MIDDLE SCHOOL STUDENT PERCEPTIONS OF MATHEMATICS MOTIVATION AND TEACHER SUPPORT IN A HIGHER-INCOME SETTING

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ABSTRACT

Decrements in mathematics motivation across early adolescence are a concern in the United States, particularly for females and African Americans given their underrepresentation in math-related career pathways. Disturbing trends highlight the need to further understand student motivation during the middle school years, when motivational losses begin. Teacher support is a key contextual factor associated with motivation, however less is known about the role of teacher support as a protective factor against motivational decrements specifically among African Americans and females. The current study utilized a cross-sectional design to examine relationships among mathematics motivation, teacher support, and student characteristics (i.e., race and gender) for 1021 fifth through eighth grade students from a New Jersey school district in a relatively higher-income community. The students completed a survey measuring four aspects of mathematics motivation and two aspects of teacher support. Multiple regression analyses did not replicate previous research showing straight-forward declines in motivation across the middle school years. Unexpectedly, across race and gender, students in later grades reported lower *costs* associated with math effort and higher *expectancy* for math success than those in earlier grades. That said, analyses did reveal a concerning trend about two aspects of motivation for females. Comparing responses across grade level, females did not differ in their *valuing* of math or their *future interest* in math. Males in later grades, in contrast, reported higher *valuing* of and *future interest* in math compared to their male peers in earlier grades. This suggests a gender motivation gap might be initiated toward the end of middle school. Also noteworthy was that teacher support was found to be positively associated with motivation for all students, regardless of gender and race. Thus, teacher support was promotive for all, but not a unique protective factor for African American and female students. In fact, analyses showed that *teacher help* had a stronger association with the *expectancy* aspect of motivation for males than for females. Overall, these results highlight the importance of teacher support in math motivation as well as the unique relationships between contextual factors and motivation based on student grade level and gender.

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Introduction

Based on decades of educational research, academic motivation has emerged as a leading contributor to students' abilities to successfully engage in academic activities, learn from instruction, and meet standards of academic competency (Wentzel & Wigfield, 2009). Student motivation has been linked to numerous academic indicators including grades, state wide standardized test scores, course enrollment, and graduation rates (Eccles, 2008; Lotkowski, Robbins & Noeth, 2004; Marsh, Koller, Trautwein, Ludtke, & Baumert, 2005). Thus, students with low levels of academic motivation are at higher risk for poor short term and long term outcomes such as high school dropout and unemployment (Archambault, Janosz, Fallu, & Pagani, 2009; Fan & Wolters, 2012; Janosz, LeBlanc, Boulerice, & Tremblay, 2007).

Unfortunately, research has also shown that academic motivation tends to decline as students progress through school (Gottfried, Fleming, & Gottfried, 2001; Kosovich, Hulleman, Barron, & Getty, in press; Wigfield et al., 1997). In particular, a large body of research has demonstrated notable losses in student motivation, engagement and achievement after the transition from elementary to middle school (Eccles et al., 1993; Eccles & Midgley, 1990). Middle school represents a time of substantial stress for students as they experience abrupt developmental changes as well as structural changes (e.g., tracking, departmentalized curricula, multiple teachers) in their school and social environments (Eccles, 1999). During the middle grades students are simultaneously forming new friendships, acquiring additional responsibilities, going through puberty and managing increased academic demands (Rosenblatt & Elias, 2008). Middle schools in the United States have long been scrutinized, even referred to as the "wasteland" of

American education (Wigfield & Eccles, 1994). This is largely due to the belief that many middle schools are ill equipped to meet the unique developmental needs of early adolescents. It is a short, yet influential period of time when students are often not ready to make important life decisions, yet their academic choices can carry long term consequences. Student motivation is one driving force behind their academic decisions and represents a promising area of inquiry, particularly during the middle school years.

Whereas research has revealed significant developmental declines in student motivation across a variety of subject areas, the steepest declines have been observed in the area of math (Gottfried et al., 2001; Gottfried, Marcoulides, Gottfried, Oliver, & Guerin, 2007; Wigfield, Eccles, Schiefele, Roeser, & Davis-Kean, 2006). This pervasive pattern in the literature is connected to a broader issue concerning math and science education in the United States. International comparative assessments have revealed that American students are behind those of several other countries (i.e., Korea, Singapore, China, Japan) in math achievement (Gonzales et al., 2004; TIMSS, 2011). According to the Trends in International Mathematics and Science Study (2011), the United States was outscored by 3 countries at grade 4 and was outscored by 4 countries at grade 8. Given modern society's increasing use of technology, there is a critical need to enhance science, technology, engineering, and math (STEM) education among American students in order to keep pace with the workforce revolution (National Mathematics Advisory Panel, 2008).

Given that the pursuit of STEM fields of study has been associated with early interest, commitment, motivation and achievement in math (Lubinski & Benbow, 2006), there is a need to better understand student motivation particular to this subject area.

Gaining a better understanding of math motivation is especially important for female and African American students, which are two groups underrepresented in math-related postsecondary education and career pathways (Chemers, Zurbriggen, Syed, Goza, & Bearmen, 2011; Watt, Shapka, Morris, Durik, Keating, & Eccles, 2012). A better understanding of math motivation for these groups could indicate directions for narrowing gender and racial gaps in the future.

The present study aimed to examine the link between teacher support and math motivation across the middle school years, with a focus on this link for female and African American students (two groups underrepresented in math-related college majors and careers). The study used a cross-sectional design to examine changes in math motivation across the middle school grades (5^{th}-8^{th} grade). Finally, it provided a unique examination of these issues in a school district set in a higher-income community.

Models of Achievement Motivation

For about half a century, researchers have been interested in understanding the concept of human motivation, which refers to the reasons that underlie behavior (Guay et al., 2010). A large body of the research has been concentrated in the domain of achievement motivation, which focuses on student learning and integrates principles from both developmental and educational psychology (Eccles & Wigfield, 2002). Over the years, numerous theories of achievement motivation have emerged from a variety of intellectual traditions. Four influential theories of achievement motivation are presented below.

Self-efficacy theory. One prominent social cognitive model of motivation is Bandura’s self-efficacy theory (1982), which posits that efficacy is a major influence on interests, effort, persistence and goal setting. According to Bandura (1997), self-efficacy is defined as individuals' beliefs in their abilities to successfully perform a given course of action. A study by Pintrich and DeGroot (1990) supports Bandura's notion, suggesting that individuals with higher self-efficacy tend to have higher levels of motivation and success on a given task. Self-efficacy perceptions have also been shown to better predict achievement than actual ability (Pintrich & DeGroot, 1990). Furthermore, high levels of academic self-efficacy predict subsequent performance, course enrollment and occupational ambitions (Bandura, Barbaranelli, Caprara, & Pastorelli, 2001).

Self-determination theory. A second influential model of motivation is Deci and Ryan's self-determination theory (1985), which evolved from work focused on the distinction between extrinsic and intrinsic motivation. When individuals are intrinsically motivated, they engage in an activity for its own sake. When extrinsically motivated, individuals engage in an activity in order to earn rewards or avoid punishments (Eccles & Wigfield, 2002). In over one hundred studies investigating intrinsic and extrinsic motivation, it was found that extrinsic rewards undermined intrinsic motivation to perform even inherently interesting activities (Deci, Koestner, & Ryan, 1999). Deci and Ryan argued that individuals seek out challenging activities and find these activities to be intrinsically motivating because they have an innate need for competence, relatedness to others, and a sense of autonomy (Anderman & Midgley, 1997). In other words, intrinsic motivation is maintained when individuals feel competent and self-determined, and reduced when external control is exerted.

Attribution theory. A third leading theory of motivation for the past 30 years has been Wiener's attribution theory (Eccles & Wigfield, 2002). Attribution theory emphasizes that individuals' achievement strivings are determined by their interpretations of previous achievement outcomes rather than actual outcomes or motivational dispositions (Weiner, 1985). In other words, an individual's explanations regarding the causes of success or failure are key motivational beliefs that influence subsequent achievement endeavors. According to Weiner (1992), there are four major types of achievement attributions including ability, effort, task difficulty and luck. The types of attributions a person holds determine his or her motivation based on whether the cause of success is changeable and within the individual's control (Eccles & Wigfield, 2002). Attributing an outcome to a stable cause (e.g., ability or skill) has a stronger influence on one's expectancies for future success than attributing an outcome to an unstable cause (e.g., effort). Thus, poor achievement outcomes are more likely to lead to reduced effort and motivation for those holding ability attributions than for those holding effort attributions, since a lack of ability is more difficult to change and control than a lack of effort (Weiner, 1985, 1992).

Expectancy-value theory. Finally, modern expectancy-value theory by Eccles and colleagues (1983) has emerged as a leading model of achievement motivation that incorporates the tenets of many theories of motivation, including those mentioned above. Of all the theories of motivation, the expectancy-value model is particularly applicable for adolescents because it is at this developmental stage that students have the ability to evaluate their strengths/weaknesses, probabilities of success, and the values of tasks in goal attainment. This theory is based on Atkinson's (1964) original expectancy-value model, which links achievement performance, persistence, and task choice to an individual's expectancy-related and task-value beliefs. Expectancies refer to beliefs about how one will perform various tasks or activities, whereas values refer to incentives or reasons for engaging in activities (Eccles & Wigfield, 2002).

Modern expectancy-value theories, however, have incorporated a broader variety of psychological and social determinants than earlier versions of the model. For instance, the model developed by Eccles and her colleagues (1983) distinguished between one's self-concept of domain-specific abilities and perceived task difficulty. They predicted that a combination of these two beliefs comprise one's expectations of success in particular academic domains. It was predicted that an individual would expect to do well on a given task if he perceives himself to have a high ability for that task, taking into account the perceived difficulty of the task.

In terms of subjective task value, Eccles and her colleagues (1983) proposed a broader definition than earlier models. They argued that task value is determined by task characteristics; by the general needs, goals, values, and motivational orientations of the individual; and by affective memories of comparable tasks in the past. The amount of value that one attaches to a given task is determined by the degree to which that task can fulfill needs, confirm central aspects of one's self-schema, assist in reaching goals, uphold personal values, and/or elicit positive affective associations. Furthermore, Eccles and colleagues (1983) argued that task value should be conceptualized in terms of four major domains: attainment value (the importance of doing well on a task in terms of one's self-schema and personal values), intrinsic value (inherent enjoyment of an activity), utility value (the degree to which a task is instrumental in reaching long/short term goals), and cost (what is lost, given up, or suffered as a consequence for engaging in a task).

Research has demonstrated the validity of expectancy-value models through numerous studies. Expectancies and task values are associated with both achievement and academic choices in domains such as math and language arts (Meece, Wigfield, & Eccles, 1990; Spinath, Spinath, Harlaar, & Plomin, 2004). In general, it has been shown that expectancies are more predictive of immediate achievement behaviors such as engagement and task performance (Marsh et al., 2005; Wigfield, 1994), whereas values are more predictive of future behaviors such as academic course plans and enrollment decisions (Nagy, Trautwein, Baumert, Koller, & Garrett, 2006). These findings suggest that expectancies and values have independent, yet complementary influences on behavior (Schunk et al., 2007). A more in-depth exploration of the expectancy-value model as well as other influential models of motivation and their empirical support are presented in Appendix A.

Ecological Context of Individual Motivation

Since motivation does not exist in a vacuum, it is necessary to examine how individual differences in motivation during the middle school years are linked to contextual factors, especially given the apparent incompatibility between many middle school environments and the developing needs of the adolescents they serve. Most recently, motivation literature has extended its focus on individual characteristics to include frameworks that account for developmental, ecological, and social factors that influence motivational beliefs and actions. According to Wentzel and Wigfield (2009), the complex interactions of individual and contextual characteristics are the major focus of current work on motivation.

Subject area. Individual motivation has been shown to vary across academic subjects, and domain specificity tends to increase with age as students acquire more educational experiences and curricula become increasingly departmentalized (Gottfried et al., 2001). According to Eccles and Wigfield (2002), students attach more value to activities at which they excel over time, which suggests that individuals will become increasingly motivated in academic subjects in which they experience ongoing success. A recent review of the literature on differentiation of motivation by Guay and colleagues (2010) demonstrated that children age 5–7 do not tend to differentiate between subject areas, whereas children age 8–11 typically hold more accurate self-perceptions of their relative strengths and weaknesses across academic domains. Thus, research regarding academic motivation among adolescents may be particularly informative when focused on a single subject area such as math.

Social supports. For over a decade, researchers have consistently demonstrated positive associations between social relationships (e.g., peer, parent, and teacher) and academic motivation, engagement, and achievement (Gregory & Weinstein, 2004; Hughes & Kwok, 2007; McCormick, O'Connor, Cappella, & McClowry, 2013; Wentzel, 1998). Wentzel (1998) examined social influences on academic motivation using a sample of 167 sixth-grade students. She investigated various aspects of school motivation (i.e., interests, academic goal orientations, and social goal pursuit) and their associations with parent, teacher, and peer relationships. It was found that peer support was a positive predictor of prosocial goal pursuit; and teacher and parent support were positive predictors of school-related interests and goal orientations. Parent support has also been shown to positively impact students' math proficiency, achievement, and motivation (Fan & Williams, 2010), however less is known about how specific aspects of parental involvement in children's educational experiences (e.g., parent-teacher contact, homework help, supervision) are related to student motivation.

Teacher support and math motivation. Teacher support is a key social influence on student motivation that that has been well demonstrated in the literature. Classroom environments where students perceive teachers as supportive promote student confidence and feelings of control over their ability to succeed (Akey, 2006; Skinner, Zimmer-Gembeck, & Connell, 1998). Rawnsley and Fisher (1998) investigated associations between math learning environments and student attitudes. They found that students had more positive attitudes toward math when their teacher was perceived to be highly supportive. Moreover, in the previously mentioned study using a sample of sixth grade students (Wentzel, 1998), teacher support was found to be a positive predictor of academic interest and goal pursuit.

As mentioned, there are notable decrements in academic motivation as students transition from elementary to middle school and beyond. Changes in the nature of teacher-student relationships and support resulting from these transitions have emerged as possible contributors to motivational declines (Wigfield, Eccles, Maclver, Reuman, & Midgley, 1991). The relationship between students and teachers becomes far less intimate, since teachers are required to instruct a large number of students, and students are often taught by several different teachers throughout the school day. As a result, there may be little chance of developing ongoing, supportive teacher-student contact

(Reddy, Rhodes, & Mulhall, 2003). At a time when adolescents desire enhanced social relations with adult mentors, most middle school environments do not meet those needs; hence the "developmental mismatch" that may contribute to decreases in academic motivation for middle school students (Eccles, Lord, & Midgley, 1991).

Though it is widely accepted that teacher support influences student attitudes (e.g., motivation) and achievement, less is known about the specific trajectory of perceived teacher support and its relationship to motivation as students progress through middle school. One study by Reddy and colleagues (2003) examined teacher-student relationships as a protective factor against declines in students' emotional functioning over the course of middle school. A sample of 2,585 students was followed from the sixth through eighth grades, which revealed declines in perceived teacher support over time. Furthermore, changes in perceptions of teachers' support reliably predicted changes in self-esteem and depression. While this study provides insight into the changing nature of perceived teacher support throughout the middle school years as well as its relationship with emotional functioning, more research of this type is needed to gain a better understanding of how perceptions of teacher support evolve over time and specifically impact student motivation.

Teacher support as a protective factor. Using a risk and protection framework (Rutter, 1985) with the expectancy-value model offers a new direction for motivation research. Given that student motivation and achievement outcomes often differ for students based on group affiliation (e.g., gender and race/ethnicity), particularly within specific academic domains (e.g., math), certain students may be particularly influenced by societal influences and contextual factors in the school environment that hinder future interest in math. More specifically, African American and female students experience greater risk for motivational decrements in math as they progress through school (Watt et al., 2012). It has been found that both females and African Americans are underrepresented in STEM-related college studies and careers, suggesting that these students are particularly lacking in expectancies for success and valuing of this domain. For these students, ecological influences such as teacher support may be particularly salient and serve as protective factors against negative outcomes in math.

In a study of racial differences in academic attitudes and achievement among students in affluent schools, it was found that compared to Whites, Black students were more likely to indicate teacher encouragement as a motivational factor above and beyond socioeconomic status (Ferguson, 2002). With regard to gender differences, a recent study explored how teacher-child relationships affected boys' and girls' school adjustment differently among a sample of preschoolers (Ewing & Taylor, 2009). It was found that close teacher-child relationships led to greater school competence in girls than boys, suggesting that teacher support may be a particularly important factor in girls' academic outcomes. However, more research is needed to better understand the relationships between teacher support and academic outcomes based on gender and race during the middle school years and specifically within the math domain.

Gender, math motivation, and teacher support. Whereas recent research has revealed only subtle differences in math-related abilities between males and females (Hyde, Lindberg, Linn, Ellis, & Williams, 2008), there are more significant gaps in postsecondary education paths and STEM-related career pursuits (Halpern, Aronson, Reimer, Simpkins, Star, & Wentzel, 2007; Watt et al., 2012). In 2004, women earned over 50 percent of all bachelor's and master's degrees, with less than one-fourth of those in computer sciences, physics, and engineering (NSF, 2008). Gender disparity in doctoral degree attainment is even more striking, with women earning less than one-third of all doctoral degrees in chemistry, computer sciences, math physics, and engineering. At the career level, women make up just one-quarter of the STEM workforce (NSF, 2008).

Many researchers have attempted to explain gender gaps in math-related postsecondary education and career pathways. Given that few gender differences in math achievement and course enrollment have been found at the high school level and below (NAEP, 2005; McGraw, Lubienski, & Strutchens, 2006), many have pointed to factors outside of math ability to explain why women are choosing not to pursue STEM-related degrees and careers following high school graduation (Halpern et al., 2007). Early-developing math attitudes (e.g., self-concept, interests, expectations for success) represent promising areas of inquiry that researchers have begun to explore. Consistent gender differences have been found related to children's and adolescents' beliefs about their math abilities, their math interests, and their perceptions regarding how math is relevant to their futures (Halpern et al., 2007; Simpkins & Davis-Kean, & Eccles, 2006). That is, girls tend to underestimate their math abilities and have less confidence and interest in math as they move out of elementary school and into middle school, high school, and beyond. However, research has also shown that not all girls lack confidence in their math abilities, and those with a strong math self-concept are more likely to excel in math classes and choose math-related college majors and careers (Simpkins & Davis-Kean, 2005). This implies that enhancing girls' positive attitudes about their math abilities may impact their math performance, motivation, and future choices.

Given that girls are more likely to select math courses and careers if their interest in the field is fostered throughout the school years (Wigfield et al., 2006), teacher support represents a critical area that may impact math motivation in female students. Teachers can hold gender-stereotyped attributions to success and failure, and inadvertently relay those gendered expectations and encouragements to students (Holden, 2002). It has been found that math teachers overestimate girls' effort in math, which may lead girls to attribute their achievement to effort (i.e., "I earn good grades because I work hard in math") rather than ability (i.e., "I earn good grades because I am good at math") (Tiedemann, 2000). This can then lead girls to deemphasize their natural ability in math, which may play an important role in the gender imbalance that exists among math-related college majors. Girls may be less likely to pursue higher-level math studies because they do not believe that they have the innate abilities to be successful as curricula becomes more challenging.

Additionally, research suggests that teachers tend to show more warmth and support to students for whom they hold high expectations (Brophy & Good, 1974; Meece, Glienke, & Burg, 2006). Several studies have demonstrated gender-differentiated classroom interaction patterns (e.g., teacher questions, teacher feedback, student questions/comments), especially in math and science classes. A meta-analysis of 32 studies conducted between 1970 and 2000 revealed that teachers tend to interact more with male students than female students (Jones & Dindia, 2004). More specifically, teachers have been found to call on boys more, pay more attention to boys, and present them with more complex questions (Duffy, Warren, & Walsh, 2001).

Based on expectancy-value theory of motivation, tasks associated with high expectations to succeed and high value placed on success of the tasks leads to high motivation (Eccles et al., 1983). Thus, girls who internalize gender-stereotyped expectations and values may be less motivated in math. Although females may be "going through the motions" and successfully completing required math courses in middle school and high school, they still may lack math self-efficacy and motivation to pursue math-related studies beyond high school. More evidence is needed to better understand the nature of the relationship between teacher support and math motivation for students based on gender, as well as the developmental trajectory of this relationship during the middle school years.

Race/ethnicity, math motivation, and teacher support. Similar to the needs outlined above for female students, there is also a need to better understand math motivation and supports among students based on race/ethnicity given ongoing concerns regarding the racial achievement gap in the United States education system. African American students are often the focus of these concerns, with research demonstrating that African American students trail significantly behind their White and Asian American counterparts in academic achievement (NCES, 2010). Much of the literature regarding the racial achievement gap compares the performance of middle class majority students to low income and minority students, who disproportionately attend schools that lack critical resources such as strong curricula and qualified teachers (Flores, 2007).

However, research has also shown that the racial achievement gap persists when factors such as socioeconomic status and school quality are controlled for. For example, some researchers have examined the achievement gap specifically within the context of higher-income, suburban schools (Noguera & Wing, 2006). This line of research has fueled various theoretical explanations as to why the achievement gap persists in such settings, where African American and White students attend the same schools and come from families of similar socioeconomic status.

