UNTANGLING THE RELATIONS AMONG HIGH SCHOOL STUDENTS' MOTIVATION, ACHIEVEMENT AND ADVANCED COURSE-TAKING IN MATHEMATICS: USING STRUCTURAL EQUATION MODELING WITH COMPLEX SAMPLES

A dissertation Presented to the
Faculty of the College of Education
University of Houston

In Partial Fulfillment
of the Requirements for the Degree

Doctor of Philosophy

by

Jina Wang

May, 2011

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Abstract

This study adapted the expectancy-value model of achievement motivation theory (Eccles & Wigfield, 1995; Wigfield & Eccles, 2000) to investigate the relationships among students' motivation, achievement and advanced course-taking in mathematics. Students' motivation was represented with educational expectation, self-efficacy, intrinsic and utility task value. A hypothesized conceptual model was constructed and tested using structural equation modeling (SEM). A total sample of 8,976 students, who participated in the Educational Longitudinal Study: 2002 survey at 10^{th} grade then 12^{th} grade, were utilized for the present study. Indicated from the SEM analysis for the all participants, statistically and practically significant positive associations were found between (a) self-efficacy and achievement, (b) self-efficacy and advanced course-taking, (c) intrinsic value and advanced course-taking. Furthermore, the positive mediating qualities of educational expectation for the linkage between math self-efficacy, utility value and outcome variables were also demonstrated.

However, it is inarguable that students are from a heterogeneous group, which justifies making separate estimates for subpopulation. Prior studies have indicated gender, ethnicity, and SES subgroup differences in students' math achievement and math

advanced course-taking (Byrnes, 2003; Byrnes & Takahira, 1993). Therefore, a secondary purpose of the present study was to investigate model differences across gender and four main ethnic groups (Asian, African-American, Hispanic and Caucasian). Primarily, the interrelationship patterns indicated by path coefficients among all the identified factors showed no significant differences in terms of SEM analyses for female and male students. This is in spite of the fact that females reported higher utility value in learning and higher educational expectation than males. The female students also expressed lower math self-efficacy, intrinsic value, and were outperformed in standardized math assessment by male counterparts. Theoretically, the aforementioned results suggested the hypothesized models were equally viable for both male and female students. Conversely, many results emerged indicating the expectancy-value model of achievement motivation theory fits differently across ethnic groups. For example, African-American students reported higher math intrinsic value than Caucasian peers. Furthermore, African-American students differed from Caucasian students in that math intrinsic value was not significantly associated with advanced math course-taking for African-American students. In light of the results from the present study, the repertoire of empirical findings was extended to better understand the expectancy-value model of achievement motivation. Accordingly, potential educational implications including increasing students' math self-efficacy, establishing alignment between intrinsic value and course choice, associating utility value with math subject were discussed to help promote math learning for students across gender and ethnic groups.

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Chapter I: Introduction

Problem Statement

Satisfactory math achievement has been described as a critical filter for career choices, a milestone of the pathway to higher education, and an accelerator for university graduation (Finn, Gerber, & Wang, 2002; Rose & Betts, 2001). In terms of math courses, Algebra II is considered a gateway for advanced math learning and college entrance (Horn & Nunez, 2000; Oakes, Muir, & Joseph, 2000). In particular, Adelman (2006) found students who had Algebra II in high school graduated faster from postsecondary institutions than those students who did not complete Algebra II. As a result, more high schools recommend completing Algebra II to graduate. Courses beyond Algebra II are usually considered advanced math courses. Many studies (Horn & Nunez, 2000; Leow, Marcus, Zanutto, & Boruch, 2004) have supported that students perform better on standardized math tests when they take more advanced level courses. Furthermore, Rose and Betts's (2001) report demonstrated that students who took more advanced math courses in high school tended to have significantly higher earnings 10 years after graduation. This finding not only indicates a robust correlation but implies causation because their analytic models have controlled many potential contributing factors from students, teachers, parents, and schools with the nationally representative data: High School and Beyond Survey. Furthermore, the positive effect of advanced math course-taking on earnings can be explained by its positive effect on students' ultimate level of education and indirect cognitive effect on students' logic reasoning and learning skills acquired from learning advanced math.

