relationship between meaningfulness and motivation to learn science; these linkages indicate that meaningfulness is closely tied to the people and communities in which students live and attend school – those that are predominantly African American.

Summary of Balancing Acts of Identity across Three Science Classrooms

In Chapter 5, I presented data that explained the competing cultural models at play in figured world of science created by students in this study, and the ways in which students made sense of, integrated, and used these cultural models as resources (or not) in their constructions of science-learner identities. The three cultural models depicted by students in interview and classroom observations were those of good students, good friends, and of science and scientists. Their good student cultural model reflected the ideal student, based on teacher, school, and parental expectations of students' behavior and comportment. Their peer cultural model seemed to reference the ways of knowing, doing, and being of adolescent African Americans in urban contexts. Their ways of knowing reflected differences in social class and mobility as well. The cultural model students held of science and scientists conveyed accurate and inaccurate as well as stereotypical and realistic notions of science and dispositions of scientists. Youths' cultural models reflected unexamined assumptions that were gendered, raced, and classed.

In their enactments of science learner identities, young people in this study appeared to draw from all three cultural models, engaging in what I called balancing acts (as evidenced by interview, classroom observation, and validated by survey data). Some students were more strategic than others in their negotiations of science learner identities (e.g., those with good student and in-between identities), and demonstrated more cultural capital in managing dominant cultural models that were academic and scientific against non-dominant cultural models of the social world of urban African American youth (e.g., good friend identities). Those whose balance of cultural models was more academic and scientific also had higher perceptions of their abilities as science students based on survey data. Those in the good friends and out-of-balance identity categories, for whom balance was more social, had lower perceived science ability. In-between students, who were able to achieve more equal balance between cultural models, had perceived ability near the center of the study's distribution for perceived ability in science (in-between identities). In-between students also seemed to exhibit behavior and identities most valued in their figured world of science as suggested by students' responses to questions about the attributes of classmates they admired in their science classrooms.

A complication to the balancing acts was that students negotiated their identities with others in their classrooms, who sometimes did not agree with their claims to a certain identity category. Sometimes others positioned students in identity categories that they themselves did not choose. These identities and positionings while the same across schools, were enacted differently in each setting – with identity espousals for Maxwell students looking more social than those of students at the other schools and Talley students' espousals appearing more academic. Additionally, these balancing acts looked different for girls and boys in this study, with boys' enactments looking more social than girls in the same category. Moreover, at Maxwell in particular, the boys I interviewed had lower perceived ability in science than girls did. The boys' perceptions may be an artifact of the typical student role in the science classroom at Maxwell. At this school, all students were positioned as helpers in their science classroom, although not all of them accepted or assumed this role.

This chapter outlined other types of resources available to students as well, such as the knowledge, dispositions, and associations in their figured world of science that might have facilitated their adoption of science-learner identities. This included knowledge and interests students had related to the idea of inquiry important in reform-based science, students' beliefs about and aspirations for science and non-science related occupations, and their access to individuals in those fields. Interview and open-ended survey data demonstrated that youth had stereotypes related to the careers they wanted to attain when they were asked questions about what they needed to do to realize their dreams.

First, students' responses reflected the behaviors seen as acceptable at the middle school level – attendance, paying attention, self-control, and doing your work. Second, most students did not know someone currently employed in the career of their choice. Third, the students that did have a more realistic conceptions of careers and the steps required to achieve their goals, had experiences related to career of their choice or had access to individuals employed in that profession. Last, when asked what they really thought they could be at age 25 (priming self-schema about what they could actually be given what they know about opportunities for people like themselves), almost one-third of study respondents changed their written responses from their original aspirations (e.g., doctors, lawyers, professional ball players, etc.) to less prestigious jobs that required less education. These responses differed by school, with students at Talley being most susceptible to negative schema. This susceptibility to negative schema may be due to what some research has described as a heightened sensitivity of gifted students, cognitively, socially, and emotionally.

Overall, the findings suggest that students had similar motivations to learn science, similar cultural models and negotiations of identity across schools – even with differences in school contextual conditions and features. This suggests that even across schools, students shared a similar figured world of science. Students employed this figured world to help them contend with several challenges in constructing science-learner identities, including competing cultural models, negotiating identities with others in their school contexts, as well as leveraging the cultural and social capital they had available to them that was appropriate for science. The question remains, however, what does this mean for science and science learning? What do these results suggest about building science curricula and teaching practices that make it possible for all students to learn science?

Discussion: A Figured World of Science

In this section, I explore students' figured world of science by drawing on theories of cultural difference, motivational beliefs, racial identities, and students' cultural and social resources to raise new questions about the implications of this study's results for curriculum, instruction, teacher education, and future research.

Cultural Differences

Youth indicated that they had competing cultural models by using language in which they juxtaposed their ways of knowing and doing from ways that were scientific. The interview data also revealed that learners were at times interested in and connected to the concepts introduced in their science classrooms, but only when they felt it had a practical purpose that they could directly apply to their lives. In other words, youth appeared motivated to traverse perceived cultural differences between their everyday worlds and scientific worlds when they believed they could make meaningful links to the science content. Was the language that they used due to their age or were there other factors at play? The peer cultural model and its influence may have been a contributor to the distance students felt between worlds, as it seemed a powerful influence in the lives of students that was competing with scientific and academic cultural models.

The data suggest that students understood that science requires objectivity and conformity to specific scientific dispositions, but that these requirements may have run counter to students' need for affiliation, belongingness, and subjectivity (Decuir-Gunby, 2009; D Y. Ford, 1996; Osterman, 2000). In this study I noticed that even though there was a strict dress code, many students tried to attain social status (affiliation and belongingness) and to differentiate themselves from others using jewelry, pocketbooks, and hairstyles (subjectivity). Additionally, the popular culture of youth was that of hip-hop, one of improvisation and swagger. It was possible that in comparison, science seemed the opposite with its laws, facts, and specific methods for structuring activity. They also did not get to do many of the activities themselves, but had the more passive role of observers, which may have been at odds with their need for autonomy and competence at this phase of their lives (Legault et al., 2006). This distance they felt between their everyday worlds and science worlds may have also been due to having few adults in their lives who were science workers, which made it so that had few examples of individuals in their communities to challenge and broaden the stereotypical cultural models they held of science and scientists.

Perry, Steele, and Hilliard (2003) summarized cultural difference theory as a mismatch between students' home and school cultures, with the culture of school valuing the norms of White, middle-class Americans. In the conceptual framework, I reviewed studies that applied cultural difference theory to science education, which posited that students whose cultural norms fall outside of the middle-class norms of science may cause students to experience cognitive conflict in science classrooms. Students in this study struggled to attain balance between academic and social demands may have experienced cognitive conflict. Aikenhead (1996) theorized that those whose everyday norms are congruent with those of science gain entrée into the "world" of science with few barriers to success. He argued that individuals whose everyday norms and reasoning practices were incongruent with science had to cross "borders" of understanding to become fully engaged and to obtain more than a purview of scientific practice. The borders students in this study had to cross related to negotiating solidarity with peers and maintaining a sense of who they were *and* becoming science students.

Aikenhead (1996) also argued that science teaching that does not connect to students' personal lives forces students from groups underrepresented in science to choose whether to assimilate to the cultural norms valued in science or not. One may argue that the requirement that one assimilate to certain norms may be true of science in general, but not of constructivist, reform-based science, which focuses on student-centered instruction in which teachers draw on students' prior knowledge and students build their own knowledge. However, this assumes that teachers believe in the value of inquiry-based instruction, have enough exposure to good inquiry-based teaching themselves to know how to model it for students, and believe that all of their students can engage in inquiry-based practices (Barnes & Barnes, 2005; Rodriguez, 1998).

Another assumption is that teachers draw on students' knowledge in their instructional practice. I argue that students' conceptual models of content are drawn on, but often their cultural models are not. For example, Gutierrez, Rymes, and Larson (1995) suggested that monologic interaction patterns between teachers and students establish an official script based on the teacher's agenda, and a "counterscript" containing students' voices, cultural models, and agendas that is unofficial and not visible (or valued) in the life of the classroom. Gutierrez et al. provided classroom examples that show the rich resources available in counterscripts that could be used to help students make sense of and enter into the official script. Gutierrez et al. argued that not providing ways for students to represent their knowledge using their own ways of talking and reasoning made it more difficult for them to assume dispositions and identities as members of a knowledge community. That may have been what students experienced in this study – having multiple cultural models but only one that was accepted. The other models were not entered into the official script to allow them to make sense of their struggles in constructions of science learner identities. These counterscripts may not seem important to content matter like science, but they influenced students' experiences within science classrooms whether they were acknowledged and addressed or not.

As the data illustrated, students were struggling with how to reconcile both academic and social demands of their classrooms on their own. Research has suggested that adaptations to curricular and instructional approaches are needed to help students in their processes of border crossing, including use of their language and other cultural tools as bridges to science learning (O. Lee & Fradd, 1996; Moje et al., 2001; Moje et al., 2004a; Warren, Ballenger, Ogonowski, Rosebery, Hudicourt-Barnes, 2001). However, teachers in urban school districts have additional challenges that influence their instructional choices such as pacing schedules, underpreparation for science teaching, frequent interruptions of classroom activity, lack of resources, and use of direct instruction in lieu of more innovative measures due to large class sizes (Moje, Sutherland, Cleveland-Solomon, & Heitzman van de Kerkof, 2010; Tal, Krajcik, & Blumenfeld, 2006). Moreover, the world of science that many students encounter in some urban schools may not be that different from what they encounter in other subject-matter classes, because learners may not actually get to do hands-on activities. The reality is that urban youth may not get a balanced introduction to the nature of science and scientific enterprise as recommended in the standards, but to a science perceived to be difficult, foreign, and unimportant to their lives. All of the things mentioned here have resulted in students in this study having narrow cultural models of science and scientists. These challenges beg the question: In urban science classrooms, how do teachers support students in their reconciliation of competing cultural models in science classrooms in ways that help them adopt fruitful identities as science learners?

Student and Racial Identities

Why might students choose to take on unfruitful science student identities even when they know that good student, helper, and in-between identities were more useful in science classrooms? If the cultural differences described above were present, these factors paint the picture of an environment that would require a great deal of motivation for students to cross the borders of urban science classrooms to develop fruitful identities as science learners, ones that are deemed valuable and acceptable in mainstream society. The interaction results also suggest that motivation may be related to the need to help students find meaningfulness in the science they are taught. These challenges highlight that one of the major tensions of teaching science is that educators must strive to draw students into not just the routine aspects of science, and address the dilemmas inherent in teaching students important aspects of the nature and content of science, but must also keep them engaged, motivated, and connected via practical experiences and instruction (Dawson, Lederman, & Tobin, 2002; Geelan, Larochelle, & Lemke, 2002).

As stated in the conceptual framework, academic motivation is characterized by students' competency beliefs or expectancies and values for a task or domain; if students are confident in their own abilities to do a task or engage in a domain, they are more likely to value that task or domain and continue to engage in it (Pintrich & Schunk, 1996). I also stated in the conceptual framework that together their competency beliefs and values in a domain define their identities as students. Utility and intrinsic values were associated with students believing that they were involved in meaningful science activities (including discussions, examples, and things that helped them in their everyday lives) and their racial identity; interview data suggested utility and intrinsic value were associated with students' need to use science in ways that helped themselves and their home communities. The variable for science utility value measured youths' perceptions of the relative usefulness of science to current and future goals, and intrinsic value captured students' individual interests related to science. Students whose current and future goals and interest were related to science learning would need to have perceived frequent engagement in meaningful science activities *and* positive racial identity to have high intrinsic and utility value. This finding coincides with research that highlights the importance of racial identity to African American students developing student identities in a content area: "Academic identification not only involves having a positive identification with school but also having a meaningful and positive connection between the academic domain and one's sense of identity, including racial identity" (DeCuir-Gunby, 2009, p. 116).

This result seems straightforward, until one looks at the other part of students' development of achievement motivation and hence student identity – perceptions of their ability within a domain. Their perceived science ability was also related to perceptions of meaningful instruction and racial identity, but was complicated by school attended. Although all students were African American, there were differences in the pride and importance that they placed on being Black. Additionally, there were differences in the amount of access students at the three schools had to science activities that they deemed meaningful. Differences across schools in youths' perceptions of their science instruction and pride and connection to their racial group suggest that whatever the instructional measures used to motivate students in this study, they must be meaningful in order to motivate students, and take into account what students in a particular context find meaningful in science. Taken together, these data suggest that students were motivated by a science that they could connect to – one that allowed them to help people in their community directly and which helped them feel better about themselves as science students in the process.

Students' Cultural and Social Resources and Science Learner Identities

I found that students' cultural models motivated the adoption of certain identities; why were some students able to do this and others could not? Bourdieu (1986) posits a theory of reproduction of class status related to the presence of three types of resources in society: economic, cultural and social capital. Cultural capital helps to explain academic success that is not related only to ability and effort, but to exposure to certain dispositions and cultural goods valued by mainstream society. In schools, cultural capital includes the embodiment and products of valued dispositions that help students succeed in school. In science classrooms in particular, useful cultural capital related to the knowledge students had of the content and the strategies they used to balance dominant (academic and scientific) and non-dominant (peer) cultural models available to them in their enactments and espousals of science identities; it even included how they used the stereotypes that many of them held about science and science knowledge, which could be considered cultural capital that was not useful or valued in science.

Their adoption of different identities did not always translate into students developing identities useful in science classrooms, indicating a lack of useful cultural capital mentioned above. The most productive identities in science were those that either put academic and scientific identities in the foreground while deemphasizing social identities (good student and helper identities), or balanced them equally (in-between identities). Recall that Bourdieu (2004) identified the scientific capital of practicing scientists related to knowledge of science, embodiment of certain characteristics, and associations provided by elite social networks; the ability to balance dominant and non-dominant cultural capital in science classrooms could be labeled one form of students' scientific capital. This raises the question: How can teachers help more students gain this form of cultural capital?

It is important to know that students had cultural capital useful to science. The knowledge students had about inquiry as consumed in popular culture representations would be cultural capital at their disposal that could be mined by teachers and curriculum developers. This is only one part of scientific capital, however. Scientific capital also has social aspects as Bourdieu's work showed. In-between students seemed to have the most social capital with teachers and students because they were able to navigate both the social and academic worlds of their middle-school environments. However, the question becomes: Is this type of social capital sufficient for science learning? Bourdieu (2004) contended that capital begets capital, such that those who have capital or access to capital will acquire more capital. One might argue that all students have similar scientific capital, in that they have similar cultural models of science. However, recent research has shown that White working- and middle-class students are more likely to have access to same-gendered individuals with science capital in their everyday lives than their minority peers (Zirkel, 2002), which may serve to mitigate conflicts of competing cultural models about the sociability (or lack thereof) of scientists. Gilmartin (2007) reviewed studies that found that "With respect to science, middle and high school students who have a science role model or mentor have more positive attitudes toward science and scientists, increased persistence in advanced science courses, and greater interest in science careers" (p. 984).