An influential culture-centered model by Ogbu (2003) posits that the educational experiences, attitudes and achievement of students are heavily influenced by the broader patters of racial inequality that persist in communities, schools, and classrooms. Although White and African American students may attend the same schools, they often have different access to demanding curricula and experience different expectations from others regarding their academic abilities (Diamond, 2006). Thus, although students share "integrated" environments, African Americans may still experience those environments as racialized, separate, and unequal.

Ogbu (1991) also specifically examined the relationships between teachers and minority students in his efforts to understand the achievement gap. He argued that racialized treatment by teachers (whether conscious or unconscious) drives minority students to disengage and form oppositional attitudes in the classroom. Within this vein, covert racism can occur in the classroom in the form of microaggressions. According to Sue and colleagues (2007), microaggressions are common verbal, behavioral, or environmental indignities that convey negative racial attitudes toward individuals of color. Teachers may unknowingly and automatically be communicating different attitudes and expectations for students based on race through everyday interactions (e.g., body language and comments), which may negatively affect the learning experiences and motivation of students from minority groups (Sue, 2010; Sue et al., 2009, 2007). These models suggest that ecological factors in schools, particularly teacher-student relationships, may be of particular importance when examining motivation and achievement for students of historically marginalized ethnic backgrounds.

Several studies have investigated the relationship between academic motivation and teacher support specifically among African American students (Tucker, Zayco, & Herman, 2002). With a sample of 117 African American students in first through twelfth grade, Tucker, Zayco and Herman (2002) found that teacher involvement was the strongest predictor of student motivation. Whereas these kinds of studies provide support for the importance of teacher support for the motivation of African American students, more research is needed to determine if and how varying levels of teacher support is related to motivation among African American students, and if high levels of teacher support can serve as a buffer against temporal decrements in math motivation for these students.

Summary

The purpose of the current study was to more closely examine the relationships between math motivation, social factors (i.e., teacher support) and individual characteristics (i.e., race and gender) within the context of a higher-income school district. Given the strong relationship between low academic motivation and poor school outcomes (e.g., low achievement and high school dropout), it is essential to gain a better understanding of academic motivation for the betterment of individuals and society as a whole. Since academic motivation does not exist in a vacuum and is associated with a variety of factors (e.g., social relationships, goal setting, self-efficacy, engagement and achievement), decreases in student motivation over time may be best understood in conjunction with contextual influences in the school setting.

Too often research examines academic motivation as an intrapsychic phenomenon without considering "the ecology of motivation." That is, studies tend to correlate self-reported student motivation and achievement outcomes without considering the range of contextual factors that promote or hinder student investment in their academic pursuits (Fortier, Vallerand, & Guay, 1995). Only recently have motivation researchers begun to examine how academic motivation is influenced by contextual factors such as teacher, parent, and peer support (Gottfried, Marcoulides, Gottfried, & Oliver, 2009; Mata, Montiero, & Peixoto, 2012; Wentzel, 1998). Moreover, few studies have examined the middle school years closely to ascertain whether developmental decrements in motivation, specifically math motivation, appear earlier or later among middle school students (i.e., fifth versus eighth grade).

Furthermore, few studies have examined if these declining motivational patterns are maintained in the contexts of higher-income schools, despite college-going paths and abundance of college-educated role models. Finally, little research has shed light on gender and racial/ethnic differences in motivation and social supports through middle school, especially within the specific context of higher-income school districts. This is especially pertinent given that racial and gender achievement and motivational gaps in math appear to be maintained in "privileged," higher-achieving schools despite abundant resources (e.g., competent staff, appropriate materials, parental involvement) (Noguera & Wing, 2006).

The current study aimed to address the aforementioned gaps through an ecological examination of trends in academic motivation and motivational supports for fifth through eighth grade students who attended a school district set in a higher-income community. Within this setting the current study explored whether trends in math motivation across the middle grade levels were consistent with national downward trends in academic motivation across grade levels. The study also examined whether motivational trends were similar for White versus African American students and male students versus female students. Finally, the current study examined the relationship between perceived teacher support and math motivation within a higher income context, as well as the impact of student characteristics (e.g., race and gender) on this relationship. Five central research questions were put forth:

I. Was motivation in math lower for middle school students in later grade levels (i.e., 8th grade) compared to those in earlier grade levels (i.e., 5th grade)? Did the differences hold above and beyond student race/gender, student reports of parent support, and their anticipated mark in the math course?

It was hypothesized that, similar to national trends in motivation, middle school students in later grades would report lower motivation than those in earlier grades after accounting for student demographic characteristics (i.e., race and gender), perceived parent support, and anticipated math achievement (i.e., letter grade).

II. Were differences in math motivation across grade levels similar for White versus African American students and male versus female students?

If statistically significant motivational differences were evident based on grade level after accounting for demographic factors, anticipated math achievement, and perceived parent support, it was hypothesized that there would be stronger negative associations between grade level and math motivation for African American and female students than their White and male counterparts.

III. Did middle school students in earlier grade levels perceive higher teacher support than those in later grade levels?

It was hypothesized that, similar to previously-established national trends, students in earlier grades would report higher levels of perceived teacher support than those in later grades.

IV. Was math teacher support associated with motivation in math after accounting for student race, student gender, anticipated math mark, and parent support?

It was hypothesized that perceived teacher support would be positively associated with math motivation above and beyond the covariates of student race, student gender, anticipated math achievement, and perceived parent support.

V. Was the strength of the association between teacher support and math motivation greater for African American versus White students or male versus female students?

It was hypothesized that the association between teacher support and math motivation would be greater for African American than White students and greater for female than male students. In other words, it was hypothesized that the protective factor of teacher support would be particularly salient for students (i.e., African Americans and females) who are more at-risk for underachievement and developmental decrements in math motivation over time given previously-established racial and gender gaps in math achievement and STEM careers. Furthermore, it was anticipated that the protective nature of teacher support would hold no matter the students' anticipated grade in math and perceived support from their parent or other adult at home.

Method

Participants

Adolescents in the present study were enrolled in two public middle schools that each served approximately 900 students in the fifth through eighth grades. The schools were part of the same regional school district, which served students from two neighboring communities in northern New Jersey. According to the 2010 census, the median household incomes in the two cities were $139,332 and $126,753. The district was classified as being in District Factor Group "I" by the New Jersey Department of Education, which is the second highest of eight groupings that are based on community socioeconomic characteristics. According to the 2011-2012 National School Lunch Program (NSLP) data, there were between 4% and 6% of students from the two middle schools eligible for free and reduced lunches.

Seventy-three percent of students completed the student survey during the 2012-2013 school year (*n* = 1303). Due to scheduling issues, fifth grade students in one of the middle schools did not participate in the survey. Fifty-two percent of the participants were females and 48% were males. The sample was comprised of students in the eighth grade (31%), seventh grade (28.5%), sixth grade (31%), and fifth grade (9.5%). The student sample was 70% White, 9% African American, 6% Hispanic, 9% Asian, <1% Native American, <1% Pacific Islander, and 5% Other. This distribution did not differ substantially from the middle school population described in a 2010-2011 survey conducted by the National Center for Education Statistics, which reported 74% White, 10% African American, 7% Hispanic, 8% Asian/Pacific Islander, <1% Native American, and 1% Other.

Of the students who completed the survey, 73% were eligible to participate in this study (n = 1021) given its focus comparing the experience of White versus African American students. Thus, students who reported their race as Hispanic, Asian, Native American, Pacific Islander, and Other were excluded from the sample. This decision was partially based on different patterns found for Asian and Hispanic students in terms of their reports of motivation. As a result, it was not appropriate to combine groups (i.e., White/Asian versus African American/Hispanic) (see Appendix C for a full report of descriptive statistics). Thus, the study participants were 89% White (n = 911) and 11% African American (n = 110). Other than race, the characteristics of the trimmed student sample did not differ substantially from the original with regard to gender (49% males; 51% females) and grade level (9.5% fifth; 30.5% sixth; 29% seventh; 31% eighth).

Procedure

District administrators granted researchers permission to administer a student survey designed to measure middle school student experiences learning math. Included on the survey were questions about math motivation and math supports from teachers (see Appendix B). The survey contained 53 questions and was administered via an anonymous online survey tool (Qualtrics) between the dates of May 15, 2013 and June 11, 2013. The survey took approximately 15-20 minutes to complete.

Rutgers Internal Review Board (IRB) approved the student survey project and granted the research team with permission to analyze the collected data. All students in the fifth through eighth grades were invited to participate in the survey. The school provided parent/caregiver consent forms to be returned if a parent did not wish for his/her child to participate. Students were also given the option to decline participation and omit any questions that they did not wish to answer. Neither school indicated that any parents or caregivers withdrew their children from the survey.

Measures

Student demographic factors. Included on the survey were questions regarding student grade level, race, gender, and anticipated math mark (i.e., letter grade). Grade level was coded as 1 (5^{th} grade) through 4 (8^{th} grade); race was dichotomously coded as either 0 (White) or 1 (African American); and gender was dichotomously coded as either 0 (male) or 1 (female). Anticipated math mark measured *students' expected math achievement* by asking students to report the academic grade they expected to receive on their next report cards, which were coded as 1 (F) through 11 (A+).

Math motivation. Students rated their math motivation using the Expectancy-Value-Cost (EVC) scale, which measured an individual's *overall level of motivation in math* according to the expectancy-value model (Kosovich et al., in press). With a previous sample 5^{th}, 6^{th}, 7^{th}, and 8^{th} grade students, confirmatory factor analysis identified a three-factor structure: math expectancy, math value, and math cost (Kosovich et al., in press). Thus, the three confirmed factors were used in the current study. That said, there were a few noteworthy differences between the current study and the Kosovich et al.'s EVC psychometric study. Kosovich et al. (in press) did not include the math future interest scale in their study, which is considered an aspect of motivation. Given the importance of students' enduring personal interests for current achievement behavior and long-term outcomes (Hidi & Renninger, 2006), the current study retained the related subscale. Furthermore, the items included in the Kosovich et al. (in press) EVC validity study utilized a 6-point Likert scale rather than an 8-point Likert scale that was used in the current study. For all items, the ratings ranged from 1 (*completely disagree*) to 8 (*completely agree*) and were coded accordingly. The scales are described along with the Chronbach's alpha, which measures the internal consistency of the items.

Math expectancy. The *Math Expectancy Scale* was used to measure *how well a student expected to learn and perform in math class*. The three-item scale (alpha = .87) included: "I know I can learn the material in my math class"; "I believe that I can be successful in my math class"; "I am confident that I can understand the material in my math class" (Kosovich et al., in press).

Math value. The *Math Value Scale* was used to measure how much a student *perceived math as important and useful*. The three-item scale (alpha = .87) included: "I think my math class is important"; "I value my math class"; I think my math class is useful" (Kosovich et al., in press).

Math cost. The *Math Cost Scale* measured a student's *judgment about the amount of effort required to be successful in math*. The four-item scale (alpha = .83) included: "My math classwork requires too much time"; "Because of the other things that I do, I don't have time to put into my math class"; "I'm unable to put in the time needed to do well in my math class"; "I have to give up too much to do well in my math class" (Kosovich et al., in press).

Math future interest. The *Math Future Interest Scale* measured a student's *inclination to engage in math-related activities in the future.* The three-item scale (alpha = .85) included: "I look forward to learning more about math"; "I want to have a job that involves math someday"; "I want to take more math classes in the future" (Hulleman & Barron, 2012).

Math teacher support. Students rated their math teachers on two scales: *Teacher Care Scale* and *Teacher Instrumental Help Scale,* which were used to measure a *student's overall perception of his/her math teacher's level of support.* These scales were taken from the Teacher as Social Context Questionnaire (Wellborn, Connell, Skinner, & Pierson, 1988). The items were slightly adapted from their original versions to ask the students questions specifically about their math teachers. All ratings ranged from 1 (*not at all true*) to 5 (*very true*) and were coded accordingly. Negatively worded items (i.e., "My math teacher doesn't seem to know when I need help") were reverse-coded from 1 (*very true)* to 5 *(not at all true).*

Teacher care. The three-item *Teacher Care Scale* (alpha = 0.81) included: "My math teacher likes me"; "My math teacher really cares about me"; "My math teacher doesn't seem to enjoy having me in class" (Wellborn et al., 1988). Past research utilizing this scale has shown that higher care was associated with higher trust in teachers and obedience to their authority (Gregory & Weinstein, 2008).

Teacher help. The five-item *Instrumental Help Scale* (alpha = .78) included: "My math teacher shows me how to solve problems for myself"; "If I can't solve a problem, my math teacher shows me different ways to try"; "My math teacher doesn't help me, even when I need it"; "Even when I run into problems, my math teacher doesn't help me"; "My math teacher doesn't seem to know when I need help" (Wellborn et al., 1988).

Parent support. The five-item *Parent Support Scale* (alpha = .82) was adapted from the items on the *Instrumental Help and Support Scale* (Wellborn et al., 1988) to measure the *level of perceived math help by a parent or someone else in the home.* The scale included: "My parent shows me how to solve math problems for myself"; "If I can't solve a math problem, my parent shows me different ways to try"; "My parent doesn't help me with math, even when I need it"; "Even when I run into problems in math, my parent doesn't help me"; "My parent doesn't seem to know when I need help with math." Positively worded items were coded from 1 (*not at all true*) to 5 (*very true*), and negatively worded items were reverse-coded from 1 (*very true)* to 5 *(not at all true).* The Parent Support Scale was used as a covariate in the multiple regression analyses to ascertain the predictive power of teacher support, above and beyond support experienced in the home.

Data Analytic Plan

First, descriptive statistics (means, ranges and standard deviations) and Pearson's correlations were run to assess for general trends in the data among all variables of interest. Included in the Pearson's correlation matrix were student demographics (grade level, race, and gender), motivation variables, and teacher support variables. The two covariates of interest (anticipated math mark and parent support) were also included in the correlation analyses.

I. Was motivation in math lower for middle school students in later grade levels (i.e., 8th grade) compared to those in earlier grade levels (i.e., 5th grade)? Did the differences hold above and beyond student race, student gender, student reports of parent support, and their anticipated mark in the math course?

Multiple linear regression analyses were performed to examine the relationships between student grade level (5th, 6th, 7th, and 8th) and each of the four subscales of math motivation (math expectancy, math value, math cost, and math future interest). Demographic factors (race/gender), anticipated math mark, and parent support were entered as covariates in Block 1, given that they have been shown to be strong predictors of achievement motivation (Eccles, 2008; Wentzel, 1998). The grade level variable was centered and added to the models in Block 2 to assess whether grade level predicted math motivation above and beyond the contribution of demographic factors, achievement, and parent support. In addition, the grade level variable was squared and entered as a predictor into each regression model in Block 2 to examine whether there were significant curvilinear relationships between grade level and each of the four motivational subscales.

II. Were differences in math motivation across grade levels similar for White versus African American students and male versus female students?

In the first series of regression analyses (Models 1-4), after Blocks 1 and 2 (described above), student race was entered in Block 3. This was repeated for the gender variable in the next series of regression analyses (Models 5-8). Moderating analyses were conducted by adding grade X race and grade X gender terms to models 1-4 and 5-8, respectively. In other words, race and gender were added as interaction terms to determine if these variables affect the direction and/or strength of the relationship between student grade level and math motivation.

III. Did middle school students in earlier grade levels perceive higher teacher support than those in later grade levels?

Pearson's correlation coefficients were used to examine the relationship between student grade level and each of the two teacher support scales.

IV. Was math teacher support associated with motivation in math after accounting for student race, student gender, anticipated math mark, and parent support?

A series of multiple linear regression analyses (Models 9-16) were used to examine the relationships between each aspect of teacher support (teacher care and teacher help) and math motivation (math expectancy, value, cost, and future interest). Demographic factors (i.e., race and gender), anticipated mark, and parent support were entered as covariates in Block 1, and teacher care and teacher help were added to the models in Block 2 to assess whether perceived teacher care and teacher help predicted math motivation above and beyond the contribution of demographic factors, anticipated achievement, and parent support.

V. Was the strength of the association between teacher support and math motivation greater for African American versus White students or male students versus female students?

Regression models 9-12 (described above) were used to assess whether the relationship between teacher support and math motivation was moderated by student race. Following Block 1 and Block 2 (described above), student race was entered in Block 3, and two interaction terms (teacher care X race and teacher help X race) were entered in Block 4. The final set of regression analyses (Models 13-16) sought to examine gender as a moderator, with student gender entered in Block 3 and teacher care X gender and teacher help X gender entered in Block 4. The regression estimates for the interaction terms were then examined to determine if the relationships between teacher support and math motivation were moderated by race or gender. For a statistically significant interaction estimate, a "probe" of the interaction was examined by graphing the relationship between teacher support and motivation for each racial/gender group above and below the mean on teacher support to better determine the nature of the significant relationship.

Results

Descriptive findings

Descriptive statistics for the math motivation and teacher support variables are reported in Table 1. The full range of scores were utilized for the four math motivation scales (*Min* = 1.00; *Max* = 8.00) and two teacher support scales (*Min* = 1.00; *Max* = 5.00). All variables appear to be slightly skewed in the negative direction with the exception of math cost, which appears to be slightly skewed in the positive direction.

This indicates that students tended to feel positive about their own motivation and teacher support they received in math courses. Nevertheless, the skewness and kurtosis values for all variables were found to be in the acceptable range (*Skewness* = -1.78 - .80; *Kurtosis* = -.30 - 4.33).

On the math expectancy and math value scales, the majority of students strongly agreed that they had the ability to succeed in math class and that math was important (*M* = 6.96; 6.78, respectively). On the math cost scale, the majority of students disagreed that math class required too much time and limited access to other activities (*M* = 2.81). On the math future interest scale, most students slightly agreed that they wished to pursue math related studies and careers in the future (*M* = 5.28). Of the four motivation scales, the math future interest scale had the lowest mean and highest standard deviation (*SD* = 1.76), indicating that this scale contained the greatest variation among the students' responses. Approximately one-third of students (30.5%) completely disagreed, strongly disagreed, disagreed, or slightly disagreed that they wished to pursue math-related studies/careers in the future, whereas approximately two-thirds of students (69.5%) completely agreed, strongly agreed, agreed, or slightly agreed that they wished to pursue math studies in the future. On each of the two teacher support scales, the majority of students (*M* = 4.32; 4.34) reported that their math teacher cared about them and helped them to solve math problems during class.

Table 1
Descriptive analysis of math motivation and teacher support variables

Variables	*M*	*SD*	*Min*	*Max*	*Skewness*	*Kurtosis*
Math Motivation Variables						
Expectancy	6.96	1.14	1.00	8.00	-1.78	4.33
Value	6.78	1.19	1.00	8.00	-1.42	2.79
Cost	2.81	1.46	1.00	8.00	.80	.40
Future Interest	5.28	1.76	1.00	8.00	-.54	-.30
Teacher Support Variables						
Teacher Care	4.32	.84	1.00	5.00	-1.66	2.67
Teacher Help	4.34	.73	1.00	5.00	-1.49	1.95

Note. M = mean; *SD* = standard deviation.

Mean plots were created across student grade levels (5^{th}, 6^{th}, 7^{th}, 8^{th}) for each of the four motivation variables. Unexpectedly, clear linear trends across the middle school years were not observed. Instead, all plots revealed curvilinear patterns with slight troughs around seventh grade (see Figure 1 for an example). Therefore, a $grade^2$ term was added to the regression models (see Tables 3 and 4) to test whether curvilinear relationships existed between the motivation variables and predictors of interest.

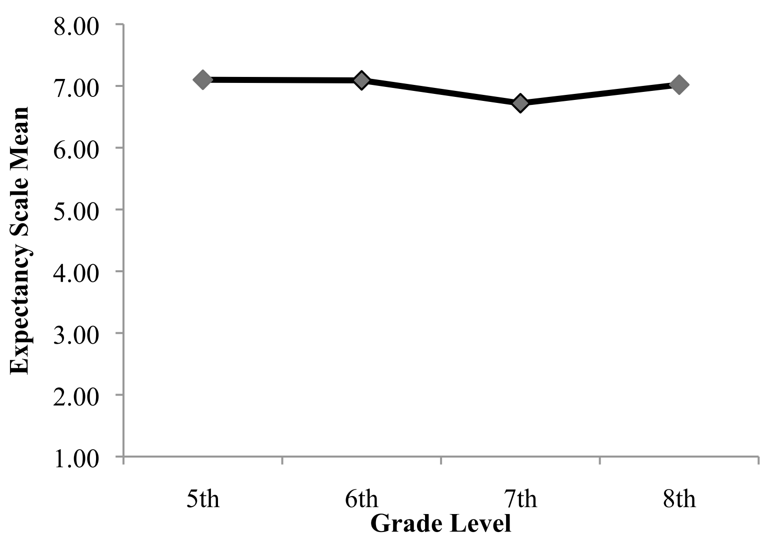

Figure 1. Mean plot for math expectancy across student grade levels

Correlations

Pearson's correlations were computed for all control, independent, and dependent variables and are reported in Table 2. All positive and negative correlations were in the expected directions. The four math motivation variables were moderately to highly inter-correlated (*r ranges from* -.47, to .69, $p < .001$), indicating that while the subscales of motivation were highly related, they also likely measured distinct constructs. Similarly, the two teacher support variables were moderately inter-correlated ($r = .64$ $p < .001$). All math motivation, teacher support, and parent support variables were moderately inter-correlated (*r ranges from* -.43 - .44, $p < .001$), indicating that students who reported higher levels of math motivation also tended to report higher levels of both teacher and parent support.