Math is the foundation for many high-demanding careers: natural sciences, engineering, and computer science (Kadijevich, 1998). In fact, math is even associated with development in social sciences, including education, communication and political sciences (Kadijevich, 1998). At present, the nation is suffering a major shortage of domestic students undertaking math-related professions, and largely resorting to overseas resources is neither a long-term strategy nor a solution to stimulating domestic employment (U. S. Department of Education, n. d., p. 3). At the same time, American students' math performance lags behind international average (OECD, 2010). Likewise, students' motivation in learning math decreases along elementary, middle schools to high schools (Gottfried, Marcoulides, Gottfried, Oliver & Guerin, 2007; Marcoulides, Gottfried, Gottfried, Oliver & Guerin, 2008; Spinath & Steinmayr, 2008). Regrettably, many American students with potential for high math achievement opt out of math educational or career path.

To prepare students for math-related careers, students need to choose and complete math-related majors in colleges. This mission is integral to prepare American students for the increasingly globalized market, and to stay ahead in the world competition. However, many high school students are under-prepared, and have to take remedial math courses in college (Parsad & Lewis, 2003), which often becomes the first major academic and psychological barrier against students' odds of choosing and staying in math-related majors in college. To ensure the supply of students selecting math as their majors and careers, high school is an especially critical period along this pipeline when students are making the choice of whether to stay in the math stream. As a consequence, encouraging student enrollment in advanced math courses to enhance achievement becomes an enduring mission for educators, researchers, and policy makers**.**

Many studies show students' advanced math course-taking can be improved by boosting students' academic motivation. Among a wide variety of motivation theories, the expectancy-value model of achievement motivation theory promoted by Wigfield and Eccles (Eccles, 1983; Eccles & Wigfield, 1995; Wigfield & Eccles, 2000; 2002) is a widely accepted and applied framework to study students' academic motivation and achievement. Therefore, the primary objective of the present study was to investigate high school students' math achievement and advanced math course-taking mainly within the framework of expectancy-value model of achievement motivation theory.

Scope of the Study

The scope of the present study will only include students' level factors, especially whether students' motivational beliefs lead to math outcomes. Nevertheless, it is necessary to be aware that factors predicting students' math achievement and advanced math course-taking are multi-dimensional. For instance, at the level of school, both theory and research indicate that schools with higher SES tend to have more resources, and students from schools requiring more mathematics courses for graduation are more likely to take advanced math courses than students from schools with lower requirements (Wang, 2010). In turn, those school factors can be translated into higher math achievement (Lee & Smith, 1997; Smith & Meier, 1995). At the level of parents, high school students' advanced math course-taking and math achievement are also significantly influenced by parents' education and goal structure (Byrnes, 2003; Gutman, 2006). Simply speaking, students with more opportunity to learn tend to obtain higher achievement. Oftentimes, factors such as motivational beliefs could be more easily modified by educators than some other factors such as school SES and parents' education. Other times, school reform such as course requirements, parents' goals and expectations may have a greater impact on promoting achievement, and on creating a high quality learning environment; while students themselves may be prone to resist change in motivational beliefs (Bong, 2001, 2002). Overall, effort has been put forth from many factors emanated from students, parents, teachers and school dimensions to explain students' math achievement. Among all the explorations to explain the factors, motivation serves as one of the major categories. The expectancy-value model of achievement motivation theory is a particularly widely-accepted and -applied framework for research and practice (Eccles, Vida, & Baber, 2004; Wigfield & Eccles, 2002). The scope of the current study is to explain students' advanced math course-taking and math achievement in terms of students' motivation beliefs within expectancy-value model of achievement motivation theory.

Chapter II: Literature Review

The literature review chapter begins by introducing the definitions and empirical research on motivation, achievement motivation and expectancy-value framework from which three main motivation terms of educational expectation, self-efficacy, and task value are extracted. Then the association of the two outcome variables, math achievement and advanced math course-taking, is clarified. The main part of this chapter focuses on reviewing educational expectation, self-efficacy, and task value in terms of their respective relationships with math achievement and advanced math course-taking.