Students in this study had little access to valued networks or networks that resulted in more positive attitudes toward science, persistence in advanced science studies, and more interest in science careers. This suggests that the social capital that they did have may not be deemed valuable in science. Individuals with scientific social capital could give youths access to valued cultural capital that they did not have access to – valued dispositional and content knowledge of science related to the work of real scientists. I argue because of this dearth of connections to individuals with scientific capital, students relied on the social networks available to them – those with their peers, local community, and teachers, individuals who interview data show were infrequently science workers. This caused youth to rely on the social and cultural capital that they had to solve problems and to assume identities as science learners. This is evident in the ways that students spoke of science that were based on the knowledge of youth in the middle grades or what they learned from television programs and school. These findings raise the question of where and how students might gain the social and cultural resources needed to be good science students, and if it is possible to explicitly teach them how to obtain such valued knowledge, dispositions, and associations in ways that allow them to see themselves as the type of people who do science both presently and in their futures. However, this study also suggests that providing more information alone is not sufficient; attention to the cultural models and motivational properties of materials and experiences that influence their negotiation of identities as science learners would also be necessary.

Section Summary

In the previous section, I discussed some of the main themes from the study's findings using the theoretical frames of cultural difference, student and racial identities, as well as the ways in which cultural and social capital affected students' adoption of science learner identities. First, the findings indicate that students saw science as separate from their everyday lives. These results raise several questions related to the types of experiences students need to become full participants in science classrooms such as: What was it about the school science that students experienced that made it a different world – was it that the instruction in their science classrooms resembled instruction in other subject area classrooms? Could it be that students in these classrooms learned science using the instructional methods used for students whose cultural models more closely resembled those valued in science? If so, how might educators provide opportunities that serve to expand both the cultural models represented in science curriculum while also helping them reconcile the cultural models that they held that were in competition with scientific cultural models?

Second, there were some results related to motivational beliefs that implied that youths' racial identities and perceived access to meaningful science were positively related to their expectancies and values for science, which raises several questions: What ways could students' cultural models be leveraged in designing meaningful activities and connections into science curriculum and instruction? How might one incorporate students' preferences for helping others into the curriculum to help them see science as a more "human" endeavor?

Third, youth in this study used their knowledge of dominant and non-dominant cultural models to negotiate their identities as science learners. Those who were best at balancing these forms of cultural capital also tended to have more social capital in these classrooms with teachers and with students. However, all forms of capital were not conducive to constructing science learner identities valued by schools. Additionally, youth had some cultural capital from their knowledge of popular culture that was not always used, while at the same time they lacked social capital valued in science that could help them construct more expansive cultural models of science and scientists. Overall, these findings help define what scientific capital looks like for students in this study, and suggest the importance of helping students cross cultural borders in science. However, they also raise questions such as: How do we increase the cultural capital of all of students who were less agentic in their balancing acts? In particular, what types of instructional environments might facilitate these maneuverings? What types of access to individuals with scientific capital would help students like those in this study gain the social capital deemed valuable in science?

Implications

Students in the classrooms I studied had inquiry-based curriculum as recommended in the standards and teachers who had experience enacting the inquiry-based instruction. This exposed them to the valued knowledge and ways of thinking that allowed them to construct realistic, though narrow cultural models of science. However, youth in this study also had competing cultural models with which they contended and which they used to construct identities as science learners; this implies that learning where and when to employ dominant or valued cultural models of science would be essential to help students from similar contexts as these students negotiate identities as science learners. The findings of this dissertation indicate that a broader view of science and scientists is required for students from underrepresented groups to develop fruitful identities as science learners in these urban classrooms. I argue that this requires that teachers build on the cultural models students have of scientists and scientists in ways that make them less insular and more expansive. In this section, I discuss the implications of these findings for curriculum, instruction, teacher education, and future research.

Curriculum and Instruction

The youth that I worked with did not seem to have broad cultural models about how to explore the natural world, and some had powerful competing cultural models contending with scientific ones. In fact, youths in this study had scientific cultural models that did not provide them with a broad view of the many ways one can do or learn about science. From these data, I recommend the need to help youth from groups underrepresented in science expand and shift as necessary their cultural models of science. This will provide them with wider visions of what is possible in science, particularly for individuals like them without access to forms of scientific capital, in particular, social connections to individuals who are science workers in their everyday lives. What complicates this is that different kids with different backgrounds (and schools) have different cultural models available to them. What are some different teaching practices and curricular moves that might offer students more expansive cultural models?

Cultural models can change, but require intentional exposure to different cultural models over time (Price, 1987; C. Lee, 2001). The context must also be taken into account; Swidler (1986) theorized that contexts that were stable were more susceptible to incremental changes to cultural realities over time than unsettled ones, where cultural models were more dogmatic due to individuals' need to hold onto something durable. However changing cultural models seem daunting given their normative nature and pervasiveness (Gee, 1999). Furthermore, cultural models of science tend to be stereotypical (Settlage & Southerland, 2007) and those of scientists are pervasive as seen in the beliefs that both children and adults in the U.S. have consistently held about scientists as socially isolated, unattractive, workaholics that are typically White, middle-aged, and middle to upper class men, who wear white lab coats (Barman, 1999; Losh et al., 2008; Rahm, 2007). How do we use lessons learned from science education research to break this pervasive cultural model of science and scientists, given the reality that many scientists *are* male, middle class, and White, and that some beliefs that individuals hold about science are correct?

Inquiry-Based Curriculum and Sources of Scientific Capital

A first and necessary step would be to employ inquiry-based curriculum, so that students can learn to think like scientists. Starting with inquiry is very important, as research suggests its importance in students' science learning (NRC, 2001). Students in this study had access to inquiry-based curriculum through the systemic reform initiative that provided them with access to realistic applications of science in their classrooms. Results from this study indicate that in addition to inquiry-based curriculum, youth could benefit from more interaction with scientists and other individuals with valued scientific capital. This is not a new idea. Several researchers currently do great work in this vein. For example, Songer and colleagues' BioKIDS Project (cf. Songer, 2006) had urban 6th graders present their own research (completed as the culmination of an ecology unit) to university scientists and students, with whom they interacted individually, receiving one-on-one feedback (http://www.biokids.umich.edu/about/participants/convphotos/www.biokids,umich.edu). Another inquiry-based curriculum project, Krajcik and Citrin's Education for Community Genomic Awareness (cf. Eklund, Rogat, Aloizie, & Krajcik, 2007), held a "DNA Night," in which students from two cities were able to listen to a speaker from the National Human Genome Research Institute and then share their work from the project's genomics curriculum with their families, community members, teachers, and district personnel http://sitemaker.umich.edu/hice/education_for_community_genomic_awareness_. One benefit of such interactions is that these opportunities provided students with expertise and feedback to which they would not normally be exposed and possibly allowed them to build knowledge about science and scientists not typical in classrooms (Jurow et al., 2008).

What becomes new about the recommendation of this study is how *sustained* the instructional intervention needs to be to create change in students' figured worlds of science. The challenge is to provide cultural resources that are explicit and continuously reinforced through multiple exposures. Moll and Gonzalez (1994) suggest ways to use funds of knowledge or cultural resources to mediate inquiry-based instruction, for working-class, language minority students in particular. Their work could serve as a model on which to build sustained instructional practices. They used data about students' cultural resources gathered from household visits as the starting point for instruction with language minority students and concluded:

> Certainly, the starting point for the use of funds of knowledge for teaching need not be the household visits, this connection can also be mediated. For example, it might be a specific classroom activity (e.g., a science lesson about plants) that motivates the search for resources (e.g., an expert) from the community. And certainly, not all classroom activities need make an immediate connection to household knowledge. But the point is that both teachers and students know and appreciate that the funds of knowledge are there and that their relevance for classroom learning, and for developing various modes of engagement (Moll & Gonzalez, 1994, p. 454).

In the science classrooms of this study, the objective would be to use students' figured world of science as a starting point of instruction. This includes those cultural resources that are part of figured worlds such as their cultural models, discourses, and resources.

Moll and Gonzalez (1994) provided a blueprint for how to use cultural resources as starting points for inquiry-based instruction. Although they did not discuss figured worlds explicitly, they provided illustrative examples of how teachers have used cultural resources to aid students' in strategic border crossings in different content areas. Two of the examples presented by Moll and Gonzalez refer directly to the aspects of the figured world of science focused on in this study, students' cultural models and resources. I present one here from Mercado (1992), in which sixth-grade Puerto Rican and African American students became researchers of questions important to them. The teacher and researcher designed activities around their interests, and used different interactions to provide access to individuals with scientific capital. Moll and Gonzalez state that following about Mercado's student participants in their summary of the work:

> Although some were reluctant to label themselves researchers, they have come to understand that through their inquiries they have access to special information that others might lack, and that they are indeed capable of doing the intellectual work necessary to conduct an investigation, and deal with the problems and frustrations of the work (Moll & Gonzalez, 1994, p. 449).

Students got access to the cultural and social capital needed in social science and increased their self-conceptions of ability through discussing issues raised from their research and the work of other researchers in weekly meetings, reviewing and validating the researcher's classroom field notes, and by presenting their work with the researcher and teacher at conferences and to students in teacher education programs (Moll & Gonzalez, 1994). They also got to "work, talk, and make presentations like researchers, and in doing so, learn that they are fully capable of more advanced work than they are usually allowed to perform in schools" (Moll & Gonzalez, 1994, p. 450). The mediators in this case were students' interests, different cultural models of school, research, and students' perceptions of their capability to do research.

Even though the language of cultural models was not referenced in Moll & Gonzalez's recount of this work, they spoke of how the teacher and researcher tapped into students' perceptions of the schooling they had and their beliefs about themselves as sixth-grade Puerto Rican and African American youth. African American youth in the current study could have benefitted from doing similar activities. For example, social science activities such as administering surveys (with which students are familiar), could be used to collect useful information about themselves and their motivation to learn science, provide them data that they could analyze and reflect upon, and provide them another lens of data collection and analysis that they could compare to the inquiry practices of their science classroom. This could allow them to explicitly examine their assumptions about science, and spark discussion that enables them to critically evaluate inquiry practice and the cultural models they hold of science and scientists. Furthermore, the existing partnerships that the systemic initiative had with those who have science capital such as the university faculty and graduate students who created the curriculum and supported curriculum enactments could be leveraged in ways that provide youth with opportunities to understand and discuss the social science research being conducted in their classrooms. This would make transparent to students what the university researchers were doing in their classrooms when they observed and worked with the teachers, and allow them to see *and* understand how such research is also science, providing them with different cultural models of science and scientists.

The example above focused on *discussions* between teachers and students, inquiry activities in which students conducted research on their interests, and interactions with individuals with scientific capital, ones that permitted students to bring their cultural resources to fore to make sense of curricular content (in addition to the hands-on activities of their inquiry-based curriculum). These discussions, inquiry activities, and interactions helped students to be more strategic in their navigations of their classroom environments and see themselves as individuals capable of doing inquiry, which may potentially motivate them to be more engaged in future inquiry activities. In this example, all parts of their figured worlds were engaged (cultural models, discourses, and resources).

The recommendation of my study is that teachers provide more opportunities in the official script for youths' cultural models to be part of classroom discussion, both those that are scientific and academic and those that are not. This type of instruction would *start from* cultural models that students have and then move toward more scientific cultural models via teacher-facilitated discourse that will help youth to lessen the conflict involved in their constructions of identities as science learners. In order for such discussions to take place, safe spaces are necessary in which students can feel free to talk, and try on different student identities, especially in school contexts where students may already feel unsafe, disconnected from, or distrustful of their peers and teachers (as some of the data indicated).

Such a focus on sense-making through discussion is important for students in middle school, because research has shown that they may have had less instructional time devoted to science in elementary schools due to pressures of standardized testing (Douville, Pugalee, & Wallace., 2003; Jones et al., 1999). Students in this study attended school in a district where standardized testing preparation took precedence over other content for the first few months of the school year. Moreover, such discussions could reinforce and deepen ideas about inquiry introduced in 7^{th}-grade science curriculum. I also suggest that students have the opportunity to have similar discussions with individuals who have valued science capital such as university students, scientists, and science and engineering faculty, museum staff, and science workers from various fields. The object is to get students in contact with scientists and their ways of knowing on a regular basis – not just from teachers, but from practitioners. This will help students gain social scientific capital, by exposing them to the dispositions of practicing science workers from a range of disciplines.

This type of interaction is important because the findings from this study and from other research have shown that students know that we do things in particular ways in science, but because these methods may not coincide with cultural models they have of themselves as individuals and the way that they do things, students did not adopt them. This requires explicit instruction that includes opportunities for students to evaluate different ways of knowing. One example of explicit instruction of this type can be seen in qualitative studies of middle school students' writing of scientific explanations. Moje et al. (2004c) found that prior to explicit instruction on ways to construct scientific explanations, 7^{th}-grade urban youth did not articulate claims about the data they analyzed, and did not provide their reasoning, although they would list evidence. However, after having many instructional conversations with teachers about scientific explanations, examining what made some explanations better than others, and having opportunities to practice writing their own, students began to show growth over time in their ability to write scientific explanations. Growth was demonstrated in three ways. First, youth became more comfortable with using scientific language in their explanations. Second, they began to support claims with evidence instead of simply listing data. Third, they started making more scientifically accurate claims as well, and began to understand differences in explanations used in different contexts. We want students to come to similar understandings with cultural models – when and where they are used, as well as which are appropriate in science and why – so that they can then use them strategically in their negotiations of science identities.