With regard to demographic variables, student grade level was modestly correlated with math value ($r = -.09$, $p < .01$), indicating that students in earlier middle school grades tended to report high valuing of their math classes in comparison to students in later middle school grades. Grade level was also modestly correlated with teacher care ($r = -.09$, $p < .01$), teacher help ($r = -.11$, $p < .01$), and parent support ($r = -.27$, $p < .001$), indicating that students in earlier grades reported higher levels of both teacher and parent support in math. Finally, grade level was correlated with anticipated math mark ($r = -.13$, $p < .001$), indicating that students in earlier grade levels predicted that they would earn higher math grades in the future than students in later grade levels. Unexpectedly, grade level was not significantly correlated with math expectancy, math cost, and math future interest.

Student race was significantly yet modestly correlated with math expectancy (r = -.08, $p < .05$), math cost (r = .12, $p < .001$), and math future interest (r = -.10, $p < .01$), indicating that White students reported higher levels of math expectancy and math future interest and lower levels of math cost than African American students. Additionally, White students tended to report higher anticipated math marks than African American students (r = -.20, $p < .001$). Student race was not significantly correlated with math value, teacher care, teacher help, and parent support.

Student gender was modestly correlated with math expectancy (r = -.10, $p < .01$) and math future interest (r = -.14, $p < .001$), indicating that females tended to report lower math expectancy and math future interest than male students. On the other hand, female students tended to report higher levels of teacher care than male students (r = .08, $p < .01$). Noteworthy was that female students tended to report slightly *higher* anticipated marks than male students despite reporting *lower* levels of expectancy for success in math (r = .07, $p < .05$). Gender was not significantly correlated with math value, math cost, teacher help, and parent support.

Table 2

Correlations among grade level, student characteristics, and perceived support

	1	2	3	4	5	6	7	8	9	10	11
1. Grade Level	____	.00	.02	-.05	-.09**	.04	-.06	-.09**	-.11**	-.27***	-.13***
2. Race/ Ethnicity		_____	.05	-.08*	-.06	.12***	-.20**	-.05	-.02	.00	-.20***
3. Gender			_____	-.10**	-.03	-.02	-.14***	.08**	.01	.05	.07*
4. Expectancy				______	.65***	-.54***	.61***	.35***	.37**	.19***	.56***
5. Value					_______	-.47***	.69***	.44***	.38***	.23***	.35***
6. Cost						_______	-.48***	-.37***	-.43***	-.20***	-.39***
7. Future Interest							_______	.36***	.32***	.16***	.39***
8. Teacher Care								_______	.64***	.19***	.23***
9. Teacher Help									_______	.22***	.23***
10. Parent Support										_______	.14***
11.Anticipated Math Mark											_______

* $p < .05$, ** $p < .01$, *** $p < .001$

Student characteristics as predictors of math motivation

The first series of regression models (Models 1-4) used student grade level and race as the predictors of interest for each of the four dependent variables (math expectancy, math value, math cost, and math future interest). Blocks were entered in succession to identify the unique variance explained by grade level and race, accounting for the variance explained by three covariates (gender, anticipated math mark, and parent support). Interaction terms (grade X race and grade^2 X race) were also entered to test for moderation effects. In each model, gender, anticipated mark, and parent support were entered as Block 1, grade and grade^2 were entered as Block 2, race was entered as Block 3, and grade X race and grade^2 X race were entered as Block 4 (see Table 3).

Covariates and math motivation. Results indicated that the three covariates were, collectively, the strongest predictors of all dependent variables (16-35% of the variance explained; see Models 1-4, Block 1). This means that gender, anticipated mark, and parent support explained a considerable amount of variance on the self-reported motivation scales. Gender significantly predicted all math motivation variables with the exception of math cost (β *ranges from* -.17 - -.06, $p < .05$), indicating that females reported lower math expectancy, math value, and math future interest than males. Much larger estimates were yielded by anticipated math mark, which significantly predicted all motivation variables (β *ranges from* -.38 - .55, $p < .001$). This indicates that students who anticipated higher math marks also tended to report higher math motivation. Finally, parent support significantly predicted all motivation variables (β *ranges from* -.15 - .19, $p < .001$), indicating that students who reported higher levels of parent support in math also tended to report higher levels of math motivation.

Grade level and math motivation. Above and beyond the covariates, a significant linear trend was identified for grade level and math cost (β = -.06, $p < .05$) (see Model 3, Block 2), which was in the unexpected direction. That is, accounting for gender, anticipated math mark, and parent support, students in later grades tended to perceive *lower* costs associated with their efforts in math compared to students in earlier grades. A more complex pattern was discovered for grade level and math expectancy, which revealed both a significant linear and curvilinear trend (β = .10 and .09, respectively, $p < .001$) (see Model 1, Block 2). This indicates that students in later grades tended to report higher expectations for their math performance compared to students in earlier grades. In addition, the significant grade^2 term indicates that there was a significant upward curve in math expectancy between the seventh and eighth grade. Figure 2 provides further details regarding the relationship between math expectancy and student grade level, which shows a steady positive differences between 5th, 6th, and 7th

grade students, and a larger positive difference between 7th and 8th grade students. Unexpectedly, student grade was not a significant predictor of math value and math future interest (see Models 2 and 4, Block 2). Overall, these results do not support the hypothesis that a decline in motivation would exist across grade levels. Instead, no change was evident for math value and math future interest, and with controls, higher math expectancy and lower math cost were reported by students in eighth grade compared to those in fifth grade.

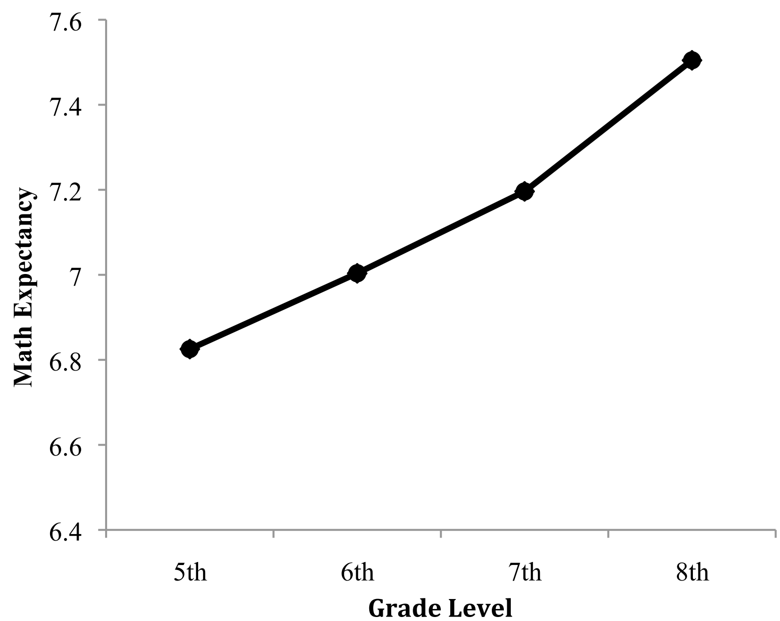

Figure 2. Student grade level predicting math expectancy

Race and math motivation. Student race was not a significant predictor of the math motivation variables. All interactions were found to be non significant, however the grade X race interaction approached significance for math future interest (β = -.06, *p* <.07). Figure 3 details the relationship between grade level and future interest based on student race. White and African American students in lower grades reported similar levels of future interest, whereas African American students in higher grades reported slightly lower levels of future interest than White students in higher grades. Furthermore, White students showed similar levels of future interest across grade levels, whereas African American students showed a more prominent negative trend in reported future interest across grade levels.

Table 3
Regression analysis for student grade and race as predictors of math motivation

	Math Motivation			
	Model 1 Expectancy	Model 2 Value	Model 3 Cost	Model 4 Future Interest
	β at each step	β at each step	β at each step	β at each step
Block 1:				
Gender	-.14***	-.06*	.01	-.17***
Anticipated Math Mark	.55***	.33***	-.38***	.38***
Parent Support	.12***	.19***	-.15***	.12***
R^2	.35***	.16***	.18***	.19***
Block 2:				
Grade Level	.10***	.02	-.06*	.02
Grade Level^2	.09***	.05	-.03	-.03
ΔR^2	.01***	.002	.004	.002
Block 3:				
Race	.04	.01	.04	-.01
ΔR^2	.002	.000	.002	.000
Block 4:				
Grade X Race	-.02	.00	.04	-.06$^+$
Grade^2 X Race	-.01	-.04	.01	-.07
ΔR^2	.000	.001	.002	.01*

*p <.05, **p<.01, ***p<.001, ^+p<.07.

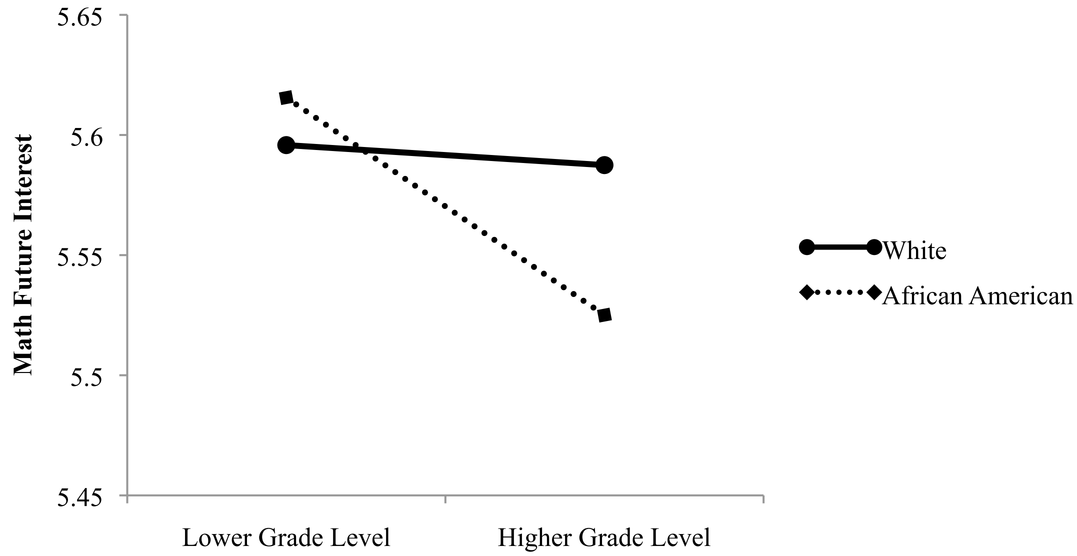

Figure 3. Student grade level and race predicting math future interest

Gender and math motivation. Regression models 5-8 used grade level and gender as the predictors of interest for each of the four motivation variables, accounting for the covariates of race, anticipated math mark, and parent support (see Table 4). Similar to the previous regression model, results indicated that the covariates were the greatest predictors of all motivation variables (16-33% of variance explained; see Models 5-8, Block 1). Anticipated mark yielded the highest estimates (β *ranges from* -.37 - .55, p <.001), while student race did not explain a significant portion of variance in any model (β *ranges from* -.02 - .04, $p > .05$). Also consistent with regression Models 1-4 above, grade level was a significant predictor of math expectancy (β = .09, $p < .001$) and math cost (β = -.06, $p < .05$) (see Models 5 and 7, Block 2).

Males and higher math motivation. Student gender was a significant predictor of math expectancy (β = -.15, $p < .001$), math value (β = -.06, $p < .05$), and math future interest (β = -.17, $p < .001$) (See Models 5, 6, and 8, Block 3). These results indicate that boys reported higher expectancies for math success, math valuing, and interest in pursuing future math studies than girls. These effects were small, however, explaining 3% or less of the variance. Unexpectedly, gender was not found to be a significant predictor of math cost.

Gender as a moderator. As hypothesized, there were significant grade^2 X gender interactions for math value ($\beta = -.11$, $p < .05$) and math future interest ($\beta = -.11$, $p < .05$), suggesting that the relationship between grade level and math value/future interest was moderated by gender. This relationship was found to be curvilinear, as indicated by the significant interaction effect containing the grade^2 term. All other interactions were found to be non significant. Figures 4 and 5 detail the significant grade^2 X gender interactions at each of the four grade levels. For math valuing, Figure 4 shows no difference among male and female students in fifth grade. However, males show a positive slope across grade levels, with a more prominent increase in slope between seventh and eighth grades. On the other hand, female students show relatively no differences in reported math value across grade levels. Thus, the hypothesized differences by gender were observed across sixth through eighth grades, with females reporting lower valuing of math compared to their male peers. Furthermore, the largest gender gap in math valuing was observed among students in eighth grade.

For math future interest, Figure 5 shows a positive slope for males and a negative slope for females. In other words, males in later grades reported *higher* future interest than those in earlier grades, and females in later grades reported *lower* future interest than those in earlier grades. Similar to the math value scale, the largest gender gap for math future interest was observed among students in eighth grade.

Table 4
Regression analysis for student grade and gender as predictors of math motivation

	Variables of Math Motivation			
	Model 5 Expectancy	Model 6 Value	Model 7 Cost	Model 8 Future Interest
	β at each step	*β* at each step	*β* at each step	*β* at each step
Block 1:				
Race	.03	.01	.04	-.02
Anticipated Math Mark	.55***	.33***	-.37***	.37***
Parent Support	.12***	.19***	-.15***	.11***
R^2	.33***	.16***	.18***	.16***
Block 2:				
Grade Level	.09***	.02	-.06*	.01
Grade Level^2	.08**	.05	-.03	-.04
ΔR^2	.01***	.002	.004	.002
Block 3:				
Gender	-.15***	-.06*	.01	-.17***
ΔR^2	.02***	.004*	.000	.03***
Block 4:				
Grade X Gender	-.01	.01	-.03	-.08$^+$
Grade^2 X Gender	-.08	-.11*	.02	-.11*
ΔR^2	.002	.004	.001	.01*

*p <.05, **p<.01, ***p<.001, ^+p<.07.

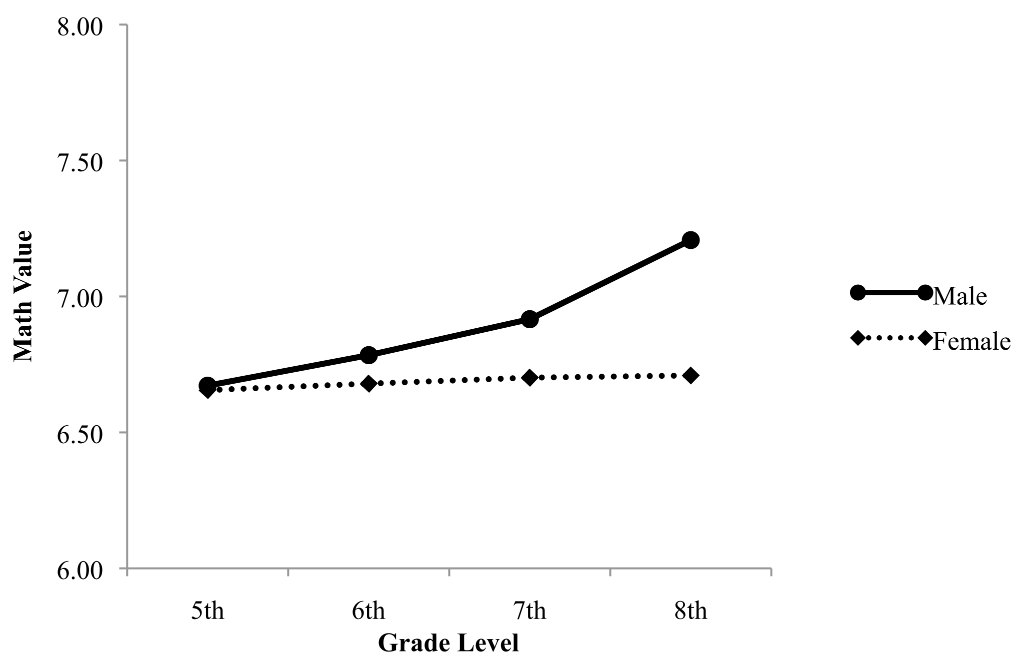

Figure 4. Student grade level and gender predicting math value

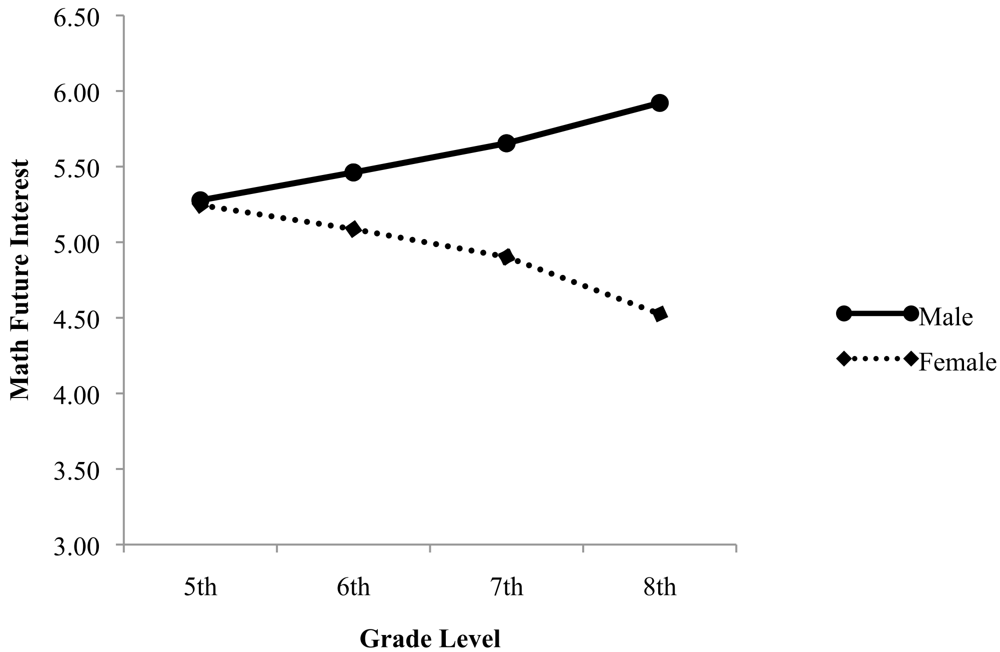

Figure 5. Student grade level and gender predicting math future interest

Teacher support and math motivation

The next series of regression models (see Tables 5 and 6) examined the association between teacher support and math motivation for students based on race (see Models 9-12) and gender (see Models 13-16), accounting for the same covariates used in Models 1-8 above. With the teacher care and teacher help variables in the models, race was not a significant predictor of math motivation (β *ranges from* .00 - .05, $p > .05$; see Models 9-12, Block 3), indicating that there were no differences between White and African American students on perceived math motivation when taking into account their perceptions of teacher support, anticipated math mark, and parent support. Gender, on the other hand, was a significant predictor of math expectancy (β = -.14, $p < .001$; see Model 13, Block 3), math value (β = -.08, $p < .01$; see Model 14, Block 3), and math future interest (β = -.19, $p < .001$; see Model 16, Block 3), indicating that boys reported higher levels of motivation than girls on most scales when taking into account perceptions of teacher support, parent support, and anticipated achievement.

Teacher care and math motivation. Teacher care significantly predicted all motivation variables (β *ranged from* -.11 - .29, p < .01), explaining 7-13% of the variance (see Models 9-16, Block 2). As hypothesized, this indicates that higher perceived teacher care was associated with higher math motivation across all scales. The largest estimates for teacher care were found for math value (β = .29, .28, p < .001; see Models 10 and 14, respectively) and math future interest (β = .23, .21, p < .001; see Models 12 and 16, respectively), suggesting that teacher care had the strongest association with valuing of math and intentions to pursue future math endeavors.

Teacher help and math motivation. Similar to teacher care, teacher help significantly predicted all motivation variables (β *ranged from* -.28 - .22, p < .01), explaining 7-13% of the variance (see Models 9-16, Block 2). This suggests that, as hypothesized, higher perceived teacher help in math was associated with higher motivation. Unlike teacher care, however, the largest estimates for teacher help were found for math expectancy (β = .21, .22, p < .001; see Models 9 and 13, respectively) and math cost (β = -.28, p < .001; see Models 10 and 14). This suggests that perceived instrumental help by math teachers was most strongly associated with students' expectancies for success and perceived costs associated with math effort.

Race and gender as moderators. When examining student race as a moderator between teacher support and math motivation, all teacher care X race and teacher help X race interactions were unexpectedly non significant (see Models 9-12, Block 4). This indicates that the relationship between math teacher support and motivation did not differ based on student race.

As for student gender, a significant teacher help X gender interaction was found for math expectancy (β = -.51, $p < .01$; see Model 13, Block 4). All other interactions were found to be non significant (see Models 14-16, Block 4). These results imply that the relationship between teacher help and expectancy for math success differed for students based on gender. The significant teacher help X gender interaction was plotted to gain a better understanding of gender as a moderator in the association between these two variables (see Figure 6). Figure 6 shows positive slopes for both males and females, indicating that higher perceived teacher help was associated with higher math expectancy for both genders. However, males and females in earlier grades reported similar levels of teacher help, whereas males in later grades reported *higher* teacher help than females in later grades. This indicates that the strength of the association between teacher support and expectancy differed by gender, with male students showing a stronger positive relationship between support and math expectancy than female students. This finding was opposite of the hypothesized outcome that there would be a stronger positive relationship between teacher support and math motivation for females than males.