Motivation is an explanatory concept for people's thoughts and behavior (Graham & Weiner, 1996). Pintrich and Schunk (2002) define motivation as a cognitive process of instigating and sustaining behavior to attain individual's goals. As a psychological state construct, motivation can be explained by concepts in expectancy-value, intrinsic-extrinsic motivation, self-efficacy, attribution, goal-orientations, and self-determination theory, which motivate students to use strategies to regulate cognition and behavior (Wolters, 1999, 2003). Achievement motivation in educational research is often considered an attitude or belief for explaining the incentive when students approach an academic task (Eccles, Wong & Peck, 2006). As reviewed by Wigfield and Eccles (2002), a large body of literature (Bong, 2001; Eccles, et al., 2006; Lent et al., 2001; Pintrich, 1990; Köller, Baumert & Schnabel, 2001; Usher & Pajares, 2009; Wigfield & Eccles, 2000) has documented achievement motivation as an essential factor for students' academic success. Among a variety of achievement motivation theories, the expectancy-value model has gained great popularity from the rigorous research explicating student achievement and academic choice (Eccles et al., 2006; Wigfield & Eccles, 2000).

Expectancy-Value Framework

The Expectancy-value framework is congruent with social cognitive theory (Bandura, 1993), which emphasizes interaction among person, behavior and environment. As the name suggests, the expectancy-value model (Eccles, 1983; Wigfield & Eccles, 2000, 2002) consists of two main motivational constructs: expectancies for success, and perceived value of engaging in a task. The expectancy portion of the expectancy-value model indicates some overlap~~s~~ with the self-efficacy model; while the value portion places great emphasis on contextual influences on students' motivation. The expectancy–value model of achievement motivation (Wigfield & Eccles, 2000; Schunk, 2004) indicates that both expectancy and task value influence achievement behaviors: persistence, choice, and performance. In addition, cultural milieu (e.g., sex-role structure, economic system) and past events (e.g., students' prior achievement) influence students' task-specific perceptions, which in turn, affect task value. Collectively, the expectancy-value model represents a valuable framework to refine achievement motivation theory by incorporating additional motivational concepts. In the present study, attention is directed to three of the most proximal components mainly drawn from the expectancy-value framework: educational expectation, self-efficacy, and task value.

Math Achievement and Advanced Math Course-Taking

As mentioned above, the main part of the literature review focuses on reviewing educational expectation, self-efficacy, and task value in terms of their respective relationships with math outcomes. Before going into details for each motivational component, it is worth understanding the association between the two outcome variables identified in the present study: math achievement and advanced math course-taking. Earlier studies have consistently stressed a positive relation between advanced math course-taking and math achievement for high school students (Lee, Burkam, Chow-Hoy, Smerdon & Geverdt, 1998; Jones, Davenport, Bryson, Berkhus & Zwick, 1986). More convincingly than prior studies, Leow et al. (2004) investigated the effects of advanced course-taking on math achievement using propensity score analyses with the data from the Third International Mathematics and Science Study (TIMSS). They found that students taking more advanced math courses had higher math achievement on standardized math tests. Their study addressed selection biases by matching 51 background variables for both treatment and control group students. Therefore, their study expressed fair confidence regarding the positive causal inference of advanced math course-taking to math achievement. However, there is a lack of study addressing the relation between advanced math course-taking and math achievement while controlling for student motivation and educational expectation factors (Leow et al., 2004). Overall, the relationship between advanced math course-taking and achievement can be reciprocal; but in the present study, advanced math course-taking serves as the predictor toward math achievement as consistent with previous research (Leow et al., 2004).

Educational Expectation

Educational expectation refers to the educational level students themselves are expected to achieve, which involves clear assessment based on ability, past performance, and ambition (Morgan, 1998). In other words, students' educational expectation conveys students' overall self-perception in educational possibility and opportunity they may obtain. For example, one student expects to graduate from a four-year college, and another student expects to graduate from a two-year associate college. Underlying the expectancy-value model of achievement motivation, educational expectation reveals close relations with self-efficacy and value components. These links are delineated in the following self-efficacy and task value sections. In this section, empirical studies are reviewed tapping into the associations of educational expectation with math achievement, and with advanced math course-taking.