Popular Culture as a Cultural Resource

Data from this study also suggest that popular culture could be a cultural resource that is a starting point of inquiry-based instruction. Students in this study were consumers of popular culture, as they confirmed in their second interview with me. Students watched shows such as CSI and Law and Order, read mysteries, as well as read books and watched televisions shows related to the realities of life for African American youth. There are currently curricula that use concepts from shows like *CSI*, such as the *Lawrence Hall of Science (LHS) Crime Lab Chemistry* curriculum http://www.lhsgems.org/GEM170.html. This curriculum draws on the interest that the public has of the genre of shows such as CSI, by having students understand the chemistry of chromatography in their crime scene investigation. LHS also has other curriculum using criminal investigation as a way to help students understand inquiry such as *Fingerprinting* and *Mystery Festival*. These curricula draw on the popularity of such shows to interest students in the science content embedded in inquiry-based science activities designed to replicate authentic activities of practicing crime scene investigators. The data of this study and that of others (e.g., Basu & Barton, 2007) indicate that students need additional supports to have more sustained interest and engagement in learning scientific inquiry.

Although these curricula draw on popular culture, they do not critique how popular culture texts[26] often unwittingly reify the very problematic cultural models that they are meant to circumvent. The same is true of other instructional materials designed to use the affordances of popular media to introduce students to science content (D. J. Ford, 2006; Steinke, 2005). Ford (2006) found that many trade books represented science as fact-based, with a focus on fun experimentation and appreciation for the natural world, with less emphasis on scientists' analysis and reasoning of the data collected. She argued that while there were accurate depictions of science and scientists in the 44 trade books she analyzed, there were also messages about who could *know* science (experts) vs. who could *do* science (everyone). She concluded that without teachers and other knowledgeable adults to mediate elementary and the middle school students' understandings of what they read in trade books, students might walk away with simplistic and problematic viewpoints of science and scientists after reading them. She suggested that trade books can be used as valuable tools in instruction if they are carefully selected and can be used:

> as part of inquiry-science curricula that integrate written text, activities, and discussion to help learners construct understandings of science. … They can be used as resources to consult for new ideas and questions and to examine experimental methods, as sources for learning more about how scientists think, or as sources of data for investigations (Magnusson &

[26] I use an expansive definition for texts as having multiple representations that include written, oral, and multimedia forms (Eisner, 1994, Wells, 1990).

> Palincsar, 2004). The use of books and other texts becomes part of the model of scientific practice (where scientists do indeed use texts), not the transmitter of representations of the nature of science (D. J. Ford, 2006, p. 231).

In the classrooms in this study, teachers could create popular culture “text sets” that could include different types of media such as clips from television shows, excerpts of mystery stories and books, as well as trade books to compare and contrast the representations of science and scientists found therein. Again, discussions, inquiry activities, and interactions in conjunction with these texts could serve to make visible students’ cultural models of science, and allow them to critically explore which aspects are stereotypical and which represent the practice of actual scientists.

Similarly, Cleveland-Solomon, Heitzman and Moje (2010) recommended pairing the reading of multiple types of texts with inquiry-based curriculum as a way to mediate students’ interpretations of the meanings of text, and that teachers support students through setting the purposes for reading of different texts, using careful questioning techniques as those used in reciprocal teaching (Palincsar & Brown, 1984), and via careful analysis of the problems a text might present to students. Such teacher mediation sets the stage for the types of discussions recommended in the current study. I argue that in addition, popular culture texts can be used to help students make sense of the stereotypical and pervasive cultural models of *scientists* that exist in popular media. For example, in television shows such *Bones* and *Law and Order: Criminal Investigation*, the main characters are brilliant people who even if they may be attractive, are socially awkward and have jobs that consume their waking hours. They rarely have families and often their only friends are also their co-workers. If students have such shows as their only source of information about scientists’ personal lives, it may serve to turn them away from science as a career path. This “turning away” was reflected in the findings of qualitative research by Parsons (1997). She found that although academically competent, African American urban and rural high school females tended to draw their conceptions of scientists from both dominant/mainstream and Black ethos or cultural orientations. They placed a high priority on personal relationships – a cultural value from their racial group. Youth in her study felt that scientists did not have the same value for relationships, which made them uninterested in following careers that would make them give up valued personal relationships. Studies like this demonstrate that youth make up their minds about important decisions with limited information.

However, this does not have to be the case. The pervasive cultural models that these shows present could be used as starting points for discussions about who can be scientists; students could then share what evidence they have from various sources. The same is true of the representations that they find in other sources such as textbooks and Internet resources. Popular culture media could be a place from which students build more realistic images through their own investigations and questions and through interactions with individuals with scientific capital that they can ask direct questions about their lives and work. Rahm (2007) found that having students grapple with such images through discussions and access to scientists helped them to create possibilities of themselves as "insiders" in the world of science. What would teachers need in order to teach this way using students' cultural models as a starting point of instruction? In the next section, I discuss the implications for teachers' learning via professional development and pre-service teacher education.

Teacher Learning

To begin teaching in this way, teachers would first have to know students' cultural models and understand the value of them as cultural resources, to see them as a place from which to start inquiry-based instruction (Moll & Gonzalez, 1994). It is also sound instructional practice to begin instruction by eliciting children's prior knowledge based on what researchers know about how children learn (Bransford, Cocking, & Brown, 2000), even cultural knowledge. One of the major obstacles of implementing instruction that builds on students' cultural resources is that many practicing and pre-service teachers do not understand or deny the influence of students' differences in their learning (Bryan & Atwater, 2002; Milner, 2005; Nieto, 2000; O. Lee, .Luykx, Buxton, Shaver, 2007; Prime & Miranda, 2006). Bryan and Atwater (2002) suggest that students' and teachers' cultural models or theories to which individuals knowingly or unknowingly subscribe will likely differ due to the U.S. student body becoming increasingly ethnically and linguistically diverse, and the teaching force remaining mostly White and female. They suggest that science education programs have the following issues in training science teachers:

> (a) despite instruction, teachers remain oblivious to the lives and communities of certain students; (b) the programs do little to cognize teachers of their own beliefs, stereotypes, and prejudices; and (c) teachers leave the programs lacking the skills needed to instruct effectively in classrooms (Bryan & Atwater, p. 832).

Milner (2005) finds that pre-service teachers think of cultural differences as "social phenomena" that are separate from content area instruction. Milner suggests that this is due to their education courses on diversity and multicultural education being context-free and separate from methods courses. Recent research indicates that practicing teachers have similar beliefs. O. Lee et al. (2007) suggested ongoing professional development that covers specific dilemmas and issues of the practice related to incorporating students' home language and culture into instruction in smaller chunks; this practice would allow teachers to debrief practices and build on new strategies on the knowledge gained over time. My work suggests that teachers' cultural models also need to be addressed in their education as a way to enable them to use students' cultural resources as starting points of instruction. As the data in this study show, culture and content are inextricable, and both were salient for students even at schools that were racially homogeneous and with teachers who were of the same race as students. This may be due to students' tendency to imagine science as outside of their everyday experiences. It is possible that this is also true of the figured worlds that the teachers in these classrooms had of science. In order to help students to learn the science knowledge, it is important to explore the figured worlds of both teachers and students through the cultural models that shape them.

There are examples in the literature of teachers' cultural models in science (Bryan & Atwater, 2002; Windschitl, 2002). Windschitl (2002) presented pre-service teachers' cultural models of science inquiry through use of interviews and journals reflecting on an inquiry project in which they designed and carried out their own investigations and presented their findings to the class. The pre-service teachers' journals suggested that they found it more difficult to develop and plan their own investigations than they imagined, and that this difficulty influenced their beliefs about whether they would use inquiry practices in the future with their own students. They articulated implicit notions of inquiry in their journals which helped to make visible to them problems that their students may have with conceptions of inquiry. These journal entries also helped to show pre-service teachers' misconceptions of inquiry, and whether they had limited or more sophisticated conceptions of inquiry. The findings from the current study suggest that it may be productive to design professional development (PD) and methods classes to make visible to teachers their cultural models of inquiry as a way to help them understand potential issues students might have in engaging in similar inquiry-based activities. In turn, this would help them to develop appropriate supports and scaffolds as they plan activities for their own students.

In addition to understanding their own cultural models in order to understand how to draw upon those of their students, it may help teachers to understand the importance of discussion in classrooms and how to facilitate ones about different cultural models. This may suggest more focus in science methods courses and in teacher PD on ways to facilitate productive discussions with youth. Research has suggested the need for teachers to assist students in gaining familiarity with the discursive practices of science, something that does not automatically occur but must be explicitly fostered (Brown, 2006; Lemke, 1990; Settlage & Southerland, 2007). Recent research provides some suggestions for leading such discussions. In their review of research about fruitful discussions, Zhang, Lundeberg, McConnell, Koehler, & Eberhardt (2010) asserted that experienced facilitators included two necessary elements in the discussions they lead such as (1) open-ended questions that did not have predetermined answers and elicited students' ideas, and (2) questions drawn from students' previous responses or ideas shared in discussion. They employed these features in a PD program with teachers new to problem-based learning. Providing such support for teacher facilitation of discussion could potentially create a space for students to share their alternative ideas and gain familiarity with the discursive practices of science that some students in this study felt less efficacious with, and this lack of efficacy in turn made science a difficult subject for them.

Finally, another recommendation would be that teachers become adept at sharing authority in their science classrooms, such that they can bring in outsiders as resources in their classrooms, in ways that build on the cultural models, discussions, and activities available in the inquiry-based curriculum. Cases of such practice could be shared with teachers in PD and in teacher education courses. I provide one extensive example of how this was done in an elementary classroom. Crawford (2008) investigated the ways that one teacher was able to model valued cultural models and to modify cultural models of authority in her elementary classroom. The shared authority cultural model the teacher aimed to foster differed from that typical of most classrooms in which the teacher and texts were the only knowledge authorities. The teacher through her talk positioned students as authorities by introducing through her teaching a scientific cultural model in which one asserts knowledge claims and provides evidence to support each claim.

Additionally, she also invited others to share expertise in the classroom. In one situation in this class, a parent's unanticipated gift to the class created an impromptu learning opportunity. A parent dropped off a milkweed plant to the class that was full of caterpillars. The teacher wanted the students to have the opportunity to care for the caterpillars and see their metamorphosis. This created a problem for the students, because the teacher admitted that she did not know how to care for the caterpillars. The lessons planned were put on hold in order to contain the caterpillars which were freely crawling on the plant. The teacher invited the parent, students, and others to provide suggestions for how to care for the caterpillars. She used several people's suggestions to help everyone investigate a solution. The teacher then allowed students to investigate each source of information.

The students, guests, and the teacher were all seen as having appropriate knowledge in the classroom, and capable of asserting what they knew. Students could then claim an identity as an authority by using this cultural model of what authority looks like introduced by the teacher. In this way, students' cultural models of who they could be in their elementary classroom were broadened through interactions with others and modeling by their teacher. Because students in my study infrequently were able to conduct investigations on their own, and had limited roles in their science classrooms, the type of modeling portrayed by the teacher in the example above employed in the classrooms I studied could serve to help youth begin to see themselves and their peers as authorities in the classroom. Inviting others to their classroom as authorities could have the added possibility of opening up the types of identities young people in urban schools like those in this study see as available to them within their figured worlds of science.

In the next section I discuss directions for future research about the identities that students adopt in science classrooms.

Directions for Future Research

This study presents a preliminary examination of the relationship between students' motivations and identifications in science and suggests some avenues for future research. The findings of this study show that science education requires more research on the factors that affected students' motivational outcomes and the identities they adopted. A necessary next step is to link motivations and science learner identities to achievement outcomes. Do students who take on out-of-balance identities also have low science grades? What types of identities do they adopt in other content areas and do they have low grades in them? Other fruitful avenues of research could be taken that investigate taking the cultural models espoused here and developing survey scales. From such measures one could then analyze differences in cultural models by gender, race, and social context, for example.

In addition, instructional programs that examine ways to change cultural models via implementation of some of the recommendations for curriculum and instruction would also be viable next steps. A focus on all of the aspects of curriculum and instruction presented above may serve to create a more meaningful science for students – through interrogation of students' cultural models, and use their cultural resources as starting points of instruction. The analyses from survey findings suggest that increasing meaningfulness may be related to increased motivation to learn, which may mediate achievement-related performance and choices. The findings from my study suggest a fruitful avenue of future research, one that interrogates African American students' notions of meaningfulness within a specific school context, and measures subsequent performance and achievement-related choices to determine the effects of interventions designed to improve meaningfulness.

Would one use existing curricular programs and add instructional strategies that incorporated cultural models? Would these cultural models then influence the interaction between students' racial identity and their perceptions of their engagement in meaningful science activities, and would this differ by school context? What type of content would best lend itself to incorporation of students' cultural models? With changes in cultural models, it would also be worthwhile to examine the ways students' identity espousals change. For example, with more expansive scientific cultural models, would students still feel the need to balance social and academic cultural models in the same ways? Was this balancing specific to the students of this study, or would similar negotiations of identity occur in other contexts?

There were several limitations of the study, which future research could address. The study had a relatively small sample size due to my using only one achievement measure, with which there were data collection issues that rendered the post-test data unusable. In the future, I would use multiple measures of achievement over time, which would allow me to connect identity and achievement data. Because I would also like to make connections to students' achievement, I would work to get access to students' grades and standardized test scores. Having a larger sample would increase the power to find significant results in the regression analyses, and enable me to make generalizations to a larger population of urban African American students – to their motivational beliefs and achievement outcomes in science.

I used the Adolescent Literacy Development (ALD) Literacy Motivation Survey (Moje, 2004b) as a first step in understanding students' competency beliefs and values related to science and literacy tasks in science. Although I had to shorten the survey due to the time constraints of survey administration, I was able to obtain results that provided some indication of the relationships among variables. Future research should use the lessons learned from this study to include more items measuring constructs such as the self-concept of ability in science and science values.

Because of the conflict caused by competing cultural models, I believe it may also be useful to add motivational constructs related to the effort and cost involved in science participation, as a way of understanding African American youths' values for science. I would also include questions related to students' gender identity and not just an indicator variable of their gender. This would allow me to understand students' beliefs about what their gender means to them, and analyze interactions between gender identity and racial identity, as done in other studies. In the current study, I could only use the dummy variable for gender to look for interactions.

This study was conducted over a short period of time, allowing me the ability to speak only about a "small window" of students' experience – the six-months from December 2005 to June 2006. Because the study consisted largely of interview data, it is possible that the findings reflect my own beliefs and intentions. This is possible given how I saw in classrooms students engaged in procedural display (Bloome et al., 1989) – in which they provided teachers the answers and/or behavior they thought their teachers desired. However, I also saw that students had agency to assert their own ideas and behaviors even in their interactions with their teachers as they became more familiar with their teachers' expectations. Employing that reasoning, I do believe that students engaged in procedural display at times in their interviews, and I made note of those times. I also tried to probe students when I thought that was the case. I was able to get to know students over the course of the study, and believe that with most students, I was able to help them understand that I was not looking for a right answer, but for their own honest beliefs.