Table 5

Regression Analysis for Teacher Support and Student Race as Predictors of Math Motivation

	Variables of Math Motivation			
	Model 9 Expectancy	Model 10 Value	Model 11 Cost	Model 12 Future Interest
	β at each step	β at each step	β at each step	β at each step
Block 1:				
Gender	-.14***	-.06*	.01	-.17***
Anticipated Math Mark	.55***	.33***	-.38***	.38***
Parent Support	.12***	.19***	-.15***	.12***
R^2	.35***	.16***	.18***	.19***
Block 2:				
Teacher Care	.10**	.29***	-.11**	.23***
Teacher Help	.21***	.12***	-.28***	.09**
ΔR^2	.07***	.13***	.12***	.08***
Block 3:				
Race	.04	.01	.05	.00
ΔR^2	.001	.000	.002	.000
Block 4:				
Teacher Care X Race	-.06	.21	.04	.162
Teacher Help X Race	.06	-.03	-.22	-.29
ΔR^2	.000	.002	.001	.002

*p <.05, **p<.01, ***p<.001, ^{+}p<.07.

Table 6
Regression Analysis for Teacher Support and Student Gender as Predictors of Math Motivation

	Variables of Math Motivation			
	Model 13 Expectancy	Model 14 Value	Model 15 Cost	Model 16 Future Interest
	β at each step	β at each step	β at each step	β at each step
Block 1:				
Race	.03	.01	.04	-.02
Anticipated Math Mark	.55***	.33***	-.37***	.37***
Parent Support	.12***	.19***	-.15***	.11***
R^2	.33***	.16***	.18***	.16***
Block 2:				
Teacher Care	.08**	.28***	-.10**	.21***
Teacher Help	.22***	.12***	-.28***	.11**
ΔR^2	.07***	.13***	.12***	.08***
Block 3:				
Gender	-.14***	-.08**	.01	-.19***
ΔR^2	.02***	.01**	.000	.03***
Block 4:				
Teacher Care X Gender	.28	-.26	.23	-.21
Teacher Help X Gender	-.51**	-.08	-.11	-.04
ΔR^2	.004*	.003	.001	.002

$*p < .05$, $**p < .01$, $***p < .001$, $^{+}p < .07$.

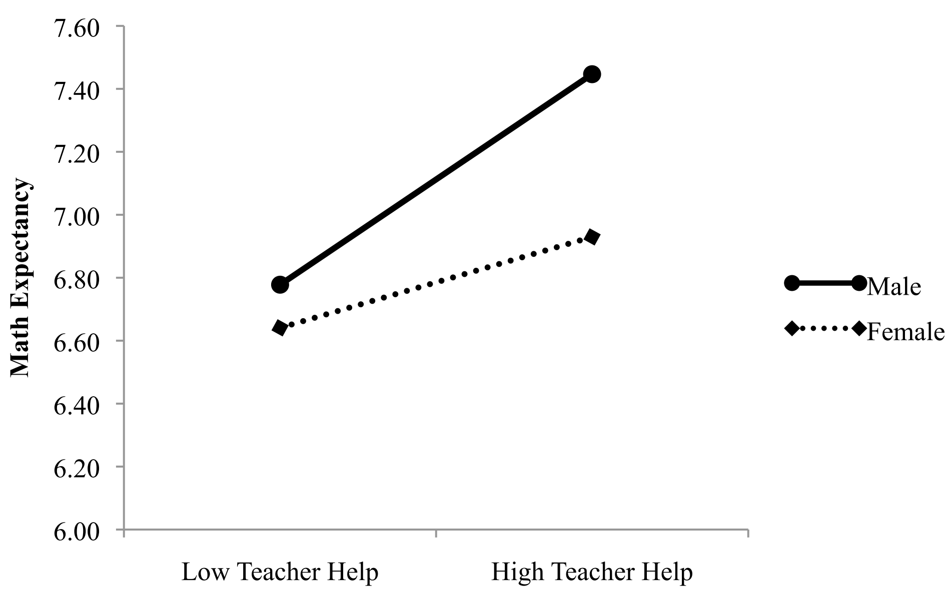

Figure 6. Perceived teacher help and gender predicting math expectancy

Discussion

The present study examined the relationships among grade level, teacher support, and four aspects of math motivation for middle school students, with a specific focus on the unique nature of these relationships for students based on their race and gender. The hypothesized negative linear trends in math motivation across grade levels were not found. Instead, complex relationships were found depending on the particular aspect of motivation (expectancy, value, cost, future interest). Unexpectedly, for males, females, White, and African American groups, expectancy for math success was higher for students in later grade levels than for those in earlier grade levels after accounting for anticipated math achievement and student-reported parent support. Moreover, the relationship between grade level and math expectancy was found to be curvilinear, with a larger difference in student-reported math expectancy between seventh and eighth grade students. Also noteworthy was that although grade level differences were consistent across student race and gender, female students reported lower overall math expectancy than male students. In addition, an unexpected linear trend was found across grade levels for the costs of working hard in math. That is, students in later grades perceived lower costs associated with their math effort than those in earlier grades, regardless of race and gender. In sum, for two aspects of motivation – expectations for success and cost for hard work – the anticipated decrements across grade level were not present. Instead, students in later grades (7^{th} and 8^{th} grade) reported higher expectancies and lower costs in math compared to their peers in earlier grades (5^{th} and 6^{th} grade).

For two scales of math motivation (value and future interest), hypothesized differences were found among students based on gender but not based on race. In other words, patterns of math value and future interest were similar for White and African American students but not for male and female students. Comparing responses across grade levels, females did not differ in their valuing of math, whereas males in later grades reported higher valuing of math than those in earlier grades. Along similar lines, males in later grades reported *higher* future interest than those in earlier grades, whereas females in later grades reported *lower* future interest than those in earlier grades. This suggests that gender gaps in math value and future interest were found to be largest among students in later middle school grades.

Also, as anticipated, teacher support (both their care and instrumental help) was significantly related to math motivation. That is, students who reported higher teacher support (as measured by perceptions of their care and instrumental help) also reported higher math motivation across all scales. Noteworthy was that students in later grades reported slightly lower teacher care and teacher help than students in earlier grades as anticipated.

The association between teacher support and math motivation did not differ by student race. Thus, teacher support was promotive for students in both racial groups, but did not have a unique protective function for African American students as anticipated. Also, for three aspects of motivation (cost, value, future interest), teachers' support was promotive for both males and females in a similar manner. In other words, it did not serve as a protective factor for girls (as had been hypothesized). One aspect of motivation was an exception, however. For students' expectations for their success in math, the pattern of teacher support across gender was complex. Significant gender differences were evident in the relationship between one aspect of teacher support (perceptions about the degree to which they provided help) and math expectancy. However, the gender differences were in an unexpected direction with a stronger teacher help and math expectancy association for males than females.

Grade level trends in math motivation. Overall, the study does not support previous work that has demonstrated straight-forward declines in student motivation across the middle grade levels (Gottfried et al., 2001; Wigfield et al., 1997). Possible reasons for the higher ratings of math expectancy and lower ratings of math cost among students in later grades, compared to earlier grades, include protective factors that are often present in higher-income, higher-achieving school settings. One such factor could be high perceived support from teachers and parents, as shown by the significant relationships between social supports and motivation that were demonstrated in this study. Other factors may include social pressures for high achievement and access to highly-educated, college-going adult role models (Eccles, 2007). As students in this type of academic environment become older, they likely face increased achievement expectations as they approached the transition to high school, where achievement outcomes carry important consequences to those in the community (e.g., college admission). Future research comparing resource-rich communities with communities facing economic struggles may shed light on the differing processes that support student math motivation as they traverse grades in middle school.

Gender differences in overall math motivation. It is important to note that although grade level trends were similar across student gender for two aspects of math motivation, females still reported overall lower math expectancy, math value, and math future interest than males when taking into account the covariates of parent support and anticipated achievement. That is, despite what grades the students expected to earn, females still reported lower math motivation for three of the four scales. Also interesting was that, according to Pearson's correlation coefficients, females tended to report higher anticipated math achievement than males. This finding is consistent with recent research showing similar or even higher math achievement for female students in spite of their underrepresentation in post-secondary math majors and careers (Halpern et al., 2007; Watt et al., 2012). This suggests that the coupling between psychological processes related to math and actual math achievement may not be as strong for females. In other words, girls are not selecting pathways toward higher-level math studies and careers despite possessing the necessary academic abilities.

In addition, lower reported math expectancies for success by females is related to previous research showing consistent gender differences in adolescents' beliefs about their math abilities (Halpern et al., 2007; Simpkins et al., 2006). Although males and females demonstrate equal math performances, females may still be less confident in math and thus underestimate their math abilities. As math curricula becomes more demanding over time, a lack of confidence in one's math abilities can impact decisions to pursue future math endeavors.

Gender differences across grade level. For two aspects of math motivation (math value and math future interest), trends across grade levels varied depending on student gender, as had been hypothesized. For math value, male students reported higher valuing of math across grade levels, whereas female students reported minimal differences in math valuing across grade levels. For math future interest, male and female students showed opposite grade level trends. That is, males reported higher future interest across grade levels, whereas females reported lower future interest across grade levels. Also noteworthy was that gender gaps in math motivation were different according to student grade level, with larger differences among those in later grades. Specifically, male and female students in earlier grades reported similar levels of both math value and math future interest, whereas females in later grades reported lower value and future interest than male students in later grades.

Modern expectancy-value theory provides support for the current study's results regarding gender gaps in math value and future interest across grade levels. Previous research utilizing an expectancy-value framework has demonstrated that task value is particularly influential in academic decision-making behavior including course plans and enrollment (Nagy et al., 2006; Schunk et al., 2007; Wigfield & Eccles, 1992, 1994). This could explain why larger gender differences across grade levels were concentrated in the math value and future interest domains, which are more closely related to future math decision-making than actual achievement. A concern would be that gender gaps in valuing and future interest could continue to widen as students transition to high school and begin making serious long-term academic and career decisions. This study's findings highlight math value and math future interest as promising areas for further inquiry regarding the persistent gender gaps in post-secondary math studies and STEM careers.

Furthermore, the current study's findings regarding gender differences in math motivation suggest that the middle grades may represent a particularly "risky" time for females, when gender gaps in certain aspects of math motivation may begin. During the middle school years, some adolescents may already be forming ideas about what types of careers they would like to pursue in the future. As a result of enduring gender role norms, females are most likely not considering futures in STEM at the same rate as males. Thus, females may not view math as relevant to their futures, especially as more abstract math concepts are introduced in later grades (e.g., algebra). Moreover, as math concepts become more advanced through the middle school years, females may face higher risks of being judged by negative stereotypes that females may have weaker math abilities than males (Steele, 1997). In other words, math failure by females may carry the extra threat of confirming society's stereotyped limitations of female math ability. As females progress through school they may consequently begin to "disidentify" with math as an important academic domain and show less interest in including math in their future life plans to avoid such threats.

Teacher support and math motivation. Previous research supports the present study's findings that contextual factors impact student motivation, particularly teacher support (Akey, 2006). Specifically, previous studies have shown that teacher support has a positive impact on student math attitudes, interests, and goal pursuits (Akey, 2006; Rawnsley & Fisher, 1998; Wentzel, 1998). The present study expanded on previous research and demonstrated a strong link between different types of teacher support and math motivation. Specifically, both teacher care and teacher help significantly predicted all motivation variables, explaining 7-13% of the variance above and beyond the covariates of anticipated math mark and parent support. This was noteworthy given the strong relationship that was also found among motivation and the covariates. Parent support and anticipated math mark significantly predicted all motivation variables, accounting for 16-33% of the variance. These findings highlight the importance of multiple contextual factors in predicting student motivation.

The current study also confirmed the hypothesis that teacher support would be negatively associated with student grade level. In other words, students in later grades perceived lower teacher support than those in earlier grades, which is consistent with previous research showing decreases in perceived teacher support among students as they progress through school (Bokhorst, Sumter, & Westenberg, 2010; Hughes, Wu, Kwok, Villarreal, & Johnson, 2012). Specifically, it has been found that teacher-student relationships during the middle school years become less personal, more formal, more evaluative, and more competitive after the transition to middle school (Lynch & Cicchetti, 1997). It may be that teachers in later grades place a greater focus on their math instructional roles versus their relationship roles with students. Students in later grades also tend to spend more time engaged in whole-class lectures and independent seatwork, and less time engaged in small-group instruction (Wigfield et al., 1991). Consequently, students may have fewer opportunities to build close interpersonal relations with teachers as they progress through school. Finally, teachers may also assume that older students do not want or require as much educational involvement from adults in the school setting as they gain more autonomy and build stronger social relationships with peers.

Multiple facets of math motivation and teacher support. The measures used in this study included multiple scales to measure distinct constructs of math motivation (expectancy, value, cost, and future interest) and teacher support (teacher care and teacher instrumental help). All scales were found to have adequate reliability, however the constructs of motivation and support were not too strongly correlated with one another—meaning they measured somewhat distinct concepts (*r* ranges from -.54 to .69). This corroborates previous psychometric work by researchers (Kosovich et al., in press; Wellborn et al., 1988) indicating that motivation and teacher support are not unitary constructs, but rather multifaceted. Future research should continue to examine multiple constructs of motivation, including unique associations among specific motivational constructs and contextual factors.

This study provides preliminary evidence to suggest that specific domains of motivation may have unique relationships to certain types of support. Specifically, standardized beta coefficients demonstrated that teacher care had the strongest association with math value and future interest ($\beta = .29, .23$, respectively), whereas teacher help had the strongest association with math expectancy and cost ($\beta = .21, -.28$, respectively). Close interpersonal support from teachers may relate to more abstract or affective oriented motivation related to math (e.g., valuing), whereas instrumental support from teachers may relate to more concrete motivational processes related to expectations for math achievement and success. Future research is needed to provide a more intricate examination of the unique relationships among specific motivation and support constructs.

Gender and teacher support. For three of the four aspects of math motivation, the positive relationships between teacher support and motivation were unexpectedly found to be similar for males and females. This shows that teacher support, in general, is promotive for both males and females in terms of the cost, value, and future interest aspects of motivation. That said, gender differences were found in the relationship between teacher help and math expectancy. A post-hoc analysis revealed that male and females in earlier grades reported similar levels of teacher help, whereas males in later grades reported higher teacher help than females in later grades. This indicates that the association between teacher help and expectancy was moderated by gender, with male students showing a stronger positive relationship between support and math expectancy than female students. This finding was opposite of the hypothesized outcome that there would be a stronger positive relationship between teacher support and math motivation for females than males. This finding may relate to previous studies regarding gender-differentiated classroom interaction patterns, which suggest that teachers tend to interact more with males than females (Jones & Dindia, 2004). Additionally, in the current study, simple correlations revealed that males reported slightly lower anticipated math achievement than females. This could imply that males were more likely to seek out teacher help in an effort to raise their achievement levels, and thus perceived help from teachers as more important to their expectancies for success in math class. Further research is needed regarding gender differences across specific domains of perceived teacher support, and how these differences may relate to motivational outcomes.

Racial differences in motivational trends. Though the current study found significant negative associations between student race and anticipated achievement, student race was not a significant predictor of the math motivation variables. Furthermore, correlations revealed African American and White students did not differ in their reports of both teacher and parent support. These findings confirm previous studies demonstrating similar levels of motivation among White and African American students despite gaps in achievement (Ferguson, 2002; Graham, 1994). This is perplexing given the well-demonstrated link between motivation and achievement. Further research is needed to uncover the complex factors associated with math achievement gaps between White and African American students in integrated, higher-income schools. There may be other processes that are not accounted for in the current study such as stereotype threat (Steele, 1997, 2003) or peer norms around academic achievement (Ferguson, 2001). It has also been shown that minority students who attend higher-income, reputedly excellent schools often have fewer family background advantages (e.g., income, books and computers at home, parents' education levels), which can impact the racial achievement gap that persists in these settings (Ferguson, 2002). The current study does not account for possible disparities in family resources among White and African American students that could have impacted reported racial differences in anticipated math achievement.

One finding related to racial differences for math future interest across grade levels is worth noting. The test of whether future interest in math varied by race across grade levels approached significance in the regression model ($p = .07$). That is, White students reported similar levels of future interest across grade levels, whereas African American students in later grades reported less future interest in math than those in earlier grades. These differences were small, however, as it was only a 5% difference in standard deviation in future interest from early grades to later grades. It is unknown whether such a small reduction is practically meaningful or not. Further research will need to use other samples to explore whether the slight difference in future interest found later in middle school for African Americans could widen into a larger racial gap in motivation through the high school years. Also, it would be important to follow students to understand if this burgeoning gap, albeit a small one, has any long-term consequences on disparities in STEM careers. It could be the case that this slight decrement in future interest in math could have real impact on meaningful decisions at critical junctures such as whether to strive for enrollment in advanced high school math classes or a math-related college major.

Limitations

There are several limitations of the current study that should be considered. This study contained a relatively homogeneous sample with regard to student race. Specifically, the sample included 911 (89%) White students and 110 (11%) African American students. Although the overall sample size was large, there were relatively small sub-samples when considering race and grade level trends. In other words, 110 African American students divided between four grade levels yielded much smaller sample sizes per group, which limits the ability of the analyses to detect effects and also limits the generalizability of the results concerning motivational trends specific to racial groups. Future research should examine these trends with a more diverse student sample to better detect potential differences in motivation patterns across racial groups.

Secondly, the current study was unable to consider the effects of "nesting" since the survey was distributed in just two schools. That is, given the small number of schools it was not possible to analyze whether the students systematically differed in their survey responses across the schools. It might be the case that some schools have strong math instructional staff which could result in students reporting high teacher support and motivations, whereas other schools may have weaker math instructional staff and thus have lower reports of motivation and support. Future research might include more schools to determine if there is a school level effect using multi-level modeling.

Another limitation to be considered is the possibility of student response bias. First, the high reliability and correlation estimates may have been inflated due to the tendency for students to score items according to a specific "style" (central vs. extreme). However, the regression models used in this study included student-reported parent support to help account for response-style, which ultimately increases confidence in the findings. Second, the social norms of an upper-middle class, high achieving school context may have exaggerated the students' ratings of math achievement, motivation, and supports. That said, in an attempt to minimize social desirability bias, the survey was administered anonymously and during a non-math class period. Nevertheless, future research should make additional efforts to account for rater bias to gain a more accurate portrait of student motivation. This could be achieved through including the perceptions of other reporters such as teachers or parents.

Finally, this study utilized a cross-sectional design, which measured student-reported motivation and supports at one particular point in time. The ratings were then used to examine trends between cohorts, which does not provide an accurate analysis of temporal changes in motivation within individual students as they progress through school. Differences observed across grade levels could therefore be explained by cohort differences among students or contextual factors (i.e., teacher characteristics, grade level curricula, or student cohort characteristics) rather than actual changes in motivation. Future research should examine motivational trends through a longitudinal design, which would involve administering surveys to the same students at multiple time points to better measure motivational change over time. That would enable researchers to better understand general trends across grade, especially the unexplained dip in seventh grade motivation that was observed in the current study.

Future Directions

This research contributed to the current literature because it provided a more focused analysis of contextual factors predicting motivation compared to most studies. While previous studies have demonstrated associations among student motivation and various contextual factors such as social supports (McCormik et al., 2013; Roeser & Eccles, 1998; Ryan et al., 1994), few have examined relationships between separate constructs of math motivation and support from math teachers among students based on group characteristics (i.e., grade level, race, and gender). Given the well-established racial and gender gaps in math achievement, post-secondary education, and career pathways (Watt et al., 2012), as well as previously documented developmental decrements in math motivation and achievement (Gottfried et al., 2001; Kosovich et al., in press), studies in this area continue to be significant. The current study highlights several possible directions for future research.

First, the current study's hypotheses regarding racial differences in motivational patterns and associations were not supported. Future research should be conducted with more diverse samples and include a greater variety of groups (i.e., Asian and Hispanic) in comparative analyses. Future studies could also include intersectional analyses of racial groups by gender to determine if motivational differences exist across racial groups according to gender. Larger samples would ensure that all sub-groups contained an adequate number of students to have the statistical power to detect effects.

Second, future research should provide a more in-depth evaluation of how socioeconomic status may impact motivational trends. Given that the current study was conducted in just one school district, it is unknown whether the results can be generalized to other schools with similar socioeconomic characteristics. Studying math motivation and teacher support among students who attend multiple schools that are set in a variety of communities would allow for analyses of school community SES as a predictor of student motivation and teacher support ratings. Comparisons among communities may also help ascertain if teacher support is even more important for motivation in more stressed communities. Finally, future inquiry regarding community SES and student motivation may shed light on this study's unexpected findings regarding grade level trends in motivation.

Although this study did not focus on math-related parent support, the fact that teacher support was a significant predictor of motivation above and beyond parent support may suggest that teacher support can serve as a buffer for students who do not receive adequate academic support at home. Given that parents are less likely to engage with their children in academic tasks related to math (Sheldon, Epstein, & Galindo, 2010), supportive math teacher-student relationships might be of particular importance. Also noteworthy was that the current study revealed a significant negative correlation between grade level and parent support, indicating that students in later grades perceived lower parent support than those in earlier grades. This would imply that special attention from teachers could be paid to older students whose parents may be less willing and/or able to assist with math homework as their children become more autonomous and the math curricula becomes more challenging. Future research can help further understand the unique roles of home versus school math supports for students across grade levels.

Implications for Practice

Gender analyses revealed important differences in motivational trends across two motivation scales (math value and math future interest). That is, males reported higher value and future interest across grades, whereas females reported no changes in math value and reported lower future interest across grades. These findings suggest that gender gaps in math motivation occur in a higher-income setting. Also noteworthy was that no gender gaps were evident for math value and math future interest among fifth grade students, whereas much larger gaps were observed among eighth grade students. These trends are concerning given that the gender gaps may increase as students progress through high school, college, and beyond.