Educational expectation and math achievement. It has been increasingly recognized that educational expectation is considered a significant intervening variable and accurate indicator of future academic achievement (Andres, Adamuti-Trache, Yoon, Pidgeon & Thomsen, 2007; Morgan, 1998). Additionally, the positive influence of educational expectation on math achievement may be explained by its positive associations with higher attendance of postsecondary education (Andres et al., 2007; Looker, 1997), and by higher engagement of students in academic activities (Longden, 2006). For instance, Andres et al. (2007) conducted a ten-year span longitudinal study with 1,055 high school graduates. In this study, educational expectation was measured by a five-category scale in 1989, and a seven-category scale in 1993 and 1998, ranging from "Grade 12 graduation" to "professional or graduate degree." They found 62% of students actualized their educational expectation when they expected to obtain a Bachelor's degree; and 82% of students actualized their educational expectation when they expected not getting a Bachelor's degree.

However, utilizing the Educational Longitudinal Study: 2002 (ELS: 2002) dataset, Carpenter (2008) failed to find students' educational expectation a significant predictor towards math achievement for 3,200 12^{th} grade students with at least one immigrant parent, no matter if they were Latino or non-Latino. Interestingly, he found a significant positive relation between students' educational expectation and parents' time in the United States. For that reason, the relation between educational expectation and math achievement for students with American-born parents may be different from students with immigrant parents.

Educational expectation and advanced math course-taking. Few studies have investigated the link between educational expectation and advanced math course-taking. Ma (2001), however, found that students with higher career aspiration ("future expectation" in the original article) were more likely to take advanced math courses, and this aspiration was independent from teacher and peer effects. Recently, Gonzalez's (2007) dissertation investigated 2,440 Latino participants in educational expectation from ELS: 2002 samples. He found Latino students' expectations regarding obtaining school education at both 10th grade and 12th grade were positively associated with the highest level of math courses students took. Likewise, Dalton, Ingels, Downing, and Bozick's (2007) report examined three high school graduating classes surveyed by the National Center for Education Statistics (NCES) in 1982 (the High School and Beyond Longitudinal Study), 1988 (the National Education Longitudinal Study), and 2004 (the Education Longitudinal Study). They found that students' educational expectation of at least earning Bachelor's degree had a significant positive effect on completing pre-calculus or calculus courses.

In summary, regarding the effects of educational expectation on math achievements and advanced math course-taking, the present study may further existing literature in two ways. First, as reviewed above, related research on special populations such as Latino in comparison with Caucasian students have been tapped into with ELS: 2002 dataset. However, the effects of educational expectation on math outcomes for Asian and African-American students have not yet been studied. Therefore, the present study paid a particular interest to the findings regarding those two under-researched ethnic groups. Second, it is noted from the above review that much more prior studies have examined students' educational or career aspiration than students' expectation. Sometimes, the author (Ma, 2001) even actually meant "aspiration" while using the term "expectation". Usually, educational aspiration refers to what student wants to achieve disregard the current situation; while educational expectation, as in the present study, refers to what student expects to achieve based on their reasonable estimation from their current status (Adams & Wu, 2002; Ingels, Pratt, Rogers, Seigel, Stutts, & Owings, 2004). Therefore, whether results for educational expectation are consistent with significant positive findings from previous studies on career or educational aspirations (Rottinghaus, Lindley, Green, & Borgen, 2002; Tang, Pan, & Newmeyer, 2008) can be an interesting additional finding for the present study.

Self-Efficacy

Academic self-efficacy can be defined as an individual's judgment or perception of his or her capabilities to perform academic tasks successfully (Bandura, 1997). For example, general self-efficacy can be measured by students' confidence levels, or their beliefs about whether they can do an excellent job on learning materials. Accordingly, math self-efficacy, sometimes conceptualized as efficacy expectancy in math (Wigfield & Eccles, 2000), refers to an individual's judgment, belief or perception of his or her capabilities to solve math problems or do well in math class. For example, math self-efficacy can be measured by students' confidence levels when asked whether they can do an excellent job on math tests. Students with high self-efficacy beliefs usually view difficult tasks as challenges, remain committed to their goals, and increase their efforts when faced with failure (Wigfield & Eccles, 2002). As such, their perseverance typically results in performance accomplishments (Pajares, 1996; Pintrich & De Groot, 1990; Zimmerman, Bandura, & Martinez-Pons, 1992). In contrast, individuals who have low self-efficacy focus on their weaknesses and often easily give up. Self-efficacy has also been conceptualized, closely related with, or fitted into some other motivation terms, such as attribution style (Pintrich, 1990), control beliefs (Schunk & Zimmerman, 2006) or competency beliefs (Crombie et al., 2005).