The sheer number and density of the interview data allowed me to learn a great deal from students' school context during the latter half of their 7^{th}-grade year. Future studies should include life history interviews as a way to understand the antecedents to the figured worlds of science that students created. Moreover, I was not able to observe all three teachers' classes as frequently as planned. In the future, I would do extensive classroom observations, and measure students' motivational constructs longitudinally as a way to understand changes over time, and in-depth study of identities in action in science classrooms. Future analysis should be longitudinal, to understand changes over the course of early adolescence, and possibly extending into students' high school experiences. To improve validity, and facilitate merging of data, similar questions could be asked in the surveys, interviews, and classroom observations of multiple students over time.

Conclusion

At the beginning of this dissertation, I stated that science was an important school subject that is a gateway to STEM career fields. It is also a career trajectory in which African Americans are underrepresented relative to their White and Asian American peers. I wanted to offer new perspectives as to why young people's identities and cultural models may shape how their identities and motivation to learn science. The conceptual framework of this study used the idea of a figured world and its constituents (cultural models, discourses, discourse communities, and resources) to illustrate the ways in which students came to identify as science learners. Because of the number of studies that focused on discourse and discourse communities, this study examined the role of cultural models and resources in identity negotiation. I desired to understand in particular the cultural models that drove them to act, what types of individuals they imagined scientists and science workers to be, and how they imagined science students to be.

I investigated one community of underrepresented youths' identities as science learners and future science workers from a particular social location (class, gender, race, and age) by merging the analysis of survey data with the analyses of interview and short-term classroom observations. This dissertation study was designed to use mixed methods to explore multiple factors influencing the motivation and science learner identities of a group of African American middle-school students in urban classrooms enacting inquiry-based science curriculum. This was done to understand the factors that may influence underrepresented groups from engaging in science. The results implied that youths' social context, gender, racial identity, and perceptions of the science they had in school were related to their motivation to learn science. The findings from the short-term observations and interviews also suggest that students had competing cultural models that they used in their constructions of identities as science learners, which differed in how well they were able to balance dominant and non-dominant forms of cultural capital; not all of these identities would be valued in mainstream science classrooms. Those who chose to identify in ways that were more aligned to the social demands of their peer group, would be less likely to be seen as good science students. Because students negotiated these identities in the social context of their classrooms, they were sometimes positioned into identities that they would not voluntarily claim.

I came to a definition of scientific capital for youth in this study that included both cultural capital – the ability to understand and leverage dominant knowledge and dispositions about science in science classrooms – and social capital, connections to individuals with valued science knowledge, dispositions, and social networks. However, what I discovered was that some of the students in this study had part of the scientific capital (the cultural capital) needed to achieve in science in the long term even if they would be classified as good students, but lacked the social capital part of scientific capital. In conclusion, these results suggest that all students in this study would benefit from access to more expansive cultural models through access to individuals with scientific capital to would allow them to create more fruitful identities as science learners. If we want to ensure that students from groups that are underrepresented in science not only have better outcomes, but aspire to and enter the science career pipeline, we must also begin to support them in their negotiations of competing cultural models that limit their ability to adopt more fruitful identities as science learners in their classrooms.

Appendices

Appendix A: Proposed Observation Schedule

Week Starting	Week 1 12/5/05	Week 2 12/12/2005	Week 3 12/19/2005	Week 4 1/2/2005	Week 5 1/9/2005
Lessons	1.1-1.3	2.1, 3.1	4.1-4C & 5.1	5.1, 6.1, start 7.1	7.1-Start 8.1
Content Focus	Definition of substances and properties	Solubility & Melting Point	Density & Properties	Wrap-Up of Properties, Scientific Explanations, & Combining Substances	Introduction to chemical reactions
Observation Focus	Lesson 1.1	Activity 2.1	Reader Section 4.1	Lesson 6.1	Reader Section 7.1
Observation Tasks Described	Focus on Teacher introduction and framing of the lesson and definitions constructed in whole class discussion (will use boom mike)	Student activity 2.1/Group-work (Will mike focus group's table)	Focus on the review of the questions in Section 4.1 of the reader. (If completed in groups, will mike focus group's table)	Focus on teacher framing and classroom discussion about scientific explanations -- informally talk with students at tables about the task (using tape recorder)	Focus on whole-class discussion of Rumpelstiltskin and introduction of the concept of chemical reaction (will use boom mike)

Week Starting	Week 6 1/16/2005	Week 7 1/23/2005	Week 8 1/30/2005	Week 9 2/6/2005	Week 10 2/13/2005
Lessons	8.1-9.1	10.1-10.2	11.1-13.1	13.2-14.1	15.1 & 16.1, A & B
Content Focus	Chemical reactions and models	Exploring chemical reactions	Chemical reactions, mixtures, and boiling	Conservation of mass	Soap-making
Observation Focus	Activity 9.1	Activity 10.2	Activity 11.1	Activity 13.2	16.1
Observation Tasks Described	Student activity 9.1/Group-work (Will mike focus group's table)	Student activity 10.2/Group-work (Will mike focus group's table)	Student activity 11.1/Group-work (Will mike focus group's table)	Student activity 13.2/Group-work (Will mike focus group's table)	Focus on Teacher framing of the lesson and whole-class discussion around soap-making.

(Light shading) Indicates lessons that I must get if completed by the teachers based on their importance to content knowledge and pre-requisite benchmarks.

(Dark shading) Indicates Lessons that may not be finished in the unit due to testing and other scheduling constraints in the school district

8 observations per classroom.

Appendix B: Adolescent Literacy Development Survey

STUDY OF SOCIAL AND CULTURAL INFLUENCE ON ADOLESCENT LITERACY DEVELOPMENT

Survey Directions and Sample

Dear Participant,

In this survey there are no right or wrong answers. We are just asking for your opinions.

You may skip any question(s) that you do not care to answer.

Many of the following questions ask you to choose a number from 1 to 7 that best describes how you think or feel. Please circle the number that best describes what you think.

HERE IS AN EXAMPLE OF THE WAY WE WILL ASK YOU QUESTIONS:

How much do you like chocolate cake?

not at all						a lot
1	2	3	4	5	6	7

Thank you for your valuable help with this study!

In this section we are going to ask you questions about your science class this year.

Here are some general questions about your science class this year.

1. How much do you like doing science?

not at all						a lot
1	2	3	4	5	6	7

2. In general, how useful is what you learn in science?

not at all useful						very useful
1	2	3	4	5	6	7

Now we have some questions asking you about how good you are in science.

3. How good at science are you?

not at all good						very good
1	2	3	4	5	6	7

4. How well do you expect to do in science class next year?

not at all well						very well
1	2	3	4	5	6	7

5. How well do you expect to do on your next science test?

not at all well						very well
1	2	3	4	5	6	7

6. How well do your parents/guardians expect you to do in science?

not at						very
all well	2	3	4	5	6	well

1	7

7. How well does your science teacher expect you to do in science?

not at all well						very well
1	2	3	4	5	6	7

Now we would like you to make some comparisons of science to other school subjects.

8. Compared to most of your other school subjects, how good are you at science?

much worse						much better
1	2	3	4	5	6	7

9. How useful is what you learn in science, compared with your other subjects at school?

not at all useful						very useful
1	2	3	4	5	6	7

10. Compared to your other schoolwork, how important is it to you to be good at science?

much less important						a lot more important
1	2	3	4	5	6	7

11. How much do you like science, compared with your other subjects at school?

much less						much more
1	2	3	4	5	6	7

Now we have a few more general questions about science.

12. In general, I find working on science assignments

very boring						very interesting
1	2	3	4	5	6	7

13. How useful do you believe science is?

not at all useful						very useful
1	2	3	4	5	6	7

14. For me, being good at science is…

	2	3	4	5	6	

not at all important						very important
1						7

15. Being good at science is an important part of who I am

not at all important						very important
1	2	3	4	5	6	7

16. If you were to list all the students in your grade from worst to best in science class, where would you put yourself?

the worst						the best
1	2	3	4	5	6	7

17. If you could, would you take more science classes than are required at your school?
_______yes _______no

In this section, think about what you have read for your science class so far this school year, both during class and for homework.

18. How **often** have you **read** the following things:	never	once a semester	once a month	every other week	every week	2-3 times a week	every day
Textbook	1	2	3	4	5	6	7
Research papers or reports	1	2	3	4	5	6	7
Novels, short stories, books, essays	1	2	3	4	5	6	7
Class notes	1	2	3	4	5	6	7
Newspaper articles	1	2	3	4	5	6	7
Magazines	1	2	3	4	5	6	7
Essays	1	2	3	4	5	6	7
Plays	1	2	3	4	5	6	7
Word problems	1	2	3	4	5	6	7
Formulas or number problems	1	2	3	4	5	6	7
Proofs	1	2	3	4	5	6	7
Graphs, charts, tables	1	2	3	4	5	6	7
Internet websites	1	2	3	4	5	6	7
Maps	1	2	3	4	5	6	7

Lab manuals	1	2	3	4	5	6	7
Science Worksheets	1	2	3	4	5	6	7
Vocabulary lists	1	2	3	4	5	6	7

Have the following things happened in your science class?

19. The teacher taught the class how to	Yes	No
Take notes	1	2
understand the explanations in the science textbook	1	2
use the ideas in the science textbook to solve problems	1	2
use the science textbook to find out what words mean	1	2
Show their thinking behind a science investigation	1	2

20. How **often** in science class do you	Please circle the number that applies to you				
	almost never	once in a while	some times	often	almost always
discuss problems and issues that are meaningful to you?	1	2	3	4	5
see or hear examples that are interesting to you?	1	2	3	4	5
learn things that help you with your everyday life?	1	2	3	4	5
read things about people of your cultural or racial group?	1	2	3	4	5

21. In science class, how **good** are you at:	Please circle the number that applies to you						
	not at all good						very good
reading your science textbook	1	2	3	4	5	6	7
reading other science texts your teacher gives you	1	2	3	4	5	6	7
Learning new science vocabulary	1	2	3	4	5	6	7
taking notes from teacher lectures	1	2	3	4	5	6	7
writing out your understanding of a science lab or investigation	1	2	3	4	5	6	7

22. In science class, how much do you **like**:	Please circle the number that applies to you						
	not at all						Very much
reading your science textbook	1	2	3	4	5	6	7
reading other science texts (magazines, newspaper articles) your teacher gives you	1	2	3	4	5	6	7
Learning new science vocabulary	1	2	3	4	5	6	7
taking notes from teacher lectures	1	2	3	4	5	6	7
writing out your understanding of a science lab or investigation	1	2	3	4	5	6	7

23. How **useful** are the following activities for helping you to **understand** science::	Please circle the number that applies to you						
	not at all useful						very useful
reading your science textbook	1	2	3	4	5	6	7
reading other science texts (magazines, newspaper articles) your teacher gives you	1	2	3	4	5	6	7
Learning new science vocabulary	1	2	3	4	5	6	7
taking notes from teacher lectures	1	2	3	4	5	6	7
writing out your understanding of a science lab or investigation	1	2	3	4	5	6	7

24. How **important** is it to you to be good at the following science class activities:	Please circle the number that applies to you						
	not at all useful						very useful
reading your science textbook	1	2	3	4	5	6	7
reading other science texts (magazines, newspaper articles) your teacher gives you	1	2	3	4	5	6	7
Learning new science vocabulary	1	2	3	4	5	6	7
taking notes from teacher lectures	1	2	3	4	5	6	7
writing out your understanding of a science lab or investigation	1	2	3	4	5	6	7

How **difficult** do you find understanding your science textbook?

not at all difficult						very difficult
1	2	3	4	5	6	7

25. How **difficult** do you find understanding other science-related things (e.g., magazines, books, handouts) your teacher gives you to read?

not at all difficult						very difficult
1	2	3	4	5	6	7

26. I find reading science things hard when . . . (Check all that apply.)

__ I don't know much about the topic.

__ I don't get to choose what I read about.

__ The topic is boring.

__ The text has too many new words.

__ The text has too many long words.

__ The text is too short.

__ The text is too long.

__ The topic is not meaningful to me.

__ The material is not useful.

STUDY OF SOCIAL AND CULTURAL INFLUENCE ON ADOLESCENT LITERACY DEVELOPMENT

Survey Directions and Sample

Dear Participant,

In this survey there are no right or wrong answers. We are just asking for your opinions.

You may skip any question(s) that you do not care to answer.

Many of the following questions ask you to choose a number from 1 to 7 that best describes how you think or feel. Please circle the number that best describes what you think.

HERE IS AN EXAMPLE OF THE WAY WE WILL ASK YOU QUESTIONS:

How much do you like chocolate cake?

not at all						a lot
1	2	3	4	5	6	7

Thank you for your valuable help with this study!

This survey asks you about what you do <u>when you are not in school</u>.

Please circle the number that applies to you.

1. Think about all the things you have done when not in school **<u>during this school year</u>**. How **<u>often</u>** do you:	Please circle the number that applies to you						
	never	once a month	2-3 times a month	once a week	3-4 times a week	every day less than 1 hour	every day more than 1 hour
a. hang out with friends	1	2	3	4	5	6	7
b. hang out with family	1	2	3	4	5	6	7
c. talk on the phone	1	2	3	4	5	6	7
d. engage in outdoor activities (hiking, walking, gardening)	1	2	3	4	5	6	7
e. play sports	1	2	3	4	5	6	7
f. write for pleasure	1	2	3	4	5	6	7
g. read for pleasure	1	2	3	4	5	6	7
h. write email or chat on Internet	1	2	3	4	5	6	7
i. play video or computer games	1	2	3	4	5	6	7
j. watch TV	1	2	3	4	5	6	7
k. play or sing music (band, choir, play instrument)	1	2	3	4	5	6	7
l. do art or drawing	1	2	3	4	5	6	7
m. do math/science activities for fun	1	2	3	4	5	6	7
n. do hobbies	1	2	3	4	5	6	7
o. do drama or dance	1	2	3	4	5	6	7
p. participate in school clubs	1	2	3	4	5	6	7
q. do activities at a community center	1	2	3	4	5	6	7
r. go to religious activities	1	2	3	4	5	6	7
s. learn a language	1	2	3	4	5	6	7
t. do homework	1	2	3	4	5	6	7
u. work for pay away from home	1	2	3	4	5	6	7
v. do volunteer or community service	1	2	3	4	5	6	7
w. do chores at home	1	2	3	4	5	6	7

(if you never worked for pay away from home please skip to question 5)

2. What <u>kind of work</u> do you do? ____

3. Think about a typical month <u>last summer</u>, how often did you work for pay?

less than once a month 1	once a month 2	2-3 times a month 3	once a week 4	3-4 times a week 5	5 times a week or more 6

(if you never watch tv please skip to question 5)

4. How often do you watch the following things on TV?	Please circle the number that applies to you						
	never						Very often
a. Comedy, drama, movies, soap operas, cartoons	1	2	3	4	5	6	7
b. Music	1	2	3	4	5	6	7
c. History, science, autobiography, tech	1	2	3	4	5	6	7
d. News	1	2	3	4	5	6	7
e. Sports	1	2	3	4	5	6	7

Now we would like to ask you some questions about what you <u>read</u> when not in school.