Taken as a whole, the findings highlight the importance of earlier math intervention efforts during the middle school years, with a special focus on fostering math valuing and interest among female students. Since males and females typically perform at comparable academic levels, the need for this type of intervention may be easily overlooked or dismissed by school personnel. These programs might focus bringing math “alive” by encouraging interactive, hands-on learning to increase student engagement and highlight real-world relevance. Middle school students, particularly girls, should also be made aware of the various benefits associated with pursuing long-term math studies and STEM careers. For example, female representatives from various universities and STEM-related career fields could serve as mentors to young girls. Similar efforts could also be made for African American students, who reported slightly lower future interest in math than White students across grade levels. These efforts can help to challenge society's racial and gender stereotypes and encourage females and African Americans to consider future careers outside of those that are "typical" or "expected" of them.

Early efforts by teachers and parents can further help to normalize the pursuit of math careers for females and African Americans. Given the strong associations between teacher support/parent support and math motivation, teachers and parents should be mindful of the powerful influence that they can have on student motivation and outcomes in math, as well as their role in either reinforcing or mitigating societal influences related to female/African American math pursuits. Teachers and parents can work together to help foster math learning from an early age through both emotional relations (care) and assistance with math work (instrumental help).

Secondly, this study demonstrated a strong link between teacher support and math motivation across all scales. This highlights the need for both caring and helping teachers for all students. Moreover, the current study provided preliminary evidence that unique relationships may exist between certain domains of teacher support and math motivation. Specifically, it was found that teacher care was most strongly related to math value and future interest, whereas teacher help was most strongly related to math expectancy and cost. The different types of teacher support also came into play when examining gender differences, with male students reporting a stronger association between teacher help and math expectancy. Teachers should be made aware of the different types of support that they can provide to students, as well as specific ways in which different types of support may impact students.

Finally, this study highlighted the potential benefits of collecting information related to student perceptions. Collecting student voice on their math experience could help schools conduct regular needs assessments, which could then inform new programming. Emphasizing the importance of student feedback may also help students feel empowered and valued by their schools, which may then influence student attitudes toward learning.

Conclusion

The present study offered new insights regarding grade level trends in math motivation as well as associations between math motivation and teacher support among fifth-through-eighth grade students from a higher-income community. The study also provided a unique analysis of these trends across student race (White vs. African American) and gender. Analyses of motivational trends across grade levels revealed unexpected linear and curvilinear trends, with students in later grade levels perceiving higher math expectancy and lower math costs compared to students in earlier grades. Grade level trends were also found to vary depending on gender. Specifically, males reported higher math value and future interest from fifth through eighth grade, whereas females reported no differences (for math value) or negative trends (for math future interest) across grade levels. Overall, these results revealed increased gender differences in motivation across the middle grade levels, which may widen as students progress through high school and impact math-related academic and career endeavors. The present study also demonstrated the importance of perceived teacher support in student math motivation, both in terms of their care and instrumental help. Furthermore, the association between teacher help and math expectancy was found to be stronger for males than females, suggesting that help from teachers was a stronger predictor of boys' expectancies for math success. Unlike the observed gender differences, student race was not a significant predictor of math motivation, and no significant differences among White and African American students were found in grade level and teacher support analyses.

This study demonstrates that math motivation is a complex construct that does not exist in a vacuum. Rather, motivation is impacted by a large variety of individual and contextual factors. This study highlights just a few of those factors including demographic characteristics and social supports. Gaining a better understanding of how student motivation is impacted by specific contextual factors can help inform programming aimed at increasing student motivation to pursue lifelong learning in math, especially for historically underrepresented groups.

References

Akey, T. (2006). *School context, students' attitudes and behavior and academic achievement: an exploratory analysis.* Technical Report, MDRC.

Ames, C. (1992). Classrooms: goals, structures, and student motivation. *Journal of Educational Psychology, 84,* 261-271.

Anderman, E. M., & Wolters, C. (2006). Goals, values, and affect. In P. Alexander and P. Winne (Eds.), *Handbook of Educational Psychology* (pp. 369-389). Mahwah, NJ: Lawrence Erlbaum.

Anderman, L. H., & Midgley, C. (1997). Motivation and middle school students. In J. L. Irvin (Ed.), *What current research says to the middle level practitioner* (pp. 41-48). Columbus, OH: National Middle School Association.

Anderson, R., Manoogian, S. T., & Reznick, J. S. (1976). The undermining and enhancing of intrinsic motivation in preschool children. *Journal of Personality and Social Psychology, 34,* 915-922.

Archambault, I., Janosz, M., Fallu, J. S., & Pagani, L. S. (2009). Student engagement and its relationship with early high school dropout. *Journal of Adolescence, 32,* 651-670.

Atkinson, J. W. (1957). Motivational determinants of risk-taking behavior. *Psychological Review, 64,* 359-372.

Atkinson, J. W. (1964). *An introduction to motivation.* Princeton, NJ: Van Nostrand.

Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist, 37*, 122–147.

Bandura, A. (1986). *Social foundations of thought and action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1997). *Self-efficacy: The exercise of control.* New York: Freeman.

Bandura, A., Barbaranelli, C., Caprara, G. V., & Pastorelli, C. (2001). Self-efficacy beliefs as shapers of children's aspirations and career trajectories. *Child Development, 72,* 187-206.

Bokhorst, C. L., Sumter, S. R., & Westenberg, P. M. (2010). Social support from parents, friends, classmates, and teachers in children and adolescents aged 9 to 18 years: Who is perceived as most supportive?. *Social Development, 19,* 417-426.

Brophy, J., & Good, T. (1974). *Teacher-student relationships: Causes and consequences.* New York: Holt, Rinehart and Winston.

Chemers, M. M., Zurbriggen, E. L., Syed, M., Goza, B. K., & Bearman, S. (2011). The role of efficacy and identity in science career commitment among underrepresented minority students. *Journal of Social Issues, 67,* 469-491.

Deci, E. L. (1971). Effects of externally mediated rewards on intrinsic motivation. *Journal of Personality and Social Psychology,18,* 105-115.

Deci, E. L., Koestner, R., & Ryan, R. M. (1999). A meta-analytic review of experiments examining the effects of extrinsic rewards on intrinsic motivation. *Psychological Bulletin, 125*, 627–668.

Deci, E. L., & Ryan, R. M. (1980). The empirical exploration of intrinsic motivational processes. In L. Berkowitz (Ed.), *Advances in experimental social psychology* (pp. 39-80). New York: Academic Press.

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior.* New York: Plenum.

Deci, E. L., & Ryan, R. M. (2002). *Handbook of self-determination research.* Rochester, NY: University of Rochester Press.

Diamond, J. B. (2006). Still separate and unequal: Examining race, opportunity, and school achievement in "integrated" suburbs. *Journal of Negro Education, 75,* 495-505.

Duffy, J., Warren, K., & Walsh, M. (2001). Classroom interactions: Gender of teacher, gender of student, and classroom subject. *Sex Roles, 45*, 579–593.

Eccles, J. (1999). The development of children ages 6 to 14. *The future of children, 9*, 30-44.

Eccles, J. (2007). Families, schools, and developing achievement-related motivations and engagement. In J. E. Grusec and P. D. Hastings (Eds.). *Handbook of Socialization: Theory and research* (pp. 665-691). New York: Guilford Press.

Eccles, J. (2008). *Can middle school reform increase high school graduation rates?.* California Dropout Research Project Report, University of California.

Eccles (Parsons), J., Adler, T. F., Futterman, R., Goff, S. B., Kaczala, C. M., Meece, J. L. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motivation* (pp. 75-146). San Francisco, CA: W.H. Freeman.

Eccles, J. S., Adler, T. F., & Meece, J. L. (1984). Sex differences in achievement: A test of alternate theories. *Journal of Personality and Social Psychology, 46,* 26-43.

Eccles, J., Lord, S., Midgley, C. (1991). What are we doing to early adolescents? The impacts of educational contexts on early adolescents. *American Educational Journal,* 521-542.

Eccles, J. S., & Midgley, C. (1990). Changes in academic motivation and self-perceptions during early adolescence. In R. Montemayor, G.R. Adams & T.P. Gullotta (Eds.). *Advances in adolescent development: From childhood to adolescence* (pp. 134-155). Newbury Park, CA: Sage.

Eccles, J. S., & Wigfield, A. (2002). Motivational beliefs, values, and goals. *Annual Review of Psychology, 53*, 109–132.

Eccles, J. S., Wigfield, A., Flanagan, C., Miller, C., Reuman, D., & Yee, D. (1989). Self concepts, domain values, and self-esteem: Relations and changes at early adolescence. *Journal of Personality. 57*, 283-310.

Eccles, J. S., Wigfield, A., Midgley, C., Reuman, D., Iver, D. M., & Feldlaufer, H. (1993). Negative effects of traditional middle schools on students' motivation. *The Elementary School Journal, 93,* 553-574. dio:10.1086/461740

Ewing, A. R. & Taylor, A. R. (2009). The role of child gender and ethnicity in teacher child relationship quality and children's behavioral adjustment in preschool. *Early Childhood Research Quarterly, 24,* 92-105.

Fan, W. & Wolters, C. A. (2012). School motivation and high school dropout: The mediating role of educational expectation. *British Journal of Educational Psychology,* 1-18. doi:10.1111/bjep.12002

Ferguson, R. F. (2001). A diagnostic analysis of Black-White GPA disparities in Shaker Heights, Ohio. *Brookings Papers on Education Policy,* 347-414.

Ferguson, R. F. (2002). *What doesn't meet the eye: Understanding and addressing racial disparities in high-achieving suburban schools.* Oak Brook, IL: North Central Regional Educational Laboratory.

Flores, A. (2007). Examining disparities in mathematics education: Achievement gap or opportunity gap? *The High School Journal, 91,* 29-42.

Fortier, M. S., Vallerand, R. J., & Guay, F. (1995). Academic motivation and school performance: Toward a structural model. *Contemporary Educational Psychology*, *20*, 257-274.

Gonzales, P., Guzman, J.C., Partelow, L., Pahlke, E., Jocelyn, L., Kastberg, D., & Williams, T. (2004). *Highlights from the trends in international mathematics and science study.* Washington, DC: National Center of Education Statistics.

Good, C., Aronson, J., & Inzlicht, M. (2003). Improving adolescents' standardized test performance: An intervention to reduce the effects of stereotype threat. *Applied Developmental Psychology, 24,* 645-662.

Gottfried, A. E. (2009). The role of environment in contextual and social influences on motivation: Generalities, specificities, and causality. In K. Wentzel and A. Wigfield (Eds.), *Handbook of Academic Motivation* (pp. 463-475). NY: Taylor & Francis.

Gottfried, A. E., Fleming, J. S., & Gottfried A. W. (2001). Continuity of academic intrinsic motivation from childhood through late adolescence: A longitudinal study. *Journal of Educational Psychology, 93,* 3-13.

Gottfried, A. E., Marcoulides, G. A., Gottfried, A. W., & Oliver, P. (2009). A latent curve model of parental motivational practices and developmental decline in math and science academic intrinsic motivation. *Journal of Educational Psychology,101,* 729-739.

Gottfried, A. E., Marcoulides, G. A., Gottfried, A. W., Oliver, P., & Guerin, D. (2007). Multivariate latent change modeling of developmental decline in academic intrinsic math motivation and achievement: Childhood through adolescence. *International Journal of Behavioral Development, 31,* 317-327.

Graham, S. (1994). Motivation in African-Americans. *Review of Educational Research, 64,* 55-117.

Gregory, A. & Weinstein, R. S. (2004). Connection and regulation at home and in school: Predicting growth in achievement for adolescents. *Journal of Adolescent Research*, *4,* 405-427.

Gregory, A., & Weinstein, R. S. (2008). The discipline gap and African Americans: Defiance or cooperation in the high school classroom. *Journal of School Psychology, 46*, 455-475. doi:10.1016/j.jsp.2007.09.001

Guay, F., Chanal, J., Ratelle, C. F., Marsh, H. W., Larose, S., & Boivin, M. (2010). Intrinsic, identified, and controlled types of motivation for school subjects in young elementary school children. *British Journal of Educational Psychology, 80*, 711–735.

Halpern, D. F., Aronson, J., Reimer, N., Simpkins, S., Star, J. R., & Wentzel, K. (2007). *Encouraging girls in math and science: IES practice guide.* Washington, DC: U.S. Department of Education, National Center for Education Research, Institute of Education Science.

Halpern, D. F., Benbow, C. P., Geary, D. C., Gur, R. C., Hyde, J. S., & Gernsbacher, M. A. (2007). The science of sex differences in science and mathematics. *Psychological Science in Public Interest, 8*, 1–51.

Harackiewicz, J. M., Manderlink, G., & Sansone, C. (1984). Rewarding pinball wizardry: Effects of evaluation and cue value on intrinsic interest. *Journal of Personality and Social Psychology*, *47*, 287-300.

Hidi, S. & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist, 41*, 111-127.

Holden, C. (2002). Contributing to the debate: the perspectives of children on gender, achievement and literacy. *Journal of Educational Inquiry, 3*, 97-110.

Hughes, J. N., Wu, J. Y., Kwok, O., Villarreal, V., & Johnson, A. Y. (2012). Indirect effects of child reports of teacher-student relationship on achievement. *Journal of Educational Psychology, 104,* 350-365.

Hulleman, C. & Barron, K. (2012). *Expectancy-Value-Cost-Interest Survey Items. Unpublished scale.* Charlottesville, VA: University of Virginia.

Hyde, J. S., Lindberg, S. M., Linn, M. C., Ellis, A. B., & Williams, C. C. (2008). Gender similarities characterize math performance. *Education Forum, 321,* 494-495.

Janosz, M., LeBlanc, M., Boulerice, B., &Tremblay, R. E. (2000). Predicting types of school dropouts: A typological approach with two longitudinal samples. *Journal of Educational Psychology, 92*, 171–190.

Jones, S., & Dindia, K. (2004). A meta-analytic perspective on sex equity in the classroom. *Review of Educational Research, 74,* 443-471.

Kosovich, J. J., Hulleman, C. S., Barron, K. E., Getty, S. (in press). A practical measure of student motivation: Validity evidence for the expectancy-value-cost scale in middle school. *Journal of Early Adolescence.*

Lotkowski, V., Robbins, S., & Noeth, R. (2004) The role of academic and non-academic factors in improving college retention. *ACT Policy Report*, retrievable online at: www.atc.org/research/policy/index.htlm.

Lubinski, D. & Benbow, C. P. (2006). Study of mathematically precocious youth after 35 years: Uncovering antecedents for the development of math-science expertise. *Perspectives on Psychological Science, 1,* 316-345.

Lynch, M., & Cicchetti, D. (1997). Children's relationships with adults and peers: An examination of elementary and junior high school students. *Journal of School Psychology, 35*, 81–100.

Marsh, H. W., Trautwein, U., Lüdtke, O., Köller, O., & Baumert, J. (2005). Academic self-concept, interest, grades, and standardized test scores: Reciprocal effects models of causal ordering. *Child Development, 76*, 397–416.

Mata, M. L., Montiero, V., & Peixoto, F. (2012). Attitudes towards mathematics: Effects of individual, motivational, and social support factors. *Child Development Research, 1,* 1-10. doi:10.1155/2012/876028

McGraw, R., Lubienski, S. T., & Strutchens, M. E. (2006). A closer look at gender in NAEP mathematics achievement and affect data: Intersections with achievement, race/ethnicity, and socioeconomic status. *Journal for Research in Mathematics Education, 37,* 129-150.

Meece, J. L., Glienke, B. B., & Burg, S. (2006). Gender and motivation. *Journal of School Psychology, 44*, 351-373.

Meece, J. L., Wigfield, A., & Eccles, J. S. (1990). Predictors of math anxiety and its consequences for young adolescents' course enrollment intentions and performances in mathematics. *Journal of Educational Psychology*, *82*, 60–70.

Midgley, C., Feldlaufer, H., Eccles, J. (1989). Change in teacher efficacy and student self- and task-related beliefs in mathematics during the transition to junior high school. *APA, 81*, 247-258.

Midgley, C., Maehr, M., Hruda, L., Anderman, E., Freeman, K., et al. (2000). *Manual for patterns of adaptive learning.* Ann Arbor, MI: University of Michigan.

Mizell, C. A. (2000). Racial and gender variations in the process shaping earnings' potential: the consequence of poverty in early adulthood. *Journal of Sociology & Social Welfare, 27,* 113-139.

Nagy, G., Trautwein, U., Baumert, J., Koller, O., & Garrett, J. (2006). Gender and course selection in upper secondary education: Effects of academic self-concept and intrinsic value. *Educational Research and Evaluation, 12,* 323-345.

National Mathematics Advisory Panel. (2008). *The final report of the national mathematics advisory panel.* Washington, DC: U.S. Department of Education.

National Center for Education Statistics. (2010). *Digest of Education Statistics.* Washington, DC: U.S. Department of Education.

National Center for Education Statistics. (2012). *Highlights from TIMSS 2011: Mathematics and science achievement of U.S. fourth-and eighth-grade students in an international context.* Washington, DC: U.S. Department of Education.

National Science Foundation. (2008). *NSF, division of science resource statistics, science and engineering degrees: 1966-2006.* Arlington, VA.

Newman, R. S. (1990). Children's help-seeking in the classroom: The role of motivational factors and attitudes. *Journal of Educational Psychology, 82*, 71-80.

Noguera, P. A., & Wing, J. Y. (2006). *Unfinished business: Closing the racial achievement gap in our schools.* San Francisco, CA: Jossey-Bass.

Ogbu, J. (1991). Minority coping responses and school experience. *Journal of Psychohistory, 18,* 433-456.

Ogbu, J. (2003). *Black American students in an affluent suburb: a study of academic disengagement.* Mahway, NJ: Lawrence Erlbaum Associates.

Pintrich, P. R., & DeGroot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology, 82*, 33–40.

Rawnsley, D., & Fisher, D. L. (1998). *Learning environments in mathematics classrooms and their associations with students' attitudes and learning.* Paper presented at the Australian Association for Research in Education Conference, Adelaide, Australia.

Reddy, R., Rhodes, J., & Mulhall, P. (2003). The influence of teacher support on student adjustment in the middle school years: A latent growth curve study. *Development and Psychopathology, 15,* 119-138.

Roeser, R. W., & Eccles, J. S. (1998). Adolescents' perceptions of middle school: Relation to longitudinal changes in academic and psychological adjustment. *Journal of Research on Adolescence, 8,* 123–158.

Rosenblatt, J. L. & Elias, M. J. (2008). Dosage effects of a preventive social-emotional learning intervention on achievement loss associated with middle school transition. *Journal of Primary Prevention, 29,* 535-555.

Rutter, M. (1985). Resilience in the face of adversity. *British Journal of Psychiatry, 147*, 598-611.

Ryan, R. M. (1995). Psychological needs and the facilitation of integrative processes. *Journal of Personality, 63,* 397-427.

Ryan, R. M. & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychologist, 55,* 68-78.

Ryan, R. M., Stiller, J. D., & Lynch, J. H. (1994). Representations of relationships to teachers, parents, and friends as predictors of academic motivation and self esteem. *Journal of Early Adolescence, 14,* 226-249.

Schunk, D. H. (1991). Self-efficacy and academic motivation. *Educational Psychologist, 26,* 201-231.

Schunk, D. H. (1995). Self-efficacy, motivation, and performance. *Journal of Applied Sport Psychology, 7*, 112-137.

Schunk, D. H., Pintrich, P. R., & Meece, J. L. (2007). *Motivation in education: Theory, research and applications.* Upper Saddle River, NJ: Pearson/Merrill Prentice Hall.

Sheldon, S. B., Epstein, J. L., & Galindo, C. L. (2010). Not just numbers: Creating a partnership climate to improve math proficiency in schools. *Leadership and Policy in Schools, 9,* 27-48.

Simpkins, S. D., Davis-Kean, P. E., & Eccles, J. S. (2006). Math and science motivation: A longitudinal examination of the links between choices and beliefs. *Developmental Psychology, 42*, 70–83.

Skinner, E. A., Zimmer-Gembeck, M. J., & Connell, J. P. (1998). Individual differences and the development of perceived control. *Monographs of the Society for Research in Child Development, 63,* 1-220.

Spinath, B., Spinath, F. M., Harlaar, N., & Plomin, R. (2004). Predicting school achievement from general cognitive ability, self-perceived ability, and intrinsic value. *Intelligence, 34,* 363-374.

Steele, C. M. (1997). A threat is in the air: How stereotypes shape intellectual identit and performance. *The American Psychological Association, 52,* 613-629.

Steele, C. M. (2003). Stereotype threat and African American student achievement. In T. Perry, C. Steele, & A. Hilliard (Eds.), *Young, gifted, and Black: Promoting high achievement among African American students* (pp. 109-130). Boston: Beacon Press.

Sue, D. W. (2010). *Microaggressions in Everyday Life: Race, Gender, and Sexual Orientation*. Hoboken, NJ: John Wiley & Sons, Inc.