Self-efficacy and math achievement. The positive association between self-efficacy and student achievement has been well researched and documented (Bong, 2001; Stevens et al., 2007; Tang et al., 2008; Wigfield & Eccles, 2000; Usher & Pajares, 2009). For instance, with 438 participants from 13 to 16 years old, Stevens et al. (2007) revealed that 18% of variance in students' performance on the standardized math achievement test was explained by math self-efficacy. A little earlier, Crombie et al. (2005) examined the influence of 540 ninth grade students' self-efficacy beliefs in math (labeled "competency beliefs" in the original article) towards math achievement. Using structural equation modeling, this study demonstrated students' self-efficacy in math was a significant predictor for final math grades.

More recently, Long, Monoi, Harper, Knoblauch, and Murphy (2007) investigated the predictive power of self-efficacy with hierarchical regression analysis on 255 eighth grade and 159 ninth grade students' math achievement. The majority of participants in this study were African-American students. Self-efficacy was measured by one composite score collapsed from scale scores of self-efficacy in math, science, reading and history. The math scale score was compiled from three items assessing students' ability to perform well in a math course, think through a math problem, and solve a math problem. Long et al.'s (2007) study found that students in both grades reported moderate level of self-efficacy, and their self-efficacy contributed to achievement at both eighth and ninth grade levels, although students' average achievement score was much lower in the ninth grade than that in the eighth grade.

Furthermore, Bong (2002) assessed subject-, task-, and problem-specific self-efficacy in math with 202 female high school students. Subject-specific and task-specific self-efficacy items were differentiated by removing all specifics (e.g. figures, vocabulary, etc.) from subject-specific items. For example, "I am certain I can understand the ideas taught in math class." was an example of subject-specific self-efficacy item, while "how confident are you that you can successfully solve equations containing square roots." was an example of task-specific self-efficacy item. In contrast, "how confident are you that you can successfully solve specific equations: $4x^2 + 5x - 2 = 0$?" was an example of problem-specific self-efficacy item. Bong (2002) found that students' math achievement was predicted only by self-efficacy in mathematics, while not self-efficacy in English. This finding reiterated the importance of course (math, reading, English, or science) specific measurement of self-efficacy regardless of task-, or problem-specific self-efficacy, while challenged the differential role between self-efficacy measured by concrete contents and by general self-perception.

Utilizing ELS: 2002 data, Griffin's (2008) dissertation found that math-related self-efficacy ("self-confidence" in original dissertation) was positively associated with standardized math achievement scores by means of multiple regression analyses. Therefore, the present study is expected to detect a positive link between self-efficacy and math achievement.

Self-efficacy and advanced math course-taking. Social cognitive theory (Bandura, 1977, 1993, 1997) suggests that self-efficacy beliefs powerfully influence the choices people make. Researchers in motivation have made great efforts in searching avenues of solutions (e.g. self-efficacy, task value, general control, etc.) to promote students' math enrollment. Some earlier studies by Eccles and her colleagues have demonstrated that academic self-efficacy predicted educational course choices and career choices for middle and high school students. For instance, Meece, Wigfield, and Eccles (1990) investigated the influence of students' math self-efficacy ("math ability perceptions" in the original article) on course enrollment intention with a sample of 250 seventh to ninth grade students. Their study supported their hypothesis of positive influence. More recently, Lent et al. (2001) and Stevens et al. (2004) examined the relationship between math self-efficacy and math enrollment intention with a sample of undergraduate students and high school students. Similarly, both found positive associations between math self-efficacy and intentions for advanced math course-taking with path analyses. Later, Stevens et al. (2007) further evaluated two models, which linked self-efficacy and enrollment intentions on 438 eighth to ninth grade students. Both models supported a positive effect of self-efficacy on predicting students' enrollment intentions.