Please think about a typical <u>month</u> during the <u>school year</u>, when you're not in school.

5. How many times a month do you <u>read</u> any of the following when not in school?	Please circle the number that applies to you						
	Never	at least once a month	every other week	once a week	twice a week	3-4 times a week	Every day
a. Letters, notes	1	2	3	4	5	6	7
b. Email	1	2	3	4	5	6	7
c. Novels, short stories, picture books, or plays	1	2	3	4	5	6	7
d. Information books (science or nature books, history books, etc.)	1	2	3	4	5	6	7
e. Poetry	1	2	3	4	5	6	7
f. Religious books (e.g., Koran, Bible, Catechism, Torah, other)	1	2	3	4	5	6	7
g. Comic books	1	2	3	4	5	6	7
h. Magazines	1	2	3	4	5	6	7
i. Websites	1	2	3	4	5	6	7
j. Music lyrics (words to music)	1	2	3	4	5	6	7
k. Newspapers	1	2	3	4	5	6	7
l. Biographies, autobiographies	1	2	3	4	5	6	7
m. Research papers, reports, graphs, charts, tables	1	2	3	4	5	6	7
n. Instruction manuals, cookbooks, sewing patterns (instructions on how to do something)	1	2	3	4	5	6	7

o. Maps or bus, airline, or train schedules	1	2	3	4	5	6	7
p. Catalogs or Reference books (encyclopedia, dictionary, phone book,	1	2	3	4	5	6	7
q. Other________________________ (tell us what)	1	2	3	4	5	6	7

(if you circled 1 on all the items in the above list, please skip to question 15)

(if you never read newspapers please skip to question 7)

6. What newspapers do you like to read? (check all the ones you read)

   ___*New York Times*

   ___*Detroit Free Press/News*

   ___Community or cultural newspaper (e.g. *Latino, El Central, Metro Times*)

   ___*USA Today*

   ___*Other*__________________________ *(tell us what)*

(if you never read websites please skip to question 8)

7. How often do you read the following websites?	Please circle the number that applies to you						
	never						Very often
a. Community websites	1	2	3	4	5	6	7
b. Music websites	1	2	3	4	5	6	7
c. History, science, autobiography, tech	1	2	3	4	5	6	7
d. News	1	2	3	4	5	6	7
e. Sports	1	2	3	4	5	6	7

8. How much does each of the following affect <u>what you choose</u> to read?	Please circle the number that applies to you						
	not at all important						Very important
a. your friends	1	2	3	4	5	6	7
b. your family	1	2	3	4	5	6	7
c. how well you read	1	2	3	4	5	6	7
d. how well you write	1	2	3	4	5	6	7
e. how long it is	1	2	3	4	5	6	7
f. the language/s you speak	1	2	3	4	5	6	7
g. whether you're male or female	1	2	3	4	5	6	7
h. your beliefs (religious, political)	1	2	3	4	5	6	7
i. your race or ethnicity	1	2	3	4	5	6	7
j. Other? ______________________ (tell us what)	1	2	3	4	5	6	7

Think about all the types of things you read outside of school
– either by yourself or with other people.

9. How good are you at reading them?

not at all good						very good
1	2	3	4	5	6	7

10. How much do you like to read them?

not at all						a lot
1	2	3	4	5	6	7

11. How important is it to you to read them?

not at all important						very important
1	2	3	4	5	6	7

12. How much more time would you like to have to read these things?

none						a lot
1	2	3	4	5	6	7

13. How useful is the reading you do outside school, compared with your other activities outside of school?

not at all useful						very useful
1	2	3	4	5	6	7

14. How difficult do you find most of the reading you do outside of school?

not at all difficult						very difficult
1	2	3	4	5	6	7

Reading can be easy or hard for people. Some of the things you read outside of school may be easy for you to read. Some of these things may be hard for you to read. Please tell us about when reading is hard for you.

15. I find reading hard when . . . (Check all that apply)
    ___ I don't know much about the topic.
    ___ I don't get to choose what I read about.
    ___ I'm not reading the same things as my friends.
    ___ The topic is boring.
    ___ The text has too many new words.
    ___ The text has too many long words.
    ___ The text is too short.
    ___ The text is too long.
    ___ The topic is not meaningful to me.
    ___ The material is not useful.

Now we would like to ask you some questions about the writing you do when not in school.

Please think about a typical month during the school year, when you're not in school.

16. How many times a month do you write any of the following when not in school?	Please circle the number that applies to you						
	Never	At least once a month	every other week	once a week	twice a week	3-4 times a week	Every day
a. Email, chat, shout-outs, blogs	1	2	3	4	5	6	7
b. Letters or notes on paper	1	2	3	4	5	6	7
c. Poetry	1	2	3	4	5	6	7
d. Stories	1	2	3	4	5	6	7
e. Grocery/shopping list	1	2	3	4	5	6	7
f. Instructions on how to do something	1	2	3	4	5	6	7
g. Music lyrics (words to music)	1	2	3	4	5	6	7
h. Directions on how to get somewhere	1	2	3	4	5	6	7
i. Graffiti or tagging on paper	1	2	3	4	5	6	7
j. Comics	1	2	3	4	5	6	7
k. Journal, diary, activity log	1	2	3	4	5	6	7
k. Other? ____________________ (tell us what)	1	2	3	4	5	6	7

(if you circled 1 on all the items in the above list please skip to question 24)

17. How much does each of the following affect <u>what you choose</u> to write?	Please circle the number that applies to you						
	not at all important						Very important
a. your friends	1	2	3	4	5	6	7
b. your family	1	2	3	4	5	6	7
c. how well you read	1	2	3	4	5	6	7
d. how well you write	1	2	3	4	5	6	7
e. how long it is	1	2	3	4	5	6	7
f. the language/s you speak	1	2	3	4	5	6	7
g. whether you're male or female	1	2	3	4	5	6	7
h. your beliefs (religious, political)	1	2	3	4	5	6	7
i. your race or ethnicity	1	2	3	4	5	6	7
j. Other? ______________________ (tell us what)	1	2	3	4	5	6	7

Think about all the types of things you <u>write when not in school</u> – either by yourself or with other people.

18. How good are you at writing them?

not at all good						very good
1	2	3	4	5	6	7

19. How much do you like to write them?

not at all						a lot
1	2	3	4	5	6	7

20. How important is it to you to write them?

not at all important						very important
1	2	3	4	5	6	7

21. How much more time would you like to have to write these things?

none						a lot
1	2	3	4	5	6	7

22. How useful is the writing you do outside school, compared with your other activities outside of school?

not at all useful						very useful
1	2	3	4	5	6	7

23. How difficult do you find the writing you do outside of school?

not at all difficult						very difficult
1	2	3	4	5	6	7

Writing can be easy or hard for people. Sometimes you might find things that you want to write outside of school easy to write. Some of these things may be hard for you to write. Please tell us about when things are hard to write.

24. I find writing hard when . . . (Check all that apply.)

___ I don't know anything about what I need to write.

___ Someone else gives me something to write about.

___ I don't know how to go about it.

___ I don't know what words would be cool.

___ I can't spell all the words I need to use

___ The writing task is short.

___ The writing task is long.

___ The writing task is not meaningful to me.

___ The writing task is not useful to me.

___ Someone is going to read my writing.

___ Nobody is going to read my writing.

___ I don't know who's going to read my writing.

Now we would like to ask you questions about what makes you who you are. Different things are important to different kinds of people.

25. How important is each of the following to the kind of person you are?	Please circle the number that applies to you						
	not at all important						Very important
a. your friends	1	2	3	4	5	6	7
b. your family	1	2	3	4	5	6	7
c. how well you read	1	2	3	4	5	6	7
d. how well you write	1	2	3	4	5	6	7
e. the language/s you speak	1	2	3	4	5	6	7
f. whether you are male or female	1	2	3	4	5	6	7
g. your religious beliefs	1	2	3	4	5	6	7
h. your political beliefs	1	2	3	4	5	6	7
i. your race or ethnicity	1	2	3	4	5	6	7
j. music	1	2	3	4	5	6	7
k. playing sports	1	2	3	4	5	6	7
l. doing schoolwork	1	2	3	4	5	6	7
m. Other:____________________ (tell us what)	1	2	3	4	5	6	7

Here are some questions about your background

26. What language(s) do you speak fluently?

    ____

27. What language did you learn first?

    ____

28. What language is mainly spoken at home?

    ____

29. What language do you mainly speak with your friends?

    ____

30. What language(s) can you read fluently?

    ____

(if more that one language is read)

31. What language(s) do you prefer to read in? ___________________ or __ it doesn't matter

32. What language(s) can you write fluently?
____

(if more than one language is written)
33. What language(s) do you prefer to write in? __________________ or ___it doesn't matter

34. Where were you born? City______________ State __________ Country __________

35. What is your mother/female guardian's highest level of education (check only one)?
___ didn't graduate high school
___ graduated high school or GED
___ vocational training or training certificate (electrician, hairdresser, chef, mechanic)
___ some college
___ college degree
___ masters degree
___ law degree, a PhD, or a medical doctor's degree
___ I don't know

36. What are your father/male guardian's highest level of education (check only one)?
___ didn't graduate high school
___ graduated high school or GED
___ vocational training or training certificate (electrician, hairdresser, chef, mechanic)
___ some college
___ college degree
___ masters degree
___ law degree, a PhD, or a medical doctor's degree
___ I don't know

Questions about how you think about your race or ethnicity:

37. What is your **racial or ethnic** background. Use as many words as you need. You might use your family background or the country your family comes from, or your cultural group, or the color of your skin, or any combination of these. For example, out of three Latino/as, one might say he was a Puerto Rican, another might say she was Mexican, a third might say she was Hispanic. It would be the same with three Black people: one might say she was a Black American, another a Haitian, a third Black and Hispanic.

What would you say about yourself? ______________________________________

38. How important is it for you to know about your racial/ethnic background?

not at all important						very important
1	2	3	4	5	6	7

39. How proud are you of your racial/ethnic background?

not at all proud						very proud
1	2	3	4	5	6	7

40.	Strongly agree				Strongly disagree
a. I have a strong sense of belonging to my own racial/ethnic group.	1	2	3	4	5
b. I am happy that I am a member of the group I belong to.	1	2	3	4	5
c. Only members of my racial/ethnic group can really understand me.	1	2	3	4	5
d. Because of your race/ethnic group, no matter how hard you work, you will always have to work harder than others to prove yourself.	1	2	3	4	5
e. Because of your race/ethnic group, it is important that you do better than other kids at school in order to get ahead.	1	2	3	4	5

41.	not at all true of me	a little true of me	somewhat true of me	very true of me	extremely true of me
a. I have a close community of friends because of my race/ethnicity.	1	2	3	4	5
b. People of my race/ethnicity have a culturally rich heritage	1	2	3	4	5
c. I have meaningful traditions because of my race/ethnicity.	1	2	3	4	5
d. People of my race/ethnicity are very supportive of each other.	1	2	3	4	5

Finally we have some questions about your goals for the future.

42. If you could have any job you wanted, what job would you most like to have at age 25?
____

43. People can't always get the job they would most like. What job do you think you will **<u>really</u>** have when you are 25?
____

44. If you could have any type of education you wanted, what type of education would you like to get in the future? (please check one)

_____ graduate from high school

_____ vocational or technical training (e.g. electrician, hairdresser, chef, pre-school teacher)

_____ some college

_____ graduate from a business or two-year college

_____ graduate from a four-year college

_____ get a master's degree or a teaching credential

_____ get a law degree, a PhD, or a medical doctor's degree

45. We can't always do what we most want to do. What type of education do you think you will **<u>really</u>** get in the future? (please check one)

_____ graduate from high school

_____ vocational or technical training (e.g. electrician, hairdresser, chef, pre-school teacher)

_____ some college

_____ graduate from a business or two-year college

_____ graduate from a four-year college

_____ get a master's degree or a teaching credential

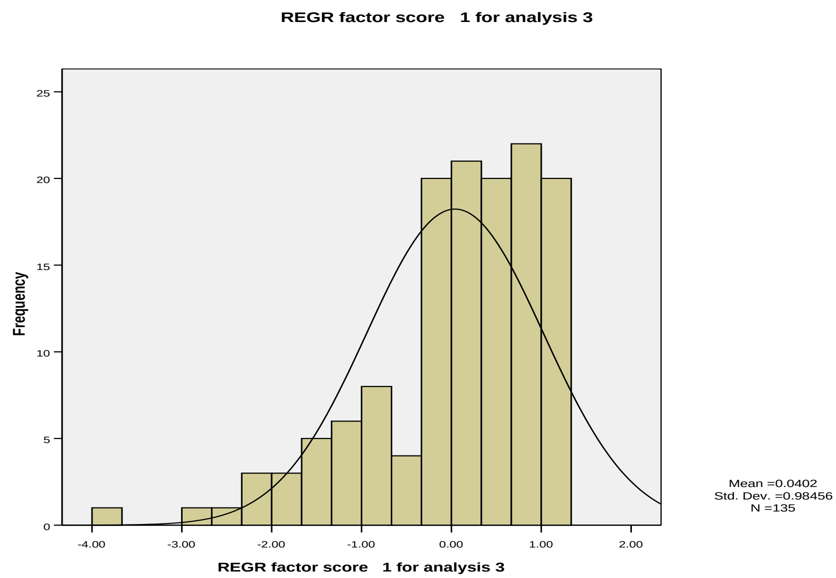
_____ get a law degree, a PhD, or a medical doctor's degree

46. Some things can help you in getting the education you want. Other things might hold you back from getting the education you want. Please rate how much the following things will <u>help</u> OR <u>hold you back</u> as you try to get the education you want.