Sue, D. W., Capodilupo, C. M., Torino, G. C., Bucceri, J. M., Holder, A. M. B., Nadal, K. L., & Esquilin, M. (2007). Racial microaggressions in everyday life: Implications for clinical practice. *American Psychologist, 62*, 271-286. doi:10.1037/0003-066X.62.4.271

Sue, D. W., Lin, A. I., Torino, G. C., Capodilupo, C. M., & Rivera, D. P. (2009). Racial microaggressions and difficult dialogues on race in the classroom. *Cultural Diversity and Ethnic Minority Psychology, 15*, 183-190. doi:10.1037/a0014191

Tidemann, J. (2001). Parents' gender stereotypes and teachers' beliefs as predictors of childrens' concept of their mathematical ability in elementary school. *Journal of Educational Psychology, 92,* 144-151.

Tucker, C. M., Zayco, R. A., & Herman, K. C. (2002). Teacher and child variables as predictors of academic engagement among low-income African American children. *Psychology in the Schools, 39,* 477-488.

Watt, H. M. G., Shapka, J. D., Morris, Z. A., Durik, A. M., Keating, D. P., & Eccles, J. S. (2012). Gendered motivational processes affecting high school mathematics participation, educational aspirations, and career plans: A comparison of samples from Australia, Canada, and the United States. *Developmental Psychology, 48*, 1594-1611. doi: 10.1037/a0027838

Weiner, B. (1985). An attributional theory of achievement motivation and emotion. *Psychological Review, 92*, 584-573.

Weiner, B. (1992). *Human motivation: Metaphors, theories, and research.* Newbury Park, CA: Sage

Wellborn, J., Connell, J., Skinner, E. A., & Pierson, L. H. (1988). *Teacher as social context: A measure of teacher provision of involvement, structure and autonomy support.* Rochester, NY: University of Rochester.

Wentzel, K. R. (1998). Social relationships and motivation in middle school: The role of parents, teachers, and peers. *Journal of Educational Psychology, 90,* 202-209.

Wentzel, K. R., & Wigfield, A. (2009). *Handbook of motivation at school.* Mahwah, NJ: Taylor-Frances.

Wigfield. A. (1994). Expectancy - value theory of achievement motivation: A developmental perspective. *Educational Psychology Review, 6*, 49-78.

Wigfield, A., & Eccles, J. S. (1992). The development of achievement task values: A theoretical analysis. *Developmental Review, 12*, 265-310.

Wigfield, A., & Eccles, J. S. (1994). Children's competence beliefs, achievement values, and general self-esteem: Change across elementary and middle school. *Journal of Early Adolescence 14*, 107-138.

Wigfield, A. & Eccles, J. S. (2000). Expectancy-value theory of achievement motivation. *Contemporary Educational Psychology, 25*, 68-81.

Wigfield, A., Eccles, J. S., Mac Iver, D., Reuman, D. A., & Midgley, C. (1991). Transitions during early adolescence: Changes in children's domain-specific self perceptions and general self-esteem across the transition to junior high school. *Developmental Psychology, 27,* 552-565.

Wigfield, A., Eccles, J. S., Schiefele, U., Roeser, R., & Davis-Kean, P. (2006). Development of achievement motivation. In W. Damon and N. Eisenberg (Eds.), *Handbook of child psychology* (pp. 933-1002), New York: Wiley.

Wigfield, A., Eccles, J. S., Yoon, K. S., Harold, R. D., Arbreton, A., Freedman-Doan, C., & Blumenfeld, P. C. (1997). Changes in children's competence beliefs and subjective task values across the elementary school years: A three-year study. *Journal of Educational Psychology, 89*, 451-469.

Wigfield, A., Tonks, S., & Klauda, S. L. (2009). Expectancy – value theory. In K. R. Wentzel & A. Wigfield (Eds.), *Handbook of motivation at school* (pp. 55-76). Mahwah, NJ: Lawrence Erlbaum Associates.

Appendix A

Theoretical Foundations of Achievement Motivation

There is an extensive history of scholarship on achievement motivation that spans nearly a half-century. Throughout this time, researchers have developed numerous theories of achievement motivation that have guided both research and practice. Four of the most influential theoretical approaches, including self-efficacy theory, goal theory, self-determination theory, attribution theory, and expectancy-value theory, are discussed in the following sections. The final theory (expectancy-value) focuses on the conceptualization of achievement motivation that is used in the current study.

Self-efficacy theory

Achievement motivation is first discussed in terms of self-efficacy, which refers to people's judgments of their capabilities to perform a given task (Bandura, 1982, 1986). Bandura's self-efficacy theory (1982) posits that efficacy is a major influence on interests, effort, persistence, and goal setting. It is hypothesized that people tend to engage in activities at which they feel a high sense of self-efficacy and avoid tasks at which they feel a low sense of self-efficacy. In addition, those with a high sense of self-efficacy for accomplishing a task are hypothesized to work harder and persist longer when they encounter obstacles than those with a low sense of self-efficacy (Bandura, 1986).

Individuals often appraise self-efficacy from a combination of performance accomplishments, observational (vicarious) experiences, forms of persuasion, and physiological indexes (Bandura, 1986). With regard to *performance accomplishments*, previous performances offer the most reliable guides for evaluating efficacy. Efficacy is enhanced by success and lowered by failure, however failure may not have a strong impact once a strong sense of efficacy is developed (Bandura, 1986). An individual also evaluates efficacy from *observational experiences*, or vicarious knowledge from others. Observing similar others perform a task conveys to observers that they too have the ability to perform that task (Schunk, 1991). The influence of observational information on self-efficacy is typically not as strong as performance-based information, since self-efficacy resulting from observational information can be negated by subsequent failures (Bandura, 1986).

Individuals can also assess self-efficacy through *forms of persuasion.* In other words, an individual's self-efficacy is often enhanced through persuasions from others regarding his or her capabilities to perform a task (e.g., "You can do it"). Similar to observational information, however, self-efficacy resulting from positive persuasion will be temporary if there is subsequent failure (Bandura, 1986). Finally, individuals acquire self-efficacy information from *physiological indexes* (e.g., heart rate). Physiological symptoms indicating anxiety may be interpreted to indicate lack of skills, and therefore hinder self-efficacy (Bandura, 1986).

Previous research has provided overwhelming support for Bandura's notions through demonstrating significant and positive correlations between self-efficacy and subsequent task motivation and achievement (Schunk, 1995). For example, Collins (1982) demonstrated that self-efficacy predicts motivation and achievement with a sample of children. In this study, children identified as high, average, or low in mathematical ability were classified as having high or low levels of self-efficacy for solving word problems. Students were then given word problems (some unsolvable) that they were asked to solve and were also permitted to rework problems that they solved incorrectly. It was found that students classified as having low and average math ability with high self-efficacy worked the problems for longer periods of time than for those with low self-efficacy. Therefore, these results imply that self-efficacy provides better predictions of motivation and achievement than actual ability levels.

Another correlational study by Pintrich and DeGroot (1990) examined relationships between motivation and classroom performance for 173 seventh grade students from both science and English classes. Students were administered a self-report measure of several constructs of interest including self-efficacy. It was found that self-efficacy was positively related to cognitive engagement and academic performance.

Goal theory

Goal theory represents another widely accepted theory of motivation, which was developed through the collaborative efforts of several researchers (e.g., Ames, Dweck, Maehr, and Nicholls). Overall, goal theory postulates that there are two main types of motivational orientations for academic achievement: performance goal orientations and task goal orientations. Performance (or ego-involved) goal orientations are concerned with maximizing favorable evaluations of competence (i.e., earning good grades, performing well relative to peers) and minimizing negative evaluations of competence. On the other hand, task (or mastery) goal orientations are concerned with the inherent desire to increase knowledge (Anderman & Midgley, 1997).

Research examining the relationship between personal goal orientations and achievement behaviors has shown that students with a task goal orientation are more likely to engage in challenging activities, seek help from others, and adopt useful cognitive strategies. Conversely, those with performance goal orientations tend to select tasks that are more easily accomplished, since they are more concerned with out-performing others than enhancing abilities (Ames, 1992). Anderman and Wolters (2006) also concluded that task goal orientation is positively related to a variety of adaptive achievement behaviors, including effort, persistence, and engagement.

Attribution theory

Weiner's attribution theory (1985) is based on the basic belief that students wish to understand their environments and, therefore, strive to comprehend why certain events occur. This theory posits that student *interpretations* of their achievement outcomes determine subsequent achievement strivings more than motivational dispositions or actual outcomes (Weiner, 1985). That is, an individual's explanations (attributions) regarding the causes of success or failure are key motivational beliefs that influence subsequent achievement endeavors. Weiner (1992) pointed to four major types of attributions including *ability, effort, task difficulty*, and *luck*. These four types of attributions are then classified along three causal dimensions including *locus of causality* (internal vs. external), *stability* (stable vs. unstable), and *controllability* (controllable vs. uncontrollable).

Locus of causality comprises factors that are internal (i.e., effort or ability) or external to the person (i.e., luck or task difficulty) (Weiner, 1992). For example, if a student believes that he failed an exam because he did not exert enough effort, he is choosing an internal cause because effort is internal to the student. On the other hand, if the student believes that he failed the exam because the test was too difficult, he is choosing an external cause because task difficulty is external to the student.

Stability comprises factors that are stable (i.e., ability or task difficulty) or unstable (i.e., effort or luck) (Weiner, 1992). For example, if a student believes that he received a poor math grade because of his lack of math ability, he is choosing a stable cause since math ability is often viewed as being a permanent quality ("I am good/bad at math"). In contrast, if a student believes that he received a poor math grade because he did not study hard enough, he is choosing an unstable cause since level of effort can be easily changed in the future.

Controllability comprises factors that are controllable by the individual (i.e., effort) or uncontrollable (i.e., ability or task difficulty) (Weiner, 1992). If a student feels that he failed an exam because he did not adequately study the material, the attributed cause is controllable because he possesses the choice to study or not. On the other hand, if the student feels that he failed an exam because he does not have the ability to master the material, then the attributed cause is uncontrollable because his failure was not due to personal choices.

Weiner and his colleagues (1985, 1992) indicate that the types of attributions described above (ability, effort, task difficulty, and luck) may influence subsequent achievement behavior in predictable ways based on their locus of causality, stability, and controllability dimensions. The locus of causality dimension is highly linked to affective reactions. More specifically, attributing success to an internal cause enhances one's self-esteem and sense of pride, whereas attributing failure to an internal cause is associated with shame. Attributing success to an external cause enhances one's gratitude, while attributing failure to an external cause is associated with anger.

The stability and controllability dimensions influence individuals' expectancies for success. That is, in the face of failure, attributions to stable and uncontrollable causes (e.g., ability) lead to lower expectations for future success than attributions for unstable and controllable causes (e.g., effort). In the face of success, however, attributions to stable and uncontrollable causes lead to higher expectations for future success than attributions for unstable and controllable causes. Thus, poor achievement outcomes are more likely to lead to reduced motivation for those holding ability attributions (i.e., "I am good at math") than for those holding effort attributions (i.e., "I try really hard in math class"), since a lack of ability is more difficult to change and control than a lack of effort. The opposite is true for favorable achievement outcomes, which are more likely to lead to increased motivation for those holding ability attributions than for those holding effort attributions (Weiner, 1985, 1992).

Self-determination theory

Another influential model of motivation is Deci and Ryan's self-determination theory (1985), which evolved from earlier work focused on the distinction between intrinsic and extrinsic motivation. Intrinsic motivation refers to engaging in an activity because it is inherently interesting. When intrinsically motivated, an individual acts due to the perceived enjoyment or challenge of a task without the influence of external influences. On the other hand, extrinsic motivation refers to engaging in an activity because it leads to a separable outcome. When extrinsically motivated, an individual acts due to reinforcement contingencies (i.e., rewards, punishments) (Ryan & Deci, 2000).

Researchers have investigated the classic distinction between intrinsic and extrinsic motivation for several decades, and have generally found that the quality of individuals' experience and performance can be quite different based on the type of motivation that underlies behavior (Ryan & Deci, 2000). That is, over one hundred studies have shown that intrinsic motivation is hindered by extrinsic rewards (Deci et al., 1999). One of the first published studies of this type (Deci, 1971) involved a sample of college students that were paid for working on intrinsically interesting puzzles. It was found that monetary rewards undermined the students' intrinsic motivation for working on the task. This influential study has been followed by over 100 similar studies supporting the idea that rewards do not always motivate task persistence (Deci et al., 1999).

As a result of such findings, Deci and Ryan's self-determination theory (1985) is framed in terms of understanding social and environmental factors that facilitate versus undermine intrinsic motivation. They assume that human beings have evolved to be inherently active and intrinsically motivated. However, these natural processes will be impaired if critical biological and psychological nutriments are lacking or absent (Ryan, 1995). Self-determination theory primarily focuses on psychological nutriments, with three of the most critical being needs for *competence, relatedness*, and *autonomy* (Deci & Ryan, 1985). Social environments that help to meet these three basic needs are predicted to support optimal functioning.

Competence refers to feeling effective in one's social environment and experiencing opportunities to demonstrate one's capacities (Deci & Ryan, 1985). The psychological need for competence leads individuals to seek challenges that are optimal for maintaining and enhancing capacities. Competence, however, is not an acquired skill but rather a sense of confidence and efficacy in action (Deci & Ryan, 2002). One way that researchers have examined the basic need for competence is through the form of positive/negative feedback messages. It has been shown that positive feedback enhanced intrinsic motivation relative to negative feedback or no feedback, which Deci and Ryan (1980) linked to the basic need for competence. This is because events such as positive feedback help to convey messages of effectiveness (enhancing intrinsic motivation), whereas negative feedback conveys ineffectiveness (hindering intrinsic motivation).

Relatedness refers to feeling connected to others, caring for and being cared for by others, and having a sense of belongingness with one's community (Deci & Ryan, 1985). This need is concerned with the psychological sense of being with others in unity rather than the attainment of certain outcomes (e.g., sex or social status). Research regarding the need for relatedness was led by an influential study by Anderson, Manoogian, and Reznick (1976). This study found that children who worked on an inherently interesting activity in the presence of an adult who ignored their attempts to interact showed low levels of intrinsic motivation. Another study by Ryan and colleagues (1994) demonstrated that students who experience their teachers as warm and caring tend to have greater intrinsic motivation. These findings suggest that intrinsic motivation is best maintained in environments characterized by a sense of secure relatedness (Deci & Ryan, 2002).

Finally, *autonomy* refers to acting with a sense of volition (Deci & Ryan, 1985). When autonomous, individuals experience their behavior as an expression of their interests and values. Even when actions are influenced by outside sources, autonomous individuals value and concur with those influences. Studies by Deci and others (e.g., Harackiewicz, Manderlink, & Sansone, 1984) have revealed that events such as rewards, evaluation, threats, and deadlines negatively affect intrinsic motivation. This is presumably because these events prompt a shift toward a more external perceived locus of causality, thus threatening one's basic need for autonomy.

Taken together, these ideas amount to self-determination theory, which has an overall focus on the interaction between inherently active, growth-oriented human beings and social contexts in which they exist. These social contexts either support or undermine people's efforts to master and integrate their experiences into a coherent sense of self (Deci & Ryan, 2002). Therefore, individuals are intrinsically motivated to seek out optimal stimulation and challenging tasks due to their basic need for *competence*. Intrinsic motivation is maintained when individuals feel self-determined, and reduced when external control is exerted (need for *autonomy*). Finally, intrinsic motivation is most likely to flourish in contexts with high levels of interpersonal relatedness (Deci et al., 1999).

Expectancy-value theory

The expectancy-value theory represents a long-standing perspective on motivation, especially within the achievement motivation field. This model posits that individuals' task choice, persistence, and performance is a function of their beliefs about how successful they will be and the extent to which they value the task (Eccles et al., 1983; Wigfield & Eccles, 2000). Within the achievement motivation field, Atkinson (1957, 1964) developed the first formal expectancy-value model to explain behaviors such as striving for success, task choice, and task persistence. According to Atkinson (1957), achievement behaviors are determined by *achievement motives* (stable dispositions regarding motives to approach success and avoid failures), *expectancies for* *success* (expected probability for success on a given task, ranging from 0 to 1), and *incentive values* (relative attractiveness of succeeding on a given achievement task). Atkinson (1957) also explained that expectancies and values are inversely related. In other words, it was hypothesized that individuals would highly value tasks that are perceived as difficult. Empirical research has explored individuals' achievement strivings under various probabilities for success, revealing that motivation is highest when the probability for success is valued at .5 (Wigfield & Eccles, 1992).

The work by Atkinson was later followed by modern expectancy-value models, which also connects individuals' expectancy-related and task value beliefs to performance, task choice, and persistence. However, modern expectancy-value theories provide more in-depth explorations of the expectancy and value constructs, which are also linked to a broader range of psychological and social factors (Wigfield, Tonks, & Klauda, 2009). One of the most influential modern expectancy-value models was proposed by Eccles and colleagues (1983), whose work was initially focused in the area of math. They aimed to understand gender differences in math-related expectancies and values, as well as how these differences influence course enrollment and college major selections (Wigfield et al., 2009).

In the model by Eccles and colleagues (1983), it is hypothesized that expectations of success and subjective task values directly influence achievement-related performance and choices. The model also outlines that expectancies and values are influenced by perceptions of competence, perceptions of difficulty, goals and self-schemas, and affective memories. These beliefs, goals, and affective memories are influenced by one's perceptions about the attitudes and expectations of others as well as one's own interpretations of previous achievement outcomes. Finally, these perceptions and interpretations are influenced by social and cultural factors, including socializers' (i.e., teachers, parents) beliefs and behaviors, specific achievement aptitudes, prior achievement experiences, and cultural milieu (e.g., gender role stereotypes, cultural stereotypes).

In addition to connecting expectancies and values to a wider array of psychological and social factors, Eccles and colleagues (1983) also provided broader definitions of the expectancy and value constructs than Atkinson's (1957) original model. Eccles and colleagues defined expectancies for success as individuals' beliefs about how well they will perform on an upcoming task. They also explained that expectancies are conceptually different from (yet highly related to) ability beliefs (i.e., assessments of aptitude, comparisons with other students), which are noted in several other achievement motivation models (e.g., self-determination theory).

As mentioned in the introduction section, Eccles and colleagues (1983) conceptualize task values in terms of four major domains: attainment value, intrinsic value, utility value, and cost. Attainment value is defined as the personal significance of performing well on a task. Intrinsic value refers to the inherent enjoyment of a given task, which is similar to the construct of intrinsic motivation that is described by Deci and Ryan (1985). Utility value is defined as how well a task is related to one's current and future goals. Finally, cost is defined as the amount of effort required to succeed, the degree to which an activity leads to lost opportunities, and the negative aspects of engaging in an activity (e.g., performance anxiety).

A number of studies have supported the modern expectancy-value model outlined above, including three major longitudinal studies (Wigfield & Eccles, 2000). The first study followed a sample of fifth through twelfth grade students who completed questionnaires each year over a two-year period, which focused on gender differences in achievement beliefs and values in math and English (Eccles et al., 1983; Meece et al., 1990). The second study involved a sample of sixth grade elementary school students who were followed through the transition to middle school in seventh grade (Eccles et al., 1989; Wigfield, Eccles, Mac Iver, Reuman, & Midgley, 1991). This study focused on how the transition from elementary to middle school affected students' beliefs and values. The third study was conducted over the course of 10 years, which focused on how students' achievement beliefs and values changed throughout the elementary and secondary school years (Eccles et al., 1993; Wigfield et al., 1997). In this study, three cohorts of children were followed from elementary school through high school graduation. The students completed questionnaires related to their ability beliefs, expectancies for success, and subjective task values.

Overall, these studies have shown that ability-related beliefs and subjective values tend to decrease as student progress through school, with notable decreases after the transition to middle school (Eccles et al., 1983, 1989, 1993). Researchers have hypothesized that as children become older, they are better at understanding and interpreting the evaluations of others and also begin to compare themselves more to peers. As a result, children's self-beliefs become more realistic and, thus, decrease over time (Wigfield & Eccles, 2000).

The longitudinal studies mentioned above have also yielded important findings regarding the ways in which expectancies and values are related to task performance and choice. Overall, it has been shown that children's beliefs about their abilities and expectancies for success are the strongest predictors of achievement (i.e., grades). That is, ability beliefs and expectancies for success have been found to predict achievement outcomes more strongly than both previous grades and achievement values (Wigfield & Eccles, 2000).

Subjective task values, on the other hand, are the strongest predictors of academic decision-making behavior (i.e., course plans and enrollment decisions). A study by Parsons, Adler, and Meece (1984) further supports this conclusion. With a sample of 200 eighth-through-tenth grade students, Parsons and colleagues (1984) administered a battery of attitudinal measures (i.e., self-concept ability, subjective task value, perceived task difficulty, and continuing motivation) and assessed the students' math course enrollment decisions each year through high school. Perceived task value emerged as the strongest predictor of students' educational plans and as the significant mediator of sex differences in both subjective educational plans and course enrollment. All in all, the above findings suggest that expectancies for success and subjective task values have distinct, yet complimentary influences on achievement behavior, with expectancies influencing achievement and engagement (present) and subjective values influencing academic decision-making behavior (future).

The above review describes self-efficacy, goal, attribution, self-determination, and expectancy-value theories on motivation. Together they have guided research and practice for the past several decades. The five theories have areas of overlap, yet also offer unique contributions to understanding the factors that drive achievement behavior. Taken together, they reflect the complex and multifaceted nature of the forces that help explain why individuals tackle difficult tasks and pursue academic competency.

Appendix B

Student Survey

Introduction: Thank you for agreeing to take this survey. We are interested in learning more about your experiences in math class. Please choose the answer that best fits for you. No one at home or at school will ever see your answers.