However, research findings are not always consistent. For instance, Özyürek (2005) indicated that math-related self-efficacy failed to predict math-weighted major preferences using a sample of 590 high school students. More importantly, all the aforementioned work did not investigate students' actual math course enrollment, assuming high enrollment intention leads to high actual course-taking. No existing study, by searching PsycINFO database with key words "self-efficacy" and "math/ mathematics," has investigated the relationship between self-efficacy and high school math course-taking, which encourages my investigation in this matter.

Self-efficacy and educational expectation. Theoretically, self-efficacy and educational expectation share some qualities because both imply students' self-evaluation based on their past performance or abilities. Nevertheless, these two concepts or latent factors are usually measured differently because self-efficacy focuses on perceptions of successfully completing a specific academic task, while educational expectation focuses on overall educational attainment, as the case in the present study. In addition, self-efficacy and educational expectation empirically present different relationships between subject-specific motivation and outcome variables. This standpoint is being unraveled along the following sections of this Chapter.

Only a small number of studies have illustrated that higher academic self-efficacy leads to higher educational expectation. For instance, Trusty (2000) utilized data from the National Education Longitudinal Study of 1988 to examine students' educational expectation from eighth grade to two years after high school. He found students' general self-efficacy in learning and education, measured at eighth grade, had a positive relationship with their expectations of earning "at least a Bachelor's degree" two years after high school, although the percentage of high expectation students decreased along the six years.

Contradictorily, other research found that college students' self-efficacy was negatively related to short-term educational expectation (Vancouver & Kendall, 2006). Similarly, Flores, Navarro and DeWitz (2008) did not find a significant relationship between general self-efficacy in learning at college and educational expectation with 89 Mexican American high school senior students. Overall, research for the effects of math self-efficacy on expectation in educational context is insufficient and inconclusive. More studies have been documented associated with educational aspiration. As explained earlier, educational expectation is a different but closely related concept with educational aspiration. For instance, career self-efficacy is affirmed to make independent contributions towards explaining college students' level of educational aspiration (Rottinghau et al., 2002; Tang et al., 2008).

To conclude, much of the prior research has documented positive associations of self-efficacy with achievement, and with enrollment intention in math. Subsequently, the present study may further the literature in the following ways in regards to the links to self-efficacy. First, instead of enrollment intention, the actual high school enrollment by 12^{th} grade was examined. Second, the different predictive power of math self-efficacy to achievement and advanced course-taking was assessed. In other words, whether self-efficacy is a better predictor for achievement or advanced course-taking can be determined. Third, the present study not only made inquiries about the links between self-efficacy and achievement/course-taking, but also considered the associations between self-efficacy and educational expectation, between educational expectation and achievement/ course-taking, as reviewed in the previous section. Therefore, the mediator effects of educational expectation can be determined.

Task Value

Task value refers to the perceived importance of the task, or the reason why one chooses to engage in the task (Eccles, 1983; Wigfield & Eccles, 2002). As one major component of expectancy-value theory, task value can be defined within a specific subject, such as task value in math and task value in reading (Wigfield & Eccles, 2000). Further, task value in math can be classified with “intrinsic value”, “utility value”, or “attainment value”, which, respectively, refers to intrinsic enjoyment, perceived usefulness, and personal importance of accomplishing a math-related task (Wigfield & Eccles, 2000). To efficiently review related research, it is necessary to clarify four issues regarding the definition of task value. First, many empirical studies (Bong, 2001; Köller et al., 2001; Long et al., 2007) use composite task value without differentiating intrinsic value from utility value, although some other researchers find inconsistent effects for intrinsic value and utility value. Therefore, in the present study, task value refers to the composite factor unless specified otherwise. Second, although not equivalent, some researchers (Ainley et al., 2002; Renninger, 2000) use “intrinsic interest” and “utility interest” as the similar operationalization of task value. Specifically, the wordings for items measuring interest are almost identical with items measuring task value. In those cases, intrinsic value and utility value are considered analogous to intrinsic and utility interest. Third, in the present study, the literature review does not organize intrinsic value and utility value under different subheadings because most prior studies use composite task value instead of specifying intrinsic or utility value. Fourth, as Durik, Vida, and

Eccles (2006) suggest, the present study also merges attainment value into utility value. Intuitively and empirically, higher task value should lead to more focused attention, choices, persistent effort, increased cognitive and affective functioning, so as to higher achievement (Ainley et al., 2002; Wigfield & Eccles, 2000).