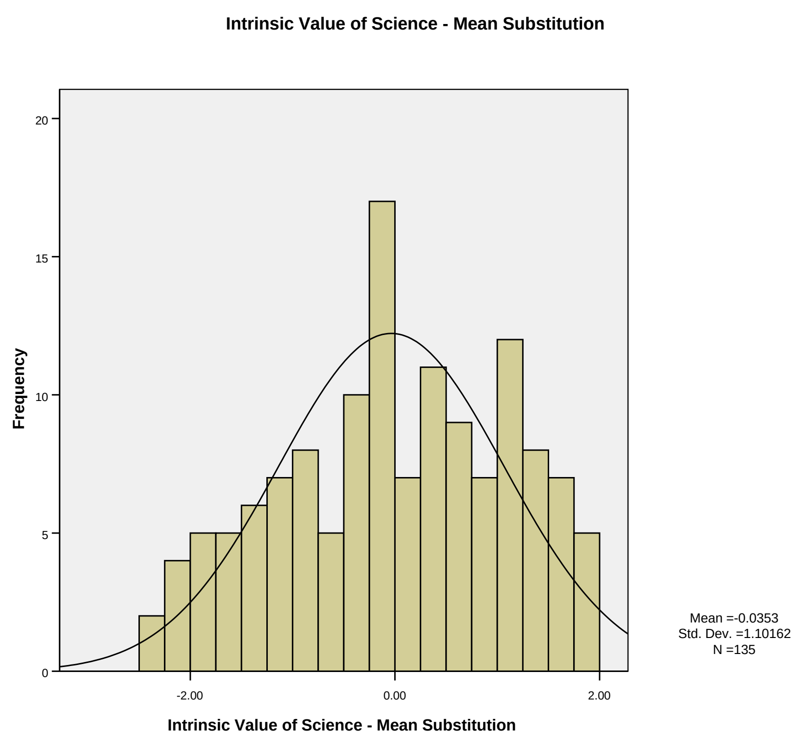
	Please circle the number that applies to you						
	will hold me back a lot	will hold me back somewhat	will hold me back a little	no influence	will help me a little	will help me some what	will help me a lot
a. Your abilities or talents	1	2	3	4	5	6	7
b. Your school grades	1	2	3	4	5	6	7
c. Your family	1	2	3	4	5	6	7
d. Having children	1	2	3	4	5	6	7
e. Your friends	1	2	3	4	5	6	7
f. Your religion/spirituality	1	2	3	4	5	6	7
g. Your financial situation	1	2	3	4	5	6	7
h. How hard you work	1	2	3	4	5	6	7
i. Luck	1	2	3	4	5	6	7
j. Your teachers	1	2	3	4	5	6	7
k. Your ethnic background	1	2	3	4	5	6	7
l. How well you read	1	2	3	4	5	6	7
m. How well you write	1	2	3	4	5	6	7
n. How good you are at math	1	2	3	4	5	6	7
o. How good you are at science	1	2	3	4	5	6	7
p. The language(s) you speak	1	2	3	4	5	6	7
q. The style of clothes you wear	1	2	3	4	5	6	7
r. Whether you are female or male	1	2	3	4	5	6	7
s. The community you live in	1	2	3	4	5	6	7
t. How much you stay true to your own racial or ethnic group	1	2	3	4	5	6	7
u. Other_______________ (tell us what)	1	2	3	4	5	6	7

You're done! Thank you for helping us with these important questions.

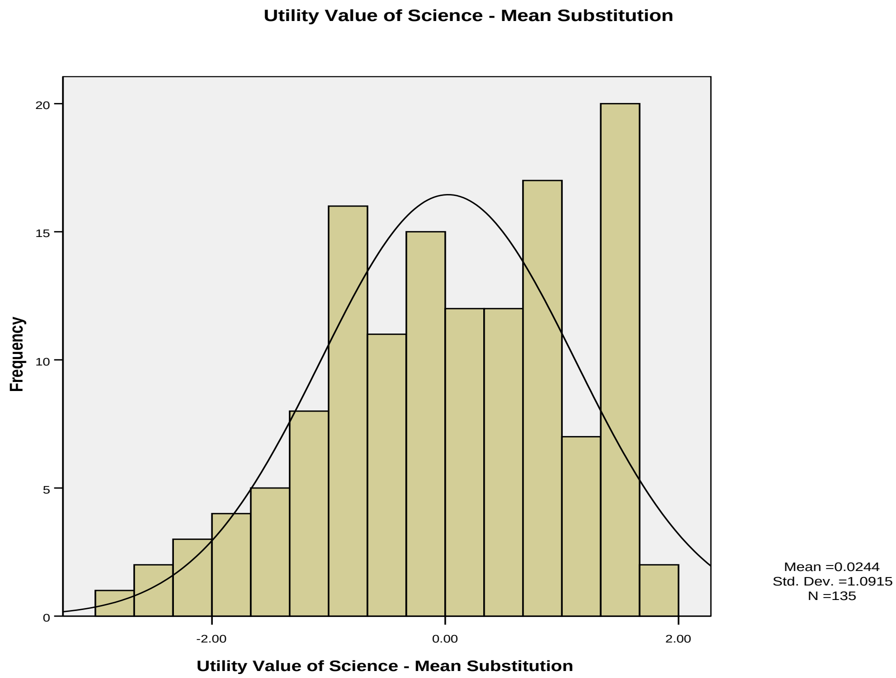
Appendix C: Regression Histograms



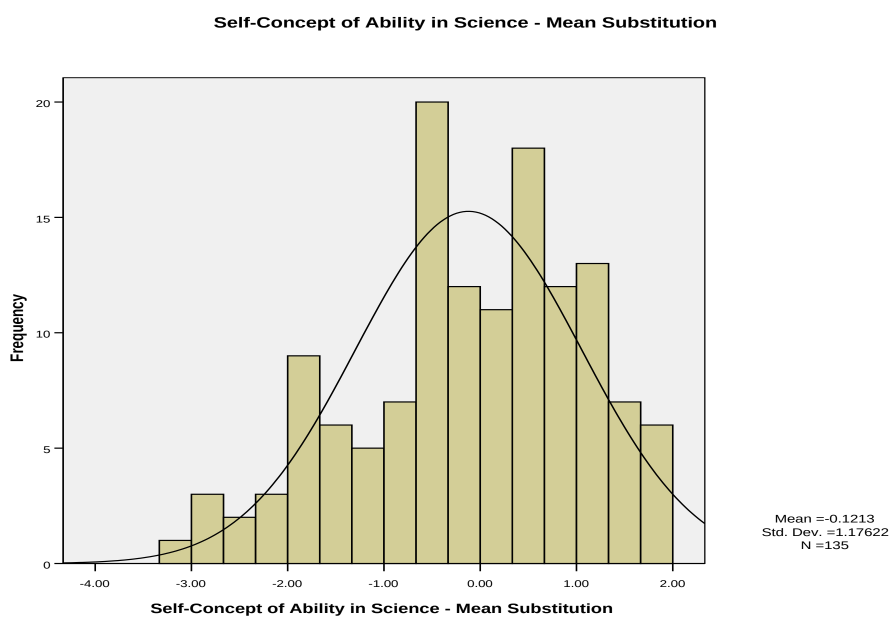
Centrality & Private Regard



Intrinsic Value



Utility Value



Self-Concept of Ability

Appendix D: Interview Protocols

Interview #1 Confidentiality Script

I'm from the University of Michigan and the group that writes the curriculum units that you use in your science class this year such as "What Affects the Air Quality in My Community" and "How Can I Make New Stuff From Old Stuff." The purpose of this interview is to ask you about your experiences in school, as well as your feelings about what it means to do well in school and in life in general.

Please know that this is not a test, and I just want you to answer questions as honestly as you can. This interview helps me learn about the experiences that you have in school, so only you can tell me what those experiences are. I may sometimes ask you about the words you use because sometimes words that we use can have different meanings for different people. I just want to make sure that I understand exactly what you mean. You may also see me write some notes down as you talk. These notes help me to ask you better questions about the things you say, and help me when I go back over the interviews later.

This interview will take approximately 25 minutes to complete. You can stop our conversation any time you'd like just by telling me that you want to stop.
Everything you say will be confidential. I will not tell your teachers or your parents what you say, so your comments will not affect your science grade in any way. Your participation is voluntary, which means that you can choose not to participate by just letting me know that you do not want to participate. You can also choose not to answer questions you do not feel comfortable answering.

I'd like to tape record our conversation so that I can listen to it later. Only people at the University of Michigan will hear your answers, but they will not know who you are. They will not know who you are because I am going to give you an alias or another name so that although I might discuss what you say, I will never use your real name. Do you have a preference for the name that I will use? (Record alias.)

Do I have your permission to tape record our conversation? (Start tape recorder)?

This is Interview #1 with (alias) and today's date is (today's date).

Now, I am going to ask you again if I have your permission to record our conversation so that I have it on tape. Do I have your permission?

Before we start, do you have any questions?

School Science Identities

How is the work in science class different than in your other classes?

- How interested are you in the subject matter you are learning in science class this year? How much do you enjoy the work you do in your science class? (Adapted from Mac Iver, Young, & Washburn, 2002)
- Do you feel like if you work hard you will learn a lot in science? If not, why not? If so, please explain. (Adapted from MacIver, Young & Washburn, 2002)
- How hard are you working to learn about science (not at all hard, as hard as I can). (Mac Iver, Young, & Washburn, 2002)
- To get good grades, how hard do you have to work in science class in comparison to your other classes?*

Is there someone in your science class that you think is a good science student?

- What types of things makes this person a good science student?
- How does the teacher show you that this student is good in science?
- How do your science classmates act toward this student?

Tell me about a time in science class when you have done something that you feel is useful in your everyday life? If so, can you tell me about it? If not, can you explain why you feel that the things you do in science are not useful in your everyday life?*

- It helps me prepare for high school (not at all a reason, very important reason).
- It helps me prepare for a career (not at all a reason, very important reason). (Both prompts from Mac Iver, Young, & Washburn, 2002).

I know that you've learned a lot about how to write a good scientific explanation in this class. Can you think of any other places in your life where you need to explain things to other people?*

- How are the explanations you write in class different than those you give in everyday situations?
- Do you feel that the way you write explanations in class helps you write more? If so, why do you think so? If not, can you give me an example of a time of a time when you enjoyed writing about something that you were assigned in school?

Can you tell me about a time in science class this year that there was something you learned that you shared with someone not in your class, like a brother, sister, parent, or friend?

Do you ever do science-like activities at home like experiments, or trying out different things to see if they work?

- …try to grow plants of my own at home? Do you see this as a science-like activity? Can you tell me why or why you may not see it that way?
- …try to bake different things at home? Do you see this as a science-like activity? Can you tell me why or why you may not see it that way?
- …try to fix different things at home? Do you see this as a science-like activity? Can you tell me why or why you may not see it that way?
- ...take things apart to see how they work? Do you see this as a science-like activity? Can you tell me why or why you may not see it that way?

General Achievement Information

What is your favorite subject in school?

- What is it about the subject that made it enjoyable for you?
- What did the teacher do to make this subject/class special for you?
- What kind of projects did you do in this class? (reading/writing/speaking activities)
- How well did you do in this class?
- How is this class useful to you in your everyday life? Can you tell me the reasons you think that?

What is your least favorite subject in school?

- What is it about the subject you don't like?
- What kind of projects did you do in this class? (reading/writing/speaking activities)
- How is this class useful to you in your everyday life? Can you tell me the reasons you think that?
- How well did you do in this class?

What is the best way to do well in school?

- What would you have to do to achieve that?
- What things might hold you back from doing well in school?

Describe what being a "good student" means to you.*

How do you think other people would describe you as a student?*

Students' Awareness of Opportunities in Education and Employment
(Possible Selves – Markus & Nurius, 1986)

What does it mean to be successful in American society?

- What would you have to do to achieve that?

- What things may hold you back from doing that? (Adapted from O'Connor, 1999)

What kind of job do you want to have when you are 25 years old? (ALD Survey)

- What would you have to do to be able to achieve this goal?
- What would hold you back from achieving this goal? (Adapted from O'Connor, 1999)

Do you know someone who is doing the type of job that you want to have someday?

- If so, what types of things have you learned from her/him about the job you want to have?*
- If not, what makes you want to do this type of job?

Interview #2 Confidentiality Script

As you know, this is our second interview together. In the first interview, I asked you questions about your experiences in and thoughts about school, particularly about science related activities. In this interview, I will be asking some similar questions, and also having you do some tasks in which you will look at some pictures and answer questions about them. I then ask you questions about some of the things you read and write in and out of school.

Please know that this is not a test, and I just want you to answer questions as honestly as you can. This interview helps me learn about the experiences you have around reading and writing practices in and out of school, so only you can tell me what those experiences are. I may sometimes ask you about the words you use because sometimes words that we use can have different meanings for different people. I just want to make sure that I understand exactly what you mean. You may also see me write some notes down as you talk. These notes help me to ask you better questions about the things you say, and help me when I go back over the interviews later.

This interview will take approximately 25 minutes to complete. You can stop our conversation any time you'd like just by telling me that you want to stop.
Everything you say will be confidential. I will not tell your teachers or your parents what you say, so your comments will not affect your science grade in any way. Your participation is voluntary,

which means that you can choose not to participate by just letting me know that you do not want to participate. You can also choose not to answer questions you do not feel comfortable answering.

We are going to tape record this interview just like the last time using the alias that you came up with, ______. Only people at the University of Michigan will hear your answers, but they will not know who you are because I will always use this alias when I refer to the information that you have shared with me.

Do I have your permission to tape record our conversation? (Start tape recorder)?

This is Interview #2 with (alias) and today's date is (today's date).

Now, I am going to ask you again if I have your permission to record our conversation so that I have it on tape. Do I have your permission?

Before we start, do you have any questions?

I am going to show you some pictures. Would you look at each person and tell me what kind of job you think the person has, and why? (My own question based on Stake & Mares, 2005; Stake &Nickens, 2005)

Prompts:

If they suggest scientist as a career, “You know I’m interested in science, so I noticed right away that you thought this person might be a scientist.

Why this person?”

Why her and not him?”

Why this woman and not that woman?”

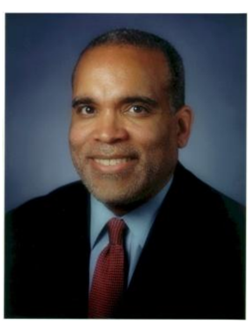
“Why this man and not that man?”

“Is there something about this picture that reminds you of someone?”