General Questions (5 Items):

1. Are you a male or female?
2. Are you a 5th, 6th, 7th, or 8th grader?
3. What racial/ethnic group do you belong to?
4. Which middle school do you go to?
5. What final grade did you earn in math last year?
6. What grade do you think you will get in math class at the end of this year?

Math Class Engagement (6 Items):

7. I sometimes get into trouble with my teacher during math class.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

8. I sometimes disturb the lesson that is going on in math class.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

9. I try hard to do well in math class.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

10. When I'm in math class, I participate in class discussions.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

11. I pay attention in math class.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

12. When I'm in math class, I listen very carefully.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

Math Class Motivation (13 Items)

13. I think my math class is important.
    a. Completely Disagree
    b. Strongly Disagree
    c. Disagree
    d. Slightly Disagree
    e. Slightly Agree
    f. Agree
    g. Strongly Agree
    h. Completely Agree

14. I know I can learn the material in my math class.
    a. Completely Disagree
    b. Strongly Disagree
    c. Disagree
    d. Slightly Disagree
    e. Slightly Agree
    f. Agree
    g. Strongly Agree
    h. Completely Agree

15. I value my math class.
    a. Completely Disagree
    b. Strongly Disagree
    c. Disagree
    d. Slightly Disagree
    e. Slightly Agree
    f. Agree
    g. Strongly Agree
    h. Completely Agree

16. My math class work requires too much time.
    a. Completely Disagree
    b. Strongly Disagree
    c. Disagree
    d. Slightly Disagree
    e. Slightly Agree
    f. Agree
    g. Strongly Agree
    h. Completely Agree

17. I believe that I can be successful in my math class.
    a. Completely Disagree
    b. Strongly Disagree
    c. Disagree
    d. Slightly Disagree
    e. Slightly Agree
    f. Agree
    g. Strongly Agree
    h. Completely Agree

18. Because of other things that I do, I don't have time to put into my math class.
    a. Completely Disagree
    b. Strongly Disagree
    c. Disagree
    d. Slightly Disagree
    e. Slightly Agree
    f. Agree
    g. Strongly Agree
    h. Completely Agree

19. I think my math class is useful.
    a. Completely Disagree
    b. Strongly Disagree
    c. Disagree
    d. Slightly Disagree
    e. Slightly Agree
    f. Agree
    g. Strongly Agree
    h. Completely Agree

20. I’m unable to put in the time needed to do well in my math class.
    a. Completely Disagree
    b. Strongly Disagree
    c. Disagree
    d. Slightly Disagree
    e. Slightly Agree
    f. Agree
    g. Strongly Agree
    h. Completely Agree

21. I am confident that I can understand the material in my math class.
    a. Completely Disagree
    b. Strongly Disagree
    c. Disagree
    d. Slightly Disagree
    e. Slightly Agree
    f. Agree
    g. Strongly Agree
    h. Completely Agree

22. I have to give up too much to do well in my math class.
    a. Completely Disagree
    b. Strongly Disagree
    c. Disagree
    d. Slightly Disagree
    e. Slightly Agree
    f. Agree
    g. Strongly Agree
    h. Completely Agree

23. I look forward to learning more about math.
    a. Completely Disagree
    b. Strongly Disagree
    c. Disagree
    d. Slightly Disagree
    e. Slightly Agree
    f. Agree
    g. Strongly Agree
    h. Completely Agree

24. I want to have a job that involves math someday.
    a. Completely Disagree
    b. Strongly Disagree
    c. Disagree
    d. Slightly Disagree
    e. Slightly Agree
    f. Agree
    g. Strongly Agree
    h. Completely Agree

25. I want to take more math classes in the future.
    a. Completely Disagree
    b. Strongly Disagree
    c. Disagree
    d. Slightly Disagree
    e. Slightly Agree
    f. Agree
    g. Strongly Agree
    h. Completely Agree

Teacher Care (3 Items)

26. My math teacher likes me.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

27. My math teacher really cares about me.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

28. My math teacher doesn't seem to enjoy having me in class.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

Math Teacher Help (5 Items):

29. My math teacher shows me how to solve problems for myself.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

30. If I can't solve a problem, my math teacher shows me different ways to try to.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true
31. My math teacher doesn't help me, even when I need it.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

32. Even when I run into problems, my math teacher doesn't help me.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

33. My math teacher doesn't seem to know when I need help.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

Parent Help/Support (5 Items):
Please answer the following questions about a parent, guardian, or someone at home who may help you with math.

34. My parent shows me how to solve math problems for myself.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

35. If I can't solve a math problem, my parent shows me different was to try to.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

36. My parent doesn't help me with math, even when I need it.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

37. Even when I run into problems with math, my parent doesn't help me.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

38. My parent doesn't seem to know when I need help in math.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

Peer Help-Seeking Intentions (9 Items):

39. When there is something I don't understand and I cannot figure it out for myself, I ask my friends for help.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

40. When I need help understanding how to do a math problem, I ask my friends.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

Think about a time when you are working on your math problems and you're having some difficulty. Sometimes you might ask your friends for help, and other times you might not. In each of the following situations, tell me how likely you are to ask for help. How likely are you to ask your friends for help when…

41. You don't understand how to do the math problem.
    a. Not at all likely
    b. A little bit likely
    c. Somewhat likely
    d. Likely
    e. Very likely

42. You don't understand the directions.
    a. Not at all likely
    b. A little bit likely
    c. Somewhat likely
    d. Likely
    e. Very likely

43. You need help with something that the teacher already explained how to do.
    a. Not at all likely
    b. A little bit likely
    c. Somewhat likely
    d. Likely
    e. Very likely

44. You are having trouble and the teacher looks busy.
    a. Not at all likely
    b. A little bit likely
    c. Somewhat likely
    d. Likely
    e. Very likely

45. You've done the problem but you're not sure of the answer.
    a. Not at all likely
    b. A little bit likely
    c. Somewhat likely
    d. Likely
    e. Very likely

46. You think you might get a bad grade if you don't get help.
    a. Not at all likely
    b. A little bit likely
    c. Somewhat likely
    d. Likely
    e. Very likely

47. You can't remember something (like a math fact) that you need in order to do the problem.
    a. Not at all likely
    b. A little bit likely
    c. Somewhat likely
    d. Likely
    e. Very likely

Perceptions of Peer Math Commitment (4 Items):

48. My friends like math class a lot.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

49. My friends think math class is boring.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

50. My friends try hard in math class.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

51. Getting good grades in math class is very important to my friends.
    a. Not at all true
    b. A little bit true
    c. Somewhat true
    d. Mostly true
    e. Very true

Appendix C

This appendix includes a de-identified copy of the student survey report that was submitted to the participating school district.

Middle School Student Perceptions of Engagement, Motivation, and Supports in Mathematics (2012-2013)

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We would like to thank all students who participated in the survey as well as all teachers and administrators who helped with survey planning and administration.

Executive Summary

This report details survey results from 1303 fifth, sixth, seventh and eighth grade students who attended a higher-income, suburban school district located in north east New Jersey during the 2012-2013 school year. The student survey was designed to examine middle school student experiences learning mathematics. Included on the survey were questions about math class engagement, math motivation, and math supports from teachers, parents, and peers. The survey was designed, implemented and analyzed by a Rutgers University research team with the assistance of school staff and permission of district administrators. All survey responses contained no names, which helps maintain confidentiality. A brief summary of findings is detailed below, which is followed by a comprehensive report of methods, results, and recommendations.

High Levels of Math Class Engagement

Overall, most students reported high levels of self-perceived engagement. The vast majority reported that they try hard, participate, and pay attention in math class. Very few students reported that they get into trouble or disturb class lessons. Analyses of group differences indicated that seventh grade students reported lower levels of math class engagement than those in other grades; girls reported higher levels of engagement than boys; and White and Asian students reported higher levels of engagement than those in other racial groups.

High Levels of Motivation, but Less Future Interest in Math

Overall, a vast majority of students found math useful and important. Most students also felt capable to do the work. However, approximately one fifth of students indicated that math class is time consuming and interferes with other activities. An even higher number of students (approximately one third to one half) indicated that they did not look forward to taking future math classes or having a future job that involves math. This suggests that students may see their engagement and valuing of math as short term. Analyses of group differences revealed a general trend of higher levels of motivation for younger students than older students. Asian students also tended to report higher levels of math motivation than those in other racial groups.

High Level of Perceived Teacher Support

Overall, most students indicated that they felt as though their math teachers cared about them and enjoyed having them in class. In addition, the majority of students reported that their math teacher helped them when in need. However, approximately one-third to one-half of students reported that their math teacher sometimes did not seem to know when they were in need of help. Younger students tended to report higher levels of teacher support than older students. Analyses also revealed no significant differences among students associated with race.

Higher Levels of Parent Support for Younger Students

Overall, many students indicated that their parent helped them with math at home. Nearly one-fifth of students were an exception to this trend. Unlike their peer, they said their parent did not help them with solving math problems or did not show them alternative ways to solve math problems. Younger students tended to report higher levels of parent support than older students, which may indicate that parents are less equipped to provide math support as curriculum becomes more challenging. With regard to racial groups differences, Asian students reported higher levels of parent support than both White and Hispanic students.

Peer Support

Overall, most students reported that their friends tried hard in math and strive to get good grades. However, approximately one fifth to one quarter also indicated that their friends did not like math class and find math class boring. This suggests that students perceive their peers as disengaged despite their own high levels of self-reported engagement in math. Interestingly, seventh grade students reported the highest level of peer help-seeking behaviors despite reporting the lowest levels of engagement, motivation and teacher support. Conversely, fifth grade students reported the lowest levels of peer help seeking behaviors despite reporting the highest levels of engagement, motivation, teacher support and parent support.

Student Comments

The final question on the survey asked students to indicate, in their own words, what has helped them learn math and what has made learning math harder. Overall, many students indicated that they liked their math teacher and found their approaches (e.g., teaching multiple methods for solving the same problem) helpful. A number of students also indicated that staying after school and receiving more individualized instruction helped them learn. Conversely, some students indicated that large class sizes, disruptive classroom behavior, rushed lessons, frequent assessments, and lack of cohesion between multiple math programs hindered their ability to learn math.

Survey Participants

- A total of 1303 students participated in the survey. Of these students, 52% were females and 48% were males. The sample was comprised of students in the eighth grade (31%), seventh grade (28.5%), sixth grade (31%), and fifth grade (9.5%) who attended two separate middle schools (46%; 54%).

- The student sample was 70% White, 9% African American, 6% Hispanic, 9% Asian, .3% Native American, .8% Pacific Islander, and 5% other. This distribution does not differ substantially from the middle school population described in a 2010-2011 survey conducted by the National Center for Education Statistics, which reported 73% White, 10% African American, 7% Hispanic, 8% Asian/Pacific Islander, .1% Native American, and 1% Other.

Survey Procedures

- District administrators granted the Rutgers research team permission to administer a student survey. The Rutgers Internal Review Board (IRB) also approved the project.

- The survey was designed to measure middle school student experiences learning math. Included on the survey were questions about math class engagement, math motivation, and math supports from teachers, parents, and peers.

- The survey contained 53 questions and was administered via an anonymous online survey tool (Qualtrics) between the dates of May 15, 2013 and June 11, 2013. The survey took approximately 15-20 minutes to complete. While students were asked to report their gender, grade, race, and school, there is no way to link student names with their responses.

- All students in the fifth through eighth grades were invited to participate in the survey. Students were provided with parent/caregiver consent forms to be returned if their parent did not wish for their child to participate. Students were also given the option to decline participation and omit any questions that they did not wish to answer. Due to scheduling issues, fifth grade students in one of the middle schools were unable to participate in the survey.

Description of the Student Survey

Self-Reported Engagement

- The *Math Class Engagement Scale* (6 items) was adapted from its original version to measure how hard students try to do well in math class as well as their level of attention during math class (adapted from Midgley et al., 2000).

Self-Reported Motivation

- Math motivation was measured using the original version of the Expectancy-Value-Cost-Interest Survey, which contains four scales pertaining to separate domains of overall student motivation in math (Hulleman & Barron, 2012; Wigfield & Eccles, 2000).

- The *Expectancy Scale* (3 items) measured how well students expect to learn and perform in math class.

- The *Value Scale* (3 items) measured how much students perceive math as important and useful.

- The *Cost Scale* (4 items) measured how much effort math class requires as well as how math class limits access to other activities.

- The *Future Interest Scale* (3 items) measured how math fits into a student's future plans.

Perceptions of Teacher Support

- Teacher support was measured using two scales (*Teacher Care* and *Teacher Help and Support*) from the Teacher as Social Context Questionnaire (Wellborn, Connell, Skinner, & Pierson, 1988). The items were slightly adapted from their original versions to ask the students questions specifically about their math teachers.

- The *Math Teacher Care Scale* (3 items) measured how much students felt that their math teachers care about them, like them, and enjoy having them in class.

- The *Math Teacher Help and Support Scale* (5 items) measured students' perceptions that their teachers help them with math problems as well as how much their teachers help them to independently solve problems and develop alternative strategies.

Perceptions of Parent Support

- Parent support was measured using the *Parent Help and Support Scale* (5 items) which was adapted from the *Teacher Help and Support Scale* contained on the Teacher as Social Context Questionnaire (Wellborn, Connell, Skinner, & Pierson, 1988). These items measured how much students perceived their parents or other adults at home help them with math problems when they are having difficulty.

Perceptions of Peer Support

- Peer support was measured using two scales (*Peer Help-Seeking* and *Peer Math Commitment*).

- The *Peer Help-Seeking Scale* (9 items) contained selected questions from the Mathematics Learning in the Classroom Questionnaire (Newman, 1990). This scale measured students' willingness to seek help from peers when they are having trouble with math.

- The *Peer Math Commitment Scale* (4 items) was adapted from its original version and measured how much students perceived their friends to enjoy math and put effort into doing well (adapted from Midgley et al., 2000).

Survey Results

Self-Reported Engagement

Math Class Engagement Scale

We want to learn about your math experience in school.	**Not at all true (%)**	**A little bit/ Somewhat true (%)**	**Mostly/ Very true (%)**
I try hard to do well in math class.	**1**	**7**	**92**
When I am in math class, I participate in class discussion.	**1**	**21**	**78**
I pay attention in math class.	**1**	**12**	**87**
When I am in math class, I listen very carefully.	**1**	**16**	**83**
I sometimes get into trouble with my teacher during math class.	**92**	**7**	**1**
I sometimes disturb the lesson that is going on in math class.	**78**	**21**	**1**

The six items related to Math Class Engagement were averaged into a scale (alpha =.77) that ranged from 2 to 5 with a mean of 4.4. Most students reported that they were academically engaged while in math class, particularly when reporting about effort (92%) and attention (87%). Furthermore, very few students (8%) reported that they sometimes get into trouble with their math teacher during class.

Groups	N	Mean	SD	F value	p value	Effect size	Tukey test[1]
All students	1301	4.4	.55				
Grade				6.49	.00	.02	
5th	124	4.50	.50				a
6th	402	4.41	.51				a
7th	371	4.30	.58				b
8th	404	4.44	.55				a
Gender				34.28	.00	.03	
Boys	630	4.3	.61				a
Girls	671	4.5	.47				b
Race				9.11	.00	.03	
White	910	4.43	4.27				a
African American	110	4.22	4.78				b
Hispanic	79	4.29	4.72				a, b
Asian/Pacific Islander	133	4.50	4.39				a
Other	67	4.15	4.70				b

[1]For Tukey test results, groups that do not share the same letter have statistically different scale scores.

There were statistically significant differences among students associated with grade, gender, and race. Fifth grade students reported being the most engaged in math class, while seventh graders reported being less engagement than students in all other grades. Girls reported more math class engagement than boys. Finally, White and Asian students reported more engagement than both African American students and students identifying as Other. It should be noted that all of these differences are considered small, with effect sizes of .03 or less.

Self-Reported Motivation

**Math Class Motivation was measured though examining four domains: Expectancy, Value, Cost, and Future Interest. Results pertaining to these domains are presented individually below.*
(Hulleman & Barron, 2012)

Expectancy Items	Completely/ Strongly disagree (%)	Disagree/ Slightly disagree (%)	Slightly Agree/ Agree (%)	Strongly/ Completely agree (%)
I know I can learn the material in my math class.	1	3	23	73
I believe that I can be successful in my math class.	2	3	19	76
I am confident that I can understand the material in my math class.	1	5	30	64

The three items related to Expectancy were averaged into a scale (alpha=.86) that ranged from 1 to 8 with a mean of 7. Overall, most students *Strongly or Completely Agree* that they have the ability to learn/understand the material and perform well in math class.

Groups	N	Mean	SD	F value	p value	Effect size	Tukey test[1]
All students	1297	6.96	1.15				
Grade				9.80	.00	.02	
5^{th}	124	7.17	.95				a
6^{th}	399	7.07	1.05				a
7^{th}	371	6.70	1.33				b
8^{th}	403	7.03	1.08				a
Gender				13.91	.00	.01	
Boys	630	7.08	1.10				a
Girls	667	6.85	1.18				b
Race				10.5	.00	.03	
White	907	6.99	1.13				a
African American	110	6.70	1.18				a, b
Hispanic	78	6.56	1.20				b
Asian/Pacific Islander	133	7.39	.91				c
Other	67	6.61	1.38				a, b

[1]For Tukey test results, groups that do not share the same letter have statistically different scale scores.

On the Expectancy scale, there were statistically significant differences among students associated with grade, gender, and race. However, the differences were small with effect sizes of .03 or less. Fifth grade students reported the most expectancy to succeed in math class, while seventh graders reported the least expectancy. Boys reported more expectancy to succeed than girls. With regard to racial groups, Asian students reported the most expectancy, while Hispanic students reported the least expectancy.

Value Items	Completely/ Strongly disagree (%)	Disagree/ Slightly disagree (%)	Slightly Agree/ Agree (%)	Strongly/ Completely agree (%)
I think my math class is important.	1	3	25	71
I value my math class.	2	4	39	55
I think my math class is useful.	1	6	28	65

The three items related to Value were averaged into a scale (alpha=.86) that ranged from 1 to 8 with a mean of 6.8. Overall, the majority of students at least *slightly agree* that they think math class is important (96%), value their math class (94%) and think math class is useful (93%).

Groups	N	Mean	SD	F value	p value	Effect size	Tukey test[1]
All students	1297	6.77	1.22				
Grade				9.05	.00	.02	
5th	124	7.03	1.05				a
6th	399	6.93	1.09				a
7th	371	6.54	1.26				b
8th	403	6.74	1.31				a, b
Gender				.39	.53	.00	
Boys	630	6.79	1.30				a
Girls	667	6.75	1.14				a
Race				4.32	.00	.01	
White	907	6.80	1.17				a, b
African American	110	6.57	1.31				a
Hispanic	78	6.55	1.23				a, b
Asian/Pacific Islander	133	7.02	1.25				b
Other	67	6.42	1.43				a

[1]For Tukey test results, groups that do not share the same letter have statistically different scale scores.

On the Value scale, there was no statistically significant difference among students associated with gender. However, there were some significant differences among students based on grade and race. Fifth and sixth grade students valued math class more than seventh grade students. Asian students valued math class the most, with significantly higher value scores than both African American students and those identifying as Other. These effect sizes were small, however, with values of .02 or less.

Cost Items	**Completely/ Strongly disagree (%)**	**Disagree/ Slightly disagree (%)**	**Slightly Agree/ Agree (%)**	**Strongly/ Completely agree (%)**
My math classwork requires too much time.	**35**	**35**	**23**	**7**
Because of other things that I do, I don't have time to put into my math class.	**54**	**28**	**14**	**4**
I'm unable to put in the time needed to do well in my math class.	**61**	**26**	**10**	**3**
I have to give up too much to do well in my math class.	**54**	**29**	**14**	**3**

The four items related to Cost were averaged into a scale (alpha=.83) that ranged from 1 to 8 with a mean of 6.2. Overall, most students *slightly disagree/disagree or completely/strongly disagree* that math class requires too much time and interferes with other activities. However, many students at least *slightly agree* that math class requires too much time (30%), and that they are unable to put in the time needed to do well in math (13%). Many students also indicated that other activities are preventing them from putting time into math class (18%) and that they have to give up too much to do well in math (17%).

Groups	N	Mean	SD	F value	p value	Effect size	Tukey test[1]
All students	1297	6.21	1.47				
Grade				8.53	.00	.02	
5th	124	6.39	1.48				a
6th	399	6.41	1.35				a
7th	371	5.91	1.57				b
8th	403	6.23	1.44				a
Gender				.03	.86	.00	
Boys	630	6.20	1.52				a
Girls	667	6.22	1.42				a
Race				11.47	.00	.03	
White	907	6.25	1.43				a
African American	110	5.70	1.60				b
Hispanic	78	6.00	1.29				a, b
Asian/Pacific Islander	133	6.77	1.48				c
Other	67	5.66	1.53				b

[1]For Tukey test results, groups that do not share the same letter have statistically different scale scores.

On the Cost scale, there were no significant differences among students based on gender. However, there were some statistically significant differences among students based on grade and race. Seventh grade students reported math class to have a higher cost than students in all other grades. With regard to race, African American students and those identifying as Other reported math class to have the highest cost, meaning that math class interferes with other activities and requires a large amount of time and effort. Asian students reported math class to have the lowest cost. All of the above differences were small, however, with effect sizes of .03 or less.