Task value and math achievement. Based on expectancy-value theory, task value influences choice, cognitive strategy use, effort, then in turn should influence achievement (Wigfield & Eccles, 2000). Empirically, past research has yielded a great deal of findings on the relationship between task value and achievement (Bong, 2001; Lent et al., 2001; Long et al., 2007; Malka & Convington, 2005; Wigfield & Eccles, 2000). In essence, task value was found strongly related to, and considered an essential factor for students' academic achievement (Lent, et al., 2001; Wigfield & Eccles, 2000), although some researchers pointed out the association was weaker than that between task value and choice (Bong, 2001). Task value was also more explicitly reported making independent and substantial contributions to explain high school students' achievement (Köller et al., 2001), as well as college students' level of education (Tang et al., 2008). More specifically, intrinsic academic task value was reported as a good predictor for academic achievement (Bong, 2001; Wigfield & Eccles, 2000).

In terms of task value in math, it was found that 10th graders' math task value had a direct positive effect on achievement in upper secondary school (Köller et al., 2001). Recently, Malka and Convington (2005) acknowledged that students' achievement increased when their understandings of utility value of accomplishing math task was encouraged. However, more recently, Long et al. (2007) found task value emerged as a significant negative contributor to achievement in high school. Task value was measured by one composite score collapsed from scale scores of task value in math, science, reading, and history. Each scale score was compiled from two items in which students identified their levels of task value and importance for each domain.

Utilizing ELS: 2002 data, Griffin's (2008) dissertation found that math intrinsic value ("attitude toward math" in the original dissertation) was negatively associated with standardized math achievement scores. As stated by the author, this result was not supported by previous research. Different from the present study, his study included both math intrinsic value items and math self-concept items in the composite variable of "math attitude". In addition, different methods of dealing with missing values were used. For the abovementioned reasons, reinvestigation of the link between task value and math achievement with ELS: 2002 dataset is necessary.

Task value and advanced math course-taking. Much research indicates that task value is a direct and strong predictor for course-taking choices (Bong, 2001; Eccles et al., 2004; Ercikan, McCreith & Lapointe, 2005). Utilizing a sample of 5,807 12th grade American students from the TIMSS: 1995 dataset, Ercikan et al. (2005) found that students' task value toward math was the strongest predictor for advanced math course enrollment. Specifically, Eccles et al.'s (2004) study selected 528 participants from a longitudinal study, the Michigan Study of Adolescent Life Transitions (MSALT: 1983), and the utility value was measured by a composite score of importance of learning math and English. In their study, students' utility value reported at sixth grade was found showing independent and considerable positive effects on advanced math course enrollment in 10th grade. Furthermore, previous research demonstrated that intrinsic academic task value was a better predictor of course-taking choices than self-efficacy

(Bong, 2001; Wigfield & Eccles, 2000). As another example, Wigfield and Eccles (2002) revealed that children with higher math-related task value had statistically significant associations with students' choice of taking higher level and more math courses. Nevertheless, majority value-related studies only supported positive links to students' intentions of course enrollment (e.g. Köller et al., 2001). Ma (2001) analyzed a national six-year longitudinal dataset with a total sample of 3,116 seventh to 12th grade students. He found math task value ("attitude towards math" in the original article) was the strongest factor affecting participation in advanced mathematics. Contradictorily, Crombie et al.'s (2005) study found that utility value predicted enrollment intentions, while intrinsic value did not demonstrate a statistically significant positive relationship with enrollment intentions.