OR

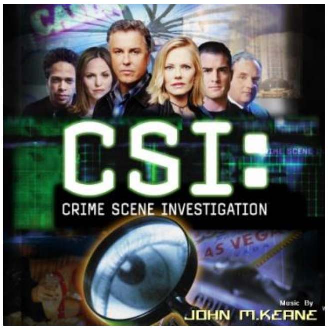
“You know that I’m interested in science, and I noticed that you didn’t think that any of these people would be scientists. Why is that?”

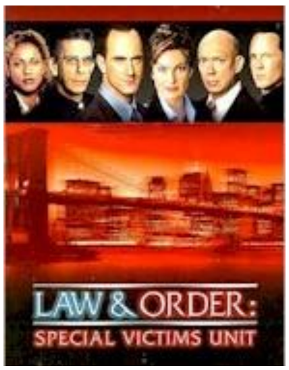



I'm going to show you some pictures of some popular TV shows. Take a look at these pictures of different TV shows.   (Bullet points are prompts about the pictures that will be asked if student doesn't say something about one of these ideas in his/her initial response))

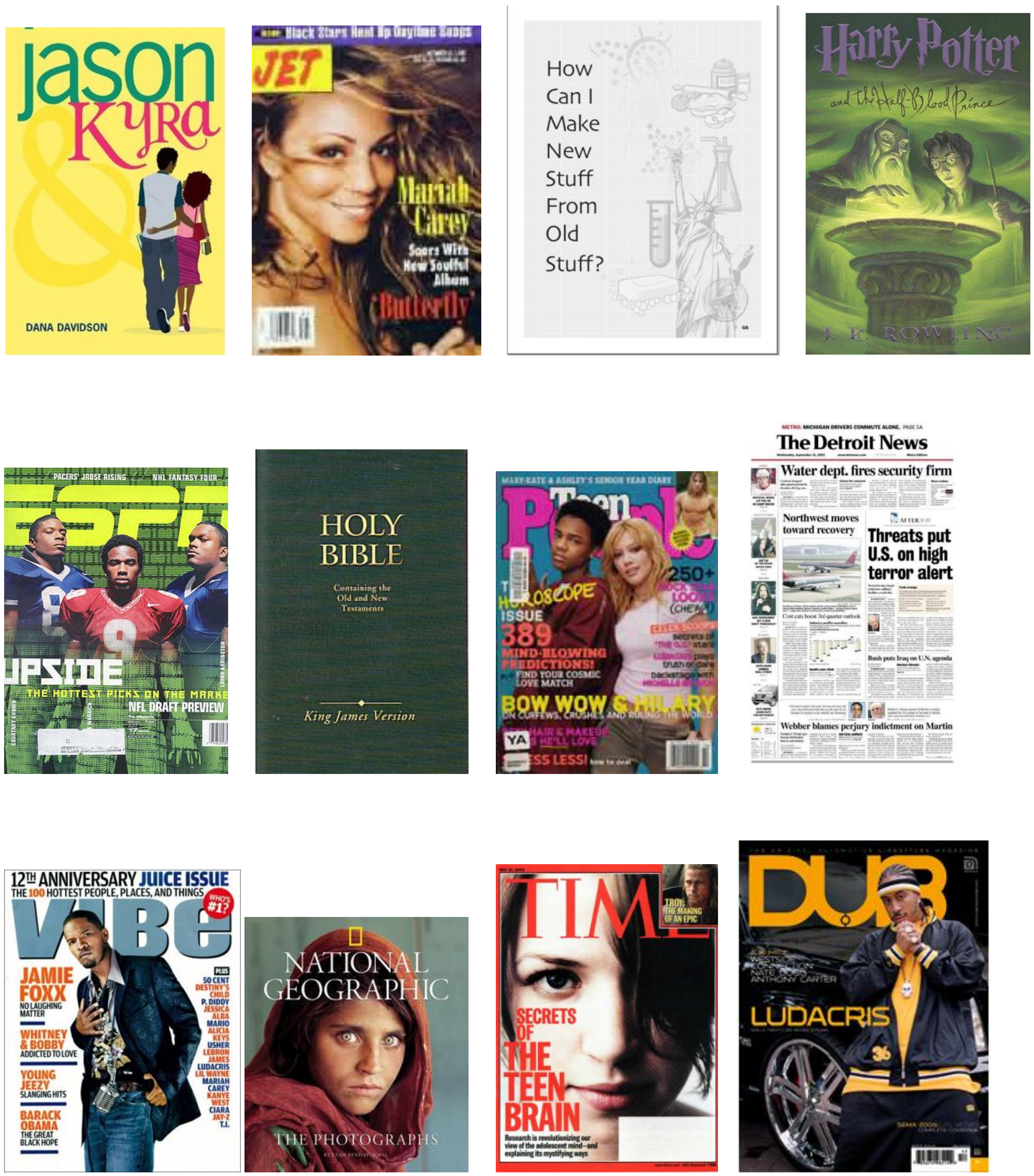
- If you could choose any of these, which one would you choose to watch first? What made you pick X [interviewer should say text type/name aloud] first? Is this something you watch regularly?
- Which one would you pick second? What made you pick X second? Is this something you watch regularly?
- What would be your third choice? What made you pick X third? Is this something you watch regularly?
- Which ones do you think your friends would choose to watch?
- Which would you watch by yourself?
- Which would you watch if hanging out with friends?
- Are there programs not shown here that are your favorites to watch?
- What types of science programs do you watch on TV? Do you watch them for fun or because they are assigned for homework? Who do you watch them with?





You can choose to read a lot of different things. Take a look at these pictures of different reading materials. If you could choose any of these, which one would you choose to read first? (Adolescent Literacy Development [ALD] Study Out of School Interview).

- What made you pick X [interviewer should say text type/name aloud] first? Have you actually read that before this, or did you just think you might like to read it?
- Which one would you pick second? What made you pick X second? Have you actually read that before this, or did you just think you might like to read it?
- What would be your third choice? What made you pick X third? Have you actually read that before this, or did you just think you might like to read it?



If there are other things you most like to read that aren't in the pictures, please tell me about them (ALD Out of School Interviews).

- What sorts of things are you best at reading? (Expectancy-Value items)
- Why do you read these things?
- Where do you get the things you read?
- Do other kids you know also read these?
- Do people older than you read these things?
- How do you find these materials?
- Where do you read [insert the text participant named]?
- Do you ever read [insert the text participant named] with other people? What kinds of people? (Advise participant not to name people but to describe relationships, types of people such as friends, siblings, relatives, etc.)

Reading Practices (ALD Out of School Interview)*:*

Do you see yourself as a reader?

- Do your family members see you as someone who likes reading?
- When you get gifts and presents from family members, do they often give you books that suit your interests?
- When was the last time that a member of your family bought you a book?

How often do you read just for fun?

- Can you give me an example [e.g., title] of one of the things that you read for fun?
- Why do you find it fun to read [insert the text named by the participant]?

Do you read things together with your family members? (e.g. newspapers, TV guide, sports reports, magazines, family letters/emails, official letters)

How often do you go to the local library to borrow books, CDs, videos? With whom?

Do you ever buy / borrow books or magazines about your favorite films or performers?

Do your friends have books that they share with you? What are they?

Do you share books with your friends? Which ones?

Writing Practices (ALD Out of School Interviews):

Do you write outside of school?

- What do you write?
- Why do you write?
- How often do you write?
- How good at writing are you? (Probe: not at all good… very good)
- How often do you write just for fun?

What kinds of things do you write just for fun?

Do you write [insert the text participant named] with other people? What kinds of people? (Advise participant not to name people but to describe relationships, types of people such as friends, siblings, relatives, etc.)

- Who do you write for?
- Who reads the things you write?
- What makes you really want to write something?
- What makes you really not want to write something?

Do you ever write in order to help yourself or other people get things done? (e.g. instructions, recipes, family mail).

Internet Usage & Practices (ALD Out of School Interview):

How often do you use the computer?

- Where do you access the internet (home, school, library, friend's house, relative's house)?
- Do you use the internet (www) to read information about your favorite actors/heroines/heroes/sporting stars/singers/bands/musicians?
- Are there things you see and hear about on television that you then go and read more about those things on the internet or in books?
- Do you do this by yourself or with friends?*
- What are your favorite websites to visit?*
- What kinds of computer games do you like to play?

Other Activities:

What types of activities do you participate in after school?

- Do you do reading/writing tasks in [insert specific activity]?
- Do you ever create speeches for activities outside of school?*
- What types of discussions do you have about things you read and write?
- How does participating in this activity [insert specific activity] differ from participating in school reading and writing activities? (Collins, 1999)

If church activities are not mentioned, “Do you participate in any activities at your church such as Sunday School, choir, plays, or Bible study?”

- If so, what type of activities?” (Collins, 1999)
- How does participating in this activity [insert specific activity] differ from participating in school reading and writing activities?” (Collins, 1999)

Interview #3 Confidentiality Script

As you know, this is our third interview together. In the first interview, I asked you questions about your experiences in and thoughts about school, particularly about science related activities. In the second we talked about your television and reading and writing preferences. In this interview, I will be asking you to read a passage and then I will ask you questions related to the passage before, during and after you read.

Please know that this is not a test, and I just want you to answer questions as honestly as you can. This interview helps me learn about your experiences from your perspective, so only you can tell me what those experiences are. I may sometimes ask you about the words you use because sometimes words that we use can have different meanings for different people. I just want to make sure that I understand exactly what you mean. You may also see me write some notes down as you talk. These notes help me to ask you better questions about the things you say, and help me when I go back over the interviews later.

This interview will take approximately 25 minutes to complete. You can stop our conversation any time you'd like just by telling me that you want to stop.
Everything you say will be confidential. I will not tell your teachers or your parents what you say, so your comments will not affect your science grade in any way. Your participation is voluntary, which means that you can choose not to participate by just letting me know that you do not want to participate. You can also choose not to answer questions you do not feel comfortable answering.

We are going to tape record this interview just like the last time using the alias that you came up with ______. Only people at the University of Michigan will hear your answers, but they will not know who you are because I will always use this alias when I refer to the information that you have shared with me.

Do I have your permission to tape record our conversation? (Start tape recorder)?

This is Interview #2 with (alias) and today's date is (today's date).

Now, I am going to ask you again if I have your permission to record our conversation so that I have it on tape. Do I have your permission?

Before we start, do you have any questions?

"I have a passage that I would like you to read out loud for me. The title of the text is _______. I am going to stop you from time to time to ask you some questions, and after you finish the passage I will ask your opinions about the passage. Could you please read the text out loud for me? (*See Attached*)

Throughout reading, I will stop student to ask questions:

STOP AFTER 2 SENTENCES (Adapted from the ALD out of School Interview):

- Can you explain to me what that part was about?
- Have you ever read about anything like that before?
- Does this remind you of anything?

Here, read this part aloud for me. (The section about the types of clothes he wants to wear).

- What do you think about as you read?
- Could the setting be a real place that exists in our time? What makes you think that?

After reading questions:

If you were to describe what the passage was about (give the main idea) to someone you know like a friend who is in the 8th grade, what would you tell him or her?*

Can you show me a part that you really enjoyed reading?

- Why did you like this part?
- Are there other parts you liked?
- Were there parts that you disliked reading? If so, can you tell me why?

If you don't know how to read a word, or if you read something and it doesn't make sense, what do you do?

Are there any parts in this passage that were hard for you to read?

- What made this part hard?
- What did you do to figure it out?

Are there any words in this passage that you had a hard time reading, or that you didn't understand?

- Can you show me some of the words?
- Are there any words that you don't know how to pronounce?
- What do you think that word meant?

Is this passage different than things you read in your subjects such as social studies or science class? How so?

If you were to write this for people your age, how would you make it different?*

- Would you write it differently for girls versus boys?

Peer Groups

The main character, Bennie, talked about his school and about trying to fit in with the other kids, and what the consequences of that decision are on his life. Thinking of the story you just read, how is Bennie's experience with his friends and his schoolwork similar to your experience with your friends and schoolwork?*

- Are there any other similarities between your life and Bennie's life? Differences?
- How much does what your friends think affect how hard you work in school? In what ways does the type of people in your class affect the way you perform in the class?
- For you, when you make decisions about whether to work hard in a class or not, what is the most important part of that decision – whether you like the subject, the teacher, what your parents might say or think, or what your friends might say or think? Can you give me an example of a class in which you decided not to work hard and why?

What are the cliques at your school?

- Do you belong to any of these groups? Describe the group to which you belong.
- Are these the same people you hang out with outside of school?
- If you do not have a group, describe the group of friends you hang out with at school.
- Is there a group that you would like to hang with, that you are not a part of now? What is it about the group that makes you want to be in it? What do you think it would take for you to be included in this group?

(The following group of questions is adapted from Graham & Taylor, 2002. Students are asked to nominate students in their science class on various dimensions. These nominations will be compared with evaluations of students as high, medium and low performing students by the teacher as a way to determine if there are gender differences in students' nominations of peers).

I would like you to nominate someone in your science class that you most admire, respect or want to be like.

…nominate someone that tries hard and gets good grades.

…nominate someone who doesn't try and receives poor grades.

…nominate someone who follows the rules in class.

…nominate someone who doesn't follow the rules in class.

…nominate someone who dresses well.

…nominate someone who is good at sports.

Are your closest friends or the group of people you hang out with interested in science? (Adapted from Stake & Mares, 2005)

- How does it help you talk to them about your homework or schoolwork in science?
- Do you ever watch science-related shows on television or read science-related books with your friends and family?
- Do you share things learned in science with other people you know? Can you give me an example of a time?

A Boy's Biggest Problem

The ninth grade stands out as a pivotal time in my life. As an *A* student I could stand up intellectually with the best. And I could hold my own with the best – or worst – of my classmates. It was a time of transition. I was leaving childhood behind and beginning to think seriously about my desire to be a doctor.

By the time I hit tenth grade, however, the peer pressure had gotten to be too much for me. Clothes were my biggest problem. "I can't wear these pants," I'd tell my mother. "Everyone will laugh at me."

"Only stupid people laugh at what you wear, Bennie, she'd say. Or, "It's not what you're wearing that makes the difference."

"But, Mother," I'd plead. "Everybody I know has better clothes than I do."

"Maybe so," she'd patiently tell me. "I know a lot of people who dress better than I do, but that doesn't make them better."

Just about every day, I begged and pressured my mother, insisting that I had to have the right kind of clothes. I knew exactly what I meant by the right kind: Italian knit shirts with suede fronts, silk pants, think-and-thin silk socks, alligator shoes, stingy brim hats, leather jackets, and suede coats. I talked about those clothes constantly, and it seemed like I couldn't think about anything else. I had to have those clothes. I had to be like the in-crowd.