Future Interest Items	**Completely/ Strongly disagree (%)**	**Disagree/ Slightly disagree (%)**	**Slightly Agree/ Agree (%)**	**Strongly/ Completely agree (%)**
I look forward to learning more about math.	**6**	**12**	**40**	**42**
I want to have a job that involves math someday.	**19**	**22**	**37**	**22**
I want to take more math classes in the future.	**11**	**16**	**40**	**33**

The three items related to Future Interest were averaged into a scale (alpha=.85) that ranged from 1 to 8 with a mean of 5.3. Many students *completely disagree, strongly disagree, disagree*, or *slightly disagree* with the statements included on this scale, indicating that many students do not look forward to learning more about math (18%) do not want a job involving math (41%), and do not want to take more math classes in the future (27%).

Groups	N	Mean	SD	F value	p value	Effect size	Tukey test[1]
All students	1297	5.33	1.79				
Grade				5.56	.00	.01	
5th	124	5.48	1.79				a, b
6th	399	5.58	1.70				a
7th	371	5.08	1.85				b
8th	403	5.27	1.80				a, b
Gender				24.93	.00	.02	
Boys	630	5.58	1.78				a
Girls	667	5.09	1.78				b
Race				10.75	.00	.03	
White	907	5.34	1.74				a
African American	110	4.79	1.87				b
Hispanic	78	5.02	1.79				a, b
Asian/Pacific Islander	133	6.13	1.72				c
Other	67	4.95	2.01				a, b

[1]For Tukey test results, groups that do not share the same letter have statistically different scale scores.

On the Future Interest scale, there were statistically significant differences among students associated with grade, gender, and race. Sixth grade students reported the most future interest in math, while seventh grade students reported the least future interest. Boys reported more future interest than girls. Asians reported more future interest in math than any other racial group, and White students reported more future interest than African American students. All group differences are considered small with effect sizes of .03 or less.

Student Perceptions of Teacher Support

******Student Perceptions of teacher support was measured using two scales: Math Teacher Care Scale and Math Teacher Help and Support Scale. Results of each scale are presented individually below.*
(Wellborn, Connell, Skinner, & Pierson, 1988)

Math Teacher Care Scale

We would like to know about your math experiences with your teacher.	Not at all true (%)	A little bit/ Somewhat true (%)	Mostly/ Very true (%)
My math teacher likes me.	**3**	**14**	**83**
My math teacher really cares about me.	**3**	**23**	**74**
My math teacher doesn't seem to enjoy having me in class.	**82**	**13**	**5**

The three items on the Math Teacher Care Scale have been averaged into a scale (alpha=.81) that ranges from 1 to 5 with a mean of 4.3. Overall, most students feel that it is *Mostly* or *Very True* that their math teacher likes them (83%), cares about them (74%), and enjoys having them in class (82%).

Groups	N	Mean	SD	F value	p value	Effect size	Tukey test[1]
All students	1290	4.32	.84				
Grade				14.61	.00	.03	
5th	123	4.51	.71				a
6th	394	4.45	.74				a
7th	371	4.10	.97				b
8th	402	4.34	.84				a
Gender				5.18	.02	.00	
Boys	626	4.26	.84				a
Girls	664	4.37	.83				b
Race				1.73	.14	.01	
White	901	4.34	.82				a
African American	110	4.20	.99				a
Hispanic	78	4.15	.91				a
Asian/Pacific Islander	133	4.39	.77				a
Other	66	4.30	.92				a

[1] For Tukey test results, groups that do not share the same letter have statistically different scale scores.

On the Math Teacher Care scale, there were some significant differences among students associated with grade and gender, but the effect sizes were small with values of .03 or less. Seventh grade students perceived less teacher care than students in the fifth, sixth, and eighth grades. Girls reported higher levels of teacher care than boys. There were no statistically significant differences among students base on race.

Math Teacher Help and Support Scale

We would like to know about your math experience with your teacher.	**Not at all true (%)**	**A little bit/ Somewhat true (%)**	**Mostly/ Very true (%)**
My math teacher shows me how to solve problems for myself.	**3**	**18**	**79**
If I can't solve a problem, my math teacher shows me different ways to try.	**5**	**22**	**73**
Even when I run into problems, my math teacher doesn't help me.	**89**	**10**	**1**
My math teacher doesn't help me, even when I need it.	**84**	**13**	**3**
My math teacher doesn't seem to know when I need help.	**59**	**34**	**7**

The five items on the Math Teacher Help and Support Scale were averaged into a scale (alpha=.79) that ranged from 1 to 5 with a mean of 4.4. Overall, the majority of students reported that their math teacher helps them when in need. However, nearly one-half of students (41%) reported that it is at least *a little bit true* that their math teacher does not seem to know when they are in need of help.

Groups	N	Mean	SD	F value	p value	Effect size	Tukey test[1]
All students	1290	4.37	.71				
Grade				29.4	.00	.06	
5th	123	4.53	.63				a, b
6th	394	4.53	.54				b
7th	371	4.10	.66				c
8th	402	4.40	.71				a
Gender				.00	.99	.00	
Boys	626	4.37	.71				a
Girls	664	4.37	.72				a
Race				2.22	.07	.01	
White	901	4.35	.73				a
African American	110	4.30	.74				a
Hispanic	78	4.35	.73				a
Asian/Pacific Islander	133	4.51	.56				a
Other	66	4.48	.65				a

[1]For Tukey test results, groups that do not share the same letter have statistically different scale scores.

On the Math Teacher Help and Support scale, there were no statistically significant differences among students associated with gender and race. However, there were significant differences based on grade. Fifth and sixth grade students reported feeling the most supported by their math teachers, while seventh grade students reported the least teacher support. All effect sizes are considered small with values of .06 or less.

Student Perceptions of Parent Support

Parent Help and Support Scale

We would like to know about your math experience at home. Please answer the following questions about a parent or adult at home who helps you with math.	**Not at all true (%)**	**A little bit/ Somewhat true (%)**	**Mostly/ Very true (%)**
My parent shows me how to solve math problems for myself.	**17**	**34**	**49**
If I can't solve a math problem, my parent shows me different ways to try.	**18**	**31**	**51**
Even when I run into trouble with math, my parent doesn't help me.	**76**	**18**	**6**
My parent doesn't help me with math, even when I need it.	**69**	**23**	**8**
My parent doesn't seem to know when I need help in math.	**62**	**29**	**9**

The five items on the Parent Help and Support Scale were averaged into a scale (alpha =.82) that ranged from 1 to 5 with a mean of 4. Overall, the majority of students reported that it is at least *a little bit true* that their parent helps them with math. However, nearly one-fifth of students reported that their parent does not help them with solving math problems by themselves (17%) or with showing them alternative ways to solve math problems (18%).

Groups	N	Mean	SD	F value	p value	Effect size	Tukey test[1]
All students	1284	3.97	.94				
Grade				30.72	.00	.07	
5th	123	4.35	.71				a
6th	389	4.21	.84				a
7th	371	3.89	.92				b
8th	401	3.68	1.02				c
Gender				.80	.37	.00	
Boys	623	3.94	.93				a
Girls	661	3.99	.96				a
Race				5.23	.00	.02	
White	898	3.95	.94				a
African American	108	3.95	.98				a, b
Hispanic	78	3.69	1.04				a
Asian/Pacific Islander	132	4.27	.85				b
Other	66	3.93	.92				a, b

[1]For Tukey test results, groups that do not share the same letter have statistically different scale scores.

On the Parent Help and Support scale, there were statistically significant differences among students associated with grade and race, but no significant differences among students associated with gender. Perceived parent support tended to be higher for younger students and lower for older students, with fifth grade students reporting the most parent support and eighth grade students reporting the least parent support. These differences are considered small, however, with an effect size of .07. Asian students reported significantly more parent support than both White and Hispanic students, but these differences are also considered small with an effect size of .02.

Student Perceptions of Peer Support

*****_Student Perceptions of Peer Support was measured using two scales: Peer Math Commitment Scale and Peer Help-Seeking Scale. Results of each scale are presented individually below._
(Newman, 1990)

Peer Math Commitment Scale

We would like to know about your math experience with your friends.	Not at all true (%)	A little bit/ Somewhat true (%)	Mostly/ Very true (%)
My friends like math class a lot.	**16**	**52**	**32**
My friends try hard in math.	**3**	**30**	**67**
Getting good grades is important to my friends.	**2**	**23**	**75**
My friends think math class is boring.	**17**	**56**	**27**

The four items on the Peer Math Commitment Scale were averaged into a scale (alpha =.74) that ranged from 1 to 5 with a mean of 3.5. While most students reported that it is at least *a little bit true* that their friends try hard in math (97%) and strive to get good grades (98%), many also indicated that their friends do not like math class (16%) and find math class boring (27%).

Groups	N	Mean	SD	F value	p value	Effect size	Tukey test[1]
All students	1284	3.49	.85				
Grade				10.91	.00	.03	
5th	123	3.68	.89				a
6th	389	3.63	.87				a
7th	371	3.32	.84				b
8th	401	3.48	.81				a
Gender				.99	.32	.00	
Boys	623	3.47	.89				a
Girls	661	3.52	.82				a
Race				3.55	.01	.01	
White	898	3.51	.83				a, b
African American	108	3.29	.99				a
Hispanic	78	3.48	.78				a, b
Asian/Pacific Islander	132	3.66	.89				b
Other	66	3.34	.89				a, b

[1]For Tukey test results, groups that do not share the same letter have statistically different scale scores.

On the Peer Math Commitment scale, there were statistically significant differences among students associated with grade and race, but no significant differences among students associated with gender. Seventh grade students reported less peer math commitment than students in fifth, sixth, and eighth grades. Asian students reported more peer math commitment than African American students. These differences are considered small, however, with effect sizes of .03 or less.

Peer Help-Seeking Scale

We would like to know about your math experience with your friends.	**Not at all true (%)**	**A little bit/ Somewhat true (%)**	**Mostly/ Very true (%)**
When there is something I don't understand and I cannot figure it out for myself, I ask my friends for help.	**9**	**35**	**56**
When I need help understanding how to do a math problem, I ask my friends.	**11**	**41**	**48**

Think about a time when you are working on your math problems and you're having some difficulty. Sometimes you might ask your friends for help, and other times you might not. In each of the following situations, tell me how likely you are to ask for help. **How likely are you to ask your friends for help when…**	**Not at all likely (%)**	**A little bit/ Somewhat likely (%)**	**Mostly/ Very likely (%)**
You don't understand how to do a math problem?	**16**	**44**	**40**
You don't understand the directions?	**15**	**36**	**49**
You need help with something that the teacher already explained how to do?	**14**	**54**	**42**
You are having trouble and the teacher looks busy?	**14**	**36**	**50**
You think you might get a bad grade if you don't get help?	**20**	**37**	**43**
You can't remember something (like a math fact) that you need in order to do the problem?	**12**	**39**	**49**
You have done the problem but you're not sure of the answer?	**13**	**48**	**39**

The nine items on the Peer Help Seeking Scale were averaged into a scale (alpha =.87) that ranged from 1 to 5 with a mean of 3.2. Between 9% and 20% of students indicated that it is *not at all true* or *not at all likely* that they will ask their friends for help with math. Similar numbers of students (36%-50%) indicated that it was *a little bit/somewhat likely* or *mostly/very likely* that they would ask their friends for help with math.

Groups	N	Mean	SD	F value	p value	Effect size	Tukey test[1]
All students	1284	3.20	.93				
Grade				9.91	.00	.02	
5^{th}	123	2.88	.87				a
6^{th}	389	3.15	.90				b
7^{th}	371	3.38	.91				c
8^{th}	401	3.18	.93				b
Gender				59.89	.00	.05	
Boys	623	3.00	.94				a
Girls	661	3.39	.88				b
Race				2.11	.08	.01	
White	898	3.24	.92				a
African American	108	3.06	.92				a
Hispanic	78	3.21	.84				a
Asian/Pacific Islander	132	3.04	1.07				a
Other	66	3.14	.87				a

[1]For Tukey test results, groups that do not share the same letter have statistically different scale scores.

On the Peer Help-Seeking scale, there were statistically significant differences among students associated with grade and gender, but no significant differences among students associated with race. Fifth grade students were the least likely to seek help in math from peers, and seventh graders were the most likely to seek help from peers. Girls were more likely to report that they seek help from peers than boys. These effect sizes were small, however, with values of .02 or less.

Students' Written Comments on the Survey

The final question on the survey asked students to indicate, in their own words, what has helped them learn math and what has made learning math harder. Selected themes and examples of student responses are presented below.

Factors that *helped* students learn math:

Teacher Support and Instructional Approach
Overall, most students had positive attitudes toward their math teachers. Many believed that they had a teacher who presented class material in a way that was easily understood. A number of students also appreciated that their teachers presented multiple methods for solving problems. A few students commented:

> *The aspect that has helped me learn math has mainly been the support of my teacher. She has always been willing to help and really explained math topics very clearly.*
>
> *My teacher makes it very easy to understand the math problems and she goes over the questions a lot.*
>
> *My teacher has helped me learn math by showing me different techniques to do and complete.*
>
> *What has helped me learn math is the different methods I know that can solve the same problem.*

Despite these positive experiences of learning multiple methods, some students acknowledged that they do not find this approach helpful. One student commented, "What made learning math harder is when my teacher uses different methods of solving a problem and makes us do the problem in every single way because I get confused with the way I was actually doing okay with."

Extra Help Outside of Class Time with Individualized Attention
A number of students indicated that some form of supplemental math instruction outside of regular class time was helpful. Many also specifically referenced that it was helpful to have a tutor or one-on-one teacher attention. Some students commented:

> *What had helped me is that the math teacher of my grade and team is willing to stay a little bit after or before school.*
>
> *I think that coming in for extra help sometimes in S.T.A.R class has helped me get 1 on 1 time to learn a topic I did not fully understand in main class.*
>
> *Today in math class, I was having trouble because I was absent yesterday. My teacher came over and gave me a mini lesson while the rest of the class did the Do Now. It was very helpful…*
>
> *In math sometimes while I'm in class my teacher has helped me but it really helps when my teacher stays after school to be one on one. I feel better that way because if I ever get a bad grade and don't want to show the class I have to stay after school but its ok because no one in my class would make fun of me for staying after school because a lot of people do.*

Factors that *hindered* student learning:

Large Class Sizes and Disruptive Behavior
Overall, many students commented that learning was hindered by large class sizes and/or disruptive behavior by fellow students. Some students commented:

> *Having a big math class has been an obstacle. When I need help and the teacher is busy teaching and helping other students, I feel the teacher should help them first and I end up not getting the help I need.*

> *In math class people who disrupt the class make it harder to learn math. When they're loud, it makes it hard to concentrate on my work.*

> *My math class is always loud it would be better if it was quiet.*

> *I think if there is too much noise and people talking it distracts me and I can get a bad grade for not getting my math done, because of people talking and disturbing me.*

> *Learning in math class is sometimes hard because a few students in class are very disrupting and take the focus of the lesson away.*

Rushed Lessons and Frequent Assessments
There were a number of student comments related to the pace of instruction and amount of tests/quizzes given by teachers. A number of students indicated that the pace of instruction was too fast, leaving them confused and behind. Many students also felt that they were given tests and quizzes too frequently, which left them feeling unprepared. Some students commented:

> *I think that the short time we have has made math harder because the teacher has to try to fit a whole lesson in 42 minutes and sometimes they have to rush to fit everything in on time.*

> *Something that has made math harder for me is having tests on new topics. Sometimes, my teacher has tests on new topics that we had learned almost one day ago.*

> *Making learning math hard is constant quiz/tests because I feel like I don't get enough practice on the topics before there is a quiz or a test.*

Lack of Cohesion Between Regular Math Class and Supplemental Instruction
Some students commented that their supplementary math period was not helpful and increased their confusion due to multiple instructional methods and lack of cohesive subject matter. Students who found the supplementary math class *helpful* often commented that the extra class was highly connected to what was taught in regular math class and helped to solidify new concepts. Some commented:

> *[My extra math class] doesn't do anything but give me more work on top of everything I already have to do and make me more confused since the teachers have different ways of teaching things.*

> *One thing that really made math harder was the fact that I had [two math classes], and in each class we're learning something different.*

Recommendations

- The high reported levels of teacher care and support by all students should be celebrated. Help-seeking should continue to be encouraged and fostered.

- Although most students reported high levels of self-perceived engagement and math self-efficacy, nearly one third of students do not want to take more math classes in the future and almost half of students do not want a job that involves math. This suggests that many students see their engagement and valuing of math as somewhat short term. Therefore, it may be helpful to consider ways to help students learn about exciting careers that draw on math skills. It may also be helpful to further incorporate math class activities/projects that help students experience the everyday relevancy of math, which underlies so much of the physical world (e.g., construction of bridges, prices of videogames, design of sports equipment). In other words, they may benefit from "mathematizing" their surrounds.

- At the same time, there are a number of highly motivated students in the area of math. One third of students *agree* or *completely agree* they want a job that involves math. It will be key to harness the energy and enthusiasm these students bring to math as they transition to high school. It may also be helpful to utilize these students to get their peers more excited about learning math. Further supporting structured, student led activities, such as peer tutoring and math club could encourage students to share their math enthusiasm and knowledge with one another.

- Although most students reported that their friends try hard in math, they also reported that their friends often feel disengaged and bored. Noteworthy was that students did not tend to report their own boredom despite seeing others as bored. Perceptions that peers are bored can impact the assumed "norms" in the classroom, which in turn can impact student behavior. It would be important to educate students that, in fact, most students are motivated and engaged in math. Sharing results of this survey with students could help correct the potential misperception that students are bored in math class.

- Given that 12-20% of students indicated that they *are not at all likely* to ask a friend for help with math and 36-54% indicated that they are *a little bit/somewhat likely,* there may be a divide between one third to one half of students who would turn to a friend for help and those who are less likely to do so. It may be important to actively teach students about how and when to turn to peers for math support. Further teaching students how to engage with one another during collaborative group work in math class and/or after school could enhance these efforts.

- Nearly one fifth of students reported that their parent never helps them solve math problems for themselves or shows them alternative ways to solve problems. This suggests that parents may lack the math skills necessary to support school instruction at home. This is further evidenced by the fact that older students (i.e., those with a more challenging curriculum) tended to report the lowest amount of parent support in math. It may be helpful to provide students, especially those who are older, with structured and consistent math support during afterschool hours.

- Given that many students said disruptive behavior hindered their ability to learn math, further coaching in classroom behavior management may be helpful. More frequent utilization of evidence-based, classroom-wide strategies (e.g., Good Behavior Game, proactive approaches, clear expectations, subtle redirection, peer redirection) might help support teachers in minimizing disruptive behavior while maximizing instruction time.

- Since some students felt that multiple math programming was confusing and counter-productive, it may be beneficial to further coordinate instruction between the various math programs. For example, concepts taught in regular math class could be simultaneously enhanced and made relevant through practical application of the same concepts during supplemental math instruction time. Practical applications should be related to areas of greatest interest to adolescents (e.g., sports, technology, money).

- Overall, there was a slight decline in self-reported engagement and motivation from early grades to later grades. This might be a cohort effect suggesting early middle school cohorts (5^{th} and 6^{th}) are different than later cohorts (7^{th} and 8^{th}). However, it might also reflect a true decrement in engagement, which might then be followed by further declines in high school. Additionally, seventh grade students consistently reported the lowest levels of engagement and motivation in math. Again, this might mean the 7^{th} grade cohort is simply different than the rest of the grades, but it also might indicate that the 7th grade represents a particularly "risky" academic year. If this is the case, further efforts in engaging this grade level might be needed. Varied instructional learning formats, use of novel materials, and cooperative learning strategies have all been shown to increase student engagement. More in-depth inquiry into the transition from 6^{th} to 7^{th} grades may also help identify contributors to the decline in math engagement and motivation.

- In general, Asian students reported the highest levels of math engagement and motivation, followed by White students. African American, Hispanic and Other students report the lowest level of math engagement and they experience the greatest "cost" in completing work (e.g., they don't feel they have enough time, they feel that putting time into math class will interfere with other preferred activities). Given the differences among racial groups, concern is warranted for three subgroups of students: African American, Hispanic and Other (which typically includes mixed race) students. There is concern that the gaps may widen as students progress through high school, and culminate in disparate learning outcomes across groups. Innovative approaches to math programming might be needed to narrow the racial gaps in engagement and motivation. One idea is to implement group-specific math programs for student groups lower on engagement and motivation. Fostering strong supports among peers in these groups may help reduce decrements in motivation/engagement over time.

- Examples of math programs (including group-specific programs) to consider:

    1) A mentoring program that connects college students with female, minority, and low-income middle school students has been associated with higher standardized test scores (Good, Aronson, & Inzlicht, 2003). More specifically, college students encourage at-risk adolescents to overcome stereotype threats in math. This is done through conveying the messages that math intelligence is malleable and academic difficulty can be attributed to the stressful nature of middle school rather than intellectual shortcomings.

    2) Men, Math, and Mission, an intensive summer program, aims to increase math interest and achievement among minority male adolescents. This is done through teaching math concepts through an innovative, project-based curriculum in a supportive environment. The summer sessions are then followed up with math tutoring and mentoring by minority male role models in the community.

    3) The National Science Foundation (NSF)-funded exemplary comprehensive mathematics curricula for middle school students, including the Connected Mathematics Project (CMP), Mathematics in Context (MiC), MathScape, Middle Grades Math Thematics, and the Middle School Mathematics through Applications Project (MMAP). These programs are designed to present math in a realistic context, engage students, motivate learning, support understanding, and ensure retention (NSF.gov).