Mother was disappointed in me and I knew it, but all I could think of was my poor wardrobe and my need for acceptance. Instead of coming directly home after school and doing my homework, I played basketball. Sometimes I stayed out until ten o'clock, and a few times until eleven.

My grades dropped. I went from the top of the class to being a *C* student. Even worse, achieving only average grades didn't bother me because I was part of the in-group. I hung out with the popular guys. They invited me to their parties and jam sessions. And fun – I was having more fun than I'd ever had in my life because I was one of the guys.

I just wasn't very happy

Excerpt from Carson, B. (1990). *Gifted Hands* (pp. 49-51). Grand Rapids, MI: Zondervan Publishing.

Appendix E: Science Pretest

Name:__________________________

How can I make new stuff from old stuff?

Pre/Post Assessment

Instructions

We are asking you to show what you understand about chemistry concepts. Please try your best even if you are unsure of your answers.

Please use a pencil to answer the questions.

For the <u>multiple-choice questions</u> record your answers on your ANSWER SHEET by filling in the circles. If you are not sure of the answer to a multiple-choice question, choose the BEST answer and go on to the next question. If you change an answer, be sure to erase your mistake completely. Choose only one answer for each question. **Make sure the number of the question you are answering is the same as the number on your ANSWER SHEET.**

For <u>written-response questions</u>**, write your answers in this test booklet**.
DO NOT write your answers on the answer sheet. Show all that you know by writing as much as you can. Write complete sentences or paragraphs. Make sure you attempt to answer each question.

If you do not understand any of these instructions, please raise your hand.

Multiple-choice questions

REMINDER: Please mark your answers on your ANSWER SHEET

1. To determine if a chemical reaction occurred, you should measure and compare which of the following?

   A. volume of the materials
   B. shape of the products
   C. properties of the substances
   D. mass of the reactants

2. A chemical reaction occurs when a student mixes carbon dioxide (CO_2) and water (H_2O).

$$CO_2 + H_2O \rightarrow \ ?$$

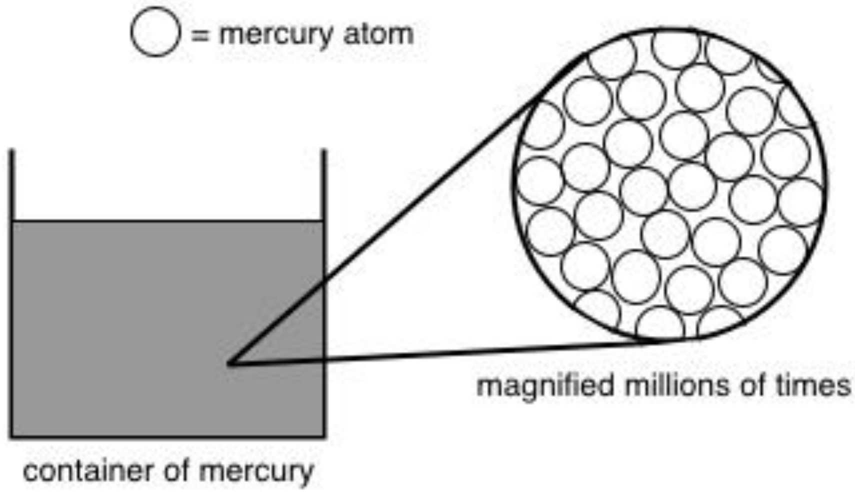
   Using the principle of conservation of mass, which of the following could be the product of the reaction?

   A. $H_2O_2 + CO_2$
   B. H_2CO_3
   C. $H_2O + CO_2$
   D. H_3CO_2

3. A student found 2 green powders that look the same. He wants to figure out if the 2 powders are the same or different substances. Which of the following is the best method to use?

   A. Measure the mass, volume, and temperature of each powder and compare.
   B. Combine both green powders and see if there is a chemical reaction.
   C. Mix the 2 green powders together and then test the properties.
   D. Determine the density, solubility, and melting point of each powder and compare.

4.



The model above represents which of the following?

A. a phase change
B. a substance
C. a chemical reaction
D. a mixture

5. Which of the following is an example of a chemical reaction?

A. mixing lemonade powder with water
B. burning marshmallows over a fire
C. melting butter in a pan
D. boiling water on a stove

6. A piece of copper is a substance because it

A. is made of the same type of atom throughout.
B. consists of many different types of atoms.
C. can be made into something different.
D. reacts with other substances.

7. A student performs the same chemical reaction experiment twice — once in an open system, and again in a closed system. The mass before the chemical reaction is 13 grams. The chemical reaction produces a gas. What would you expect the mass to be after the chemical reaction in the open and closed systems?

A. 13 grams in the open system and 15 grams in the closed system
B. 13 grams in the open system and 11 grams in the closed system
C. 11 grams in the open system and 13 grams in the closed system
D. 11 grams in the open system and 15 grams in the closed system

8. A student believes that she has measured a new property that she did not learn about in class. She calls her new property "Yepop". Here is a table of Yepop measurements for different objects:

Object	**Yepop (yp)**
Copper wire	132 yp
Copper spoon	240 yp
Glass jar	89 yp
Wooden spoon	240 yp

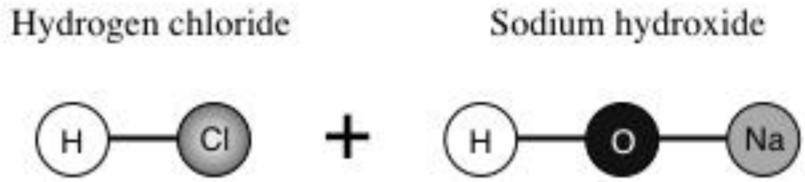
Based on her results, do you think "Yepop" is a property?

A. No, because the copper objects have different measurements.
B. No, because the same substances have the same measurements.
C. Yes, because the spoons have the same measurements.
D. Yes, because the different substances have different measurements.

9. A chemical reaction occurs when substances interact and their atoms

A. disappear.
B. change their size.
C. become new atoms.
D. recombine.

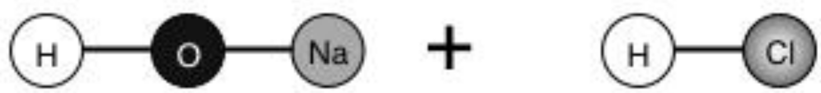
10. The following are models of two substances:



A chemical reaction occurs when hydrogen chloride and sodium hydroxide are mixed together. Which of the following are the products of the chemical reaction?

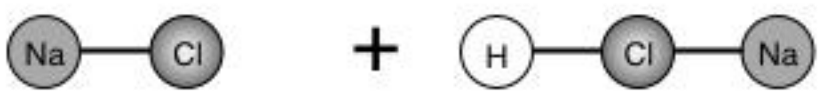
A.

B.



C.

D.



11. Which statement is always true about conservation of mass?

A. The total mass of the reactants is equal to the total mass of the products.
B. The mass of one reactant is equal to the mass of one product.
C. The total mass of a system changes in a chemical reaction.
D. The mass changes in a phase change, but not in a chemical reaction.

12. A property is

A. determined by the amount of a substance.
B. made of one type of substance.
C. a process to make a new substance.
D. a characteristic of a substance.

13. Which of the following is a possible chemical reaction?

A. $O_2 + CO_2 \rightarrow CO_2 + O_2$
B. $CuSO_4 \rightarrow CuSO_4$
C. $NaOH + HCl \rightarrow NaCl + H_2O$
D. $O_2 \rightarrow H_2$

14. Water (H_2O) cannot be turned into salt (NaCl) through a chemical reaction because

A. salt is a mixture of atoms.
B. salt and water are made of different atoms.
C. water is made of three atoms.
D. water contains liquid atoms and salt contains solid atoms.

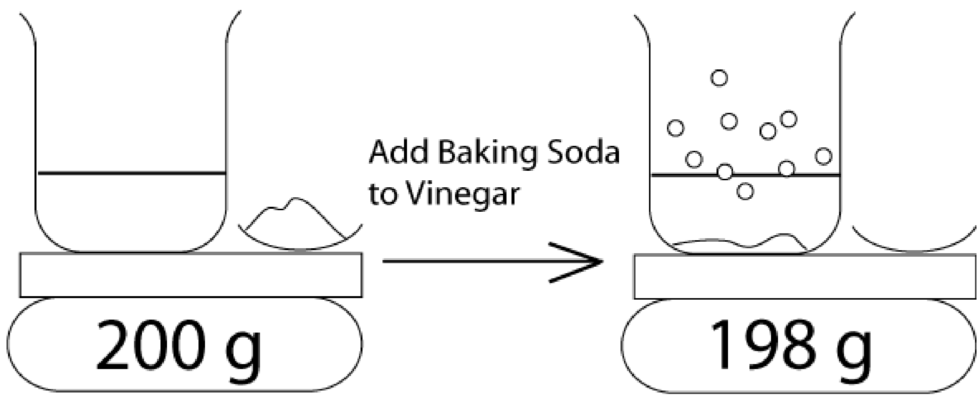
15. The total mass of two liquids is 32 grams. When a student combines the liquids in an open beaker, she observes bubbles. Then she finds that the mass of the combined liquids is 29 grams. This could be because molecules

A. became smaller.
B. escaped the beaker.
C. were destroyed.
D. packed closer together.

Written-response questions

Please write your answer for question 1 on THIS SHEET.

1. Dana places a beaker of vinegar and a Petri dish of baking soda on a balance. The balance reads 200 grams. Next, she pours the baking soda into the beaker with the vinegar. She does not cover the beaker. The baking soda and vinegar react and produce a gas. She places the beaker and the Petri dish back on the balance. The balance reads 198 grams.



Write a **scientific explanation** that answers the question: What is the mass of the gas produced when the baking soda reacted with the vinegar?

Please write your answer for question 2 on THIS SHEET.

2. Carlos takes some measurements of two liquids — butanic acid and butanol. Then he stirs the two liquids together and heats them. After stirring and heating the liquids, they form two separate layers — layer A and layer B. Carlos uses an eyedropper to get a sample from each layer and takes some measurements of each sample. Here are his results:

		Measurements				
		Density	Melting Point	Mass	Volume	Solubility in water
Before stirring &	Butanic acid	0.96 g/cm^3	-7.9 ˚C	9.78 g	10.18 cm^3	Yes
	Butanol	0.81 g/cm^3	-89.5 ˚C	8.22 g	10.15 cm^3	Yes
After stirring &	Layer A	0.87 g/cm^3	-91.5 ˚C	1.74 g	2.00 cm^3	No
	Layer B	1.00 g/cm^3	0.0 ˚C	2.00 g	2.00 cm^3	Yes

Write a **scientific explanation** that states whether a chemical reaction occurred when Carlos stirred and heated butanic acid and butanol.

Please write your answer for question 3 on THIS SHEET.

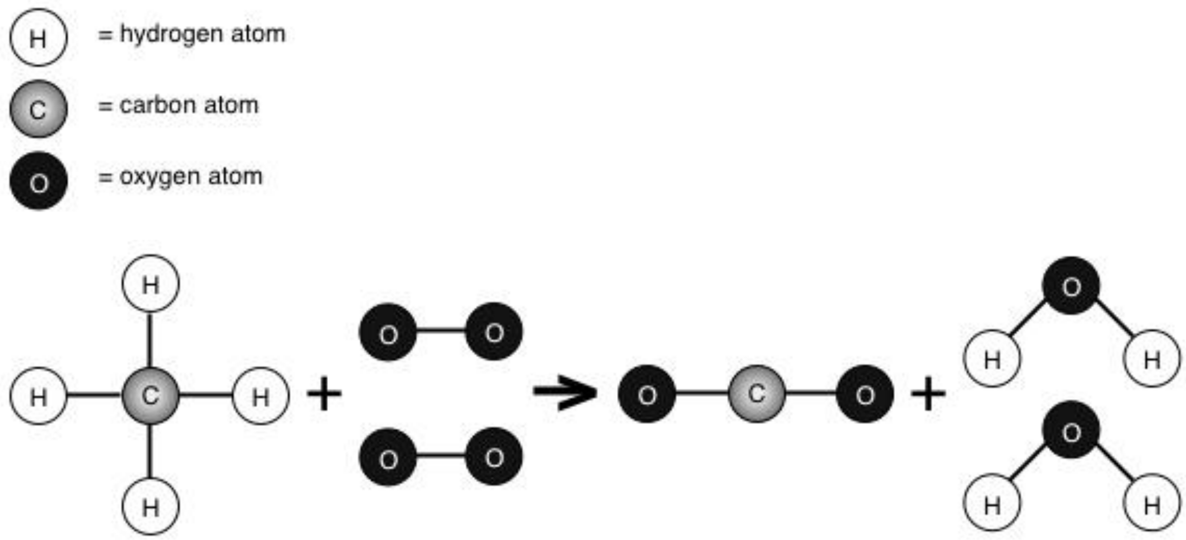
3. Examine the following data table:

	Density	Color	Mass	Melting Point
Liquid 1	0.93 g/cm^3	no color	38 g	-98 °C
Liquid 2	0.79 g/cm^3	no color	38 g	26 °C
Liquid 3	13.6 g/cm^3	silver	21 g	-39 °C
Liquid 4	0.93 g/cm^3	no color	16 g	-98 °C

Write a **scientific explanation** that states whether any of the liquids are the same substance.

Please write your answer for question 4 on THIS SHEET.

4. A student creates a model to show what happens before and after a process.



A. Does the model represent a chemical reaction? Why?

B. According to the model, do you think that the total mass before is equal to the total mass after? Why?

Appendix F: Means and Medians for Utility and Intrinsic Values

Descriptive Statistics for Science Values (N=101)

Item	Construct	Mean	Median	Standard Deviation
How much do you LIKE doing Science? (1=not at all, 7=a lot)	Intrinsic Value (Enjoyment)	4.63	5.00	1.82
How much do you LIKE Science, compared with your other subjects at school? (1=much less, 7=much more)		4.10	4.00	1.80
In general, I find working on Science assignments… (1=very boring, 7=very interesting)		4.79	5.00	2.12
In general, how USEFUL is what you learn in Science? (1=not at all useful, 7=very useful)	Utility Value (Usefulness)	5.73	6.00	1.52
How USEFUL is what you learn in Science, compared with your other subjects at school? (1=much less, 7=much more)		4.94	5.00	1.76
How USEFUL do you believe Science is? (1=not at all useful, 7=very useful)		5.31	6.00	1.82

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