Task value and educational expectation. Many studies have revealed a significantly positive link between career aspiration and career task value (Tang et al., 2008), as well as task value defined from personality aspect (Rottinghaus et al., 2002). However, far less research focuses on scrutinizing the effect of task value on educational expectation. Thus, the relation between task value and educational expectation need further investigation as recommended by Schunk and Zimmerman (2004).

To conclude, task value is recognized as a strong and direct predictor for course choices. Nevertheless, the majority of studies have investigated the effect of task value on students' intentions of advanced math course-taking, assuming students' high intention leads to high actual course enrollment later on. The present study may augment the extant literature by examining the actual math course-taking two years after the students' reported task value. Additionally, mixed results regarding the associations between students' task value and math outcomes also warrant a constructive meaning of reinvestigating links towards task value with large-scale complex samples. Lastly, the link between task value and educational expectation is basically under-researched. Hence, the present study can provide an additional piece of empirical evidence for better understanding the construct of education expectation in the motivation field.

Group Differences in Expectancy-Value Model

Students' math achievement and math advanced course-taking vary markedly across demographic groups. There is an abundance of research (e.g. Dalton et al., 2007; Eccles et al., 2006; Köller et al., 2001; Trusty, 2000) that has delved into gender, ethnicity and SES group difference topics. In lieu of the group difference issue serving as the secondary purpose of the present study, only prior studies considered close to the present study or expectancy-value model are reviewed. Specifically, group differences in mean-level differences are mentioned. Then, articles studying the different relationships covered by expectancy-value model are reviewed. Lastly, studies investigating the aforementioned different relationships using ELS: 2002 dataset are reviewed.

Gender. A long history of research (e.g. Byrnes & Takahira, 1993; Catsambis, 1994; Köller et al., 2001) has shown that boys tend to demonstrate higher value in math, higher math achievement, and opt for advanced math courses than girls. Further, Trusty (2000) used logistic regression models to examine the gender difference toward educational expectation with 1,201 female and 1,064 male students. Self-efficacy seemed more important for females' educational expectation than males', although significant positive relations were found for both gender. Specifically, he found one unit increase on self-efficacy led to 58% and 40% increase on the probability of keeping high educational expectation for female and male students, respectively.

Regarding research using ELS: 2002 dataset, Griffin's (2008) dissertation found that female students were more likely to have lower math achievements than male peers. However, on Dalton et al.'s (2007) report, high school senior students in 1982, 1992, and 2004 were compared with each other in terms of gender differences in math achievement and advanced math course-taking. They found students in 2004 had closed gender gaps; female students seemed to take as many as, and even slightly more advanced math course than male counterparts. Therefore, in the present study, gender difference in math achievement, while not in advanced math course-taking are expected. However, different from Leow et al.'s (2004) findings, the above findings indirectly failed to support the positive link between advanced math course taking and math achievement. The reasons why gender difference is worth a revisit are due in part to examine the relation between advanced math course-taking and math achievement, and in part due to necessary exploration of gender difference in motivation predictors (Trusty, 2000).

Ethnicity. In contrast with gender disparity in math, the magnitude of ethnic disparity does not seem ameliorated through time. Since minority groups, particularly African-American and Hispanic students, have indicated lower academic achievements than Caucasian and Asian peers, many studies have sought to explain the ethnic differences, mainly differential effects between Caucasian students and respective minority groups, from all facets of students' life, including the perspective of achievement motivation (Byrnes, 2003; Byrnes & Wasik, 2009; Eccles et al., 2006; Osborne, 2001). To gain insights into ethnic differences in 12th grade math achievement, Byrnes (2003) did a secondary analysis with the National Assessment of Educational Progress dataset. He found math motivation (including items reflecting students' self-efficacy, intrinsic and utility task value) was an important factor contributing to math achievement and course-taking gaps between Caucasian and African-American/Hispanic students.

Among research using ELS: 2002 dataset, Griffin's (2008) study pointed out that African-American students tended to have lower math achievements than other ethnic groups. Dalton et al. (2007) reported that Asian graduates widened their advantage over other groups in completing precalculus and calculus. They also found the gap in advanced math course-taking between African-American and Caucasian students were as wide as before. Furthermore, Gonzalez (2007) found that different from Caucasian students, the predicted probability of choosing four-year college had a negative interaction effect on student educational expectation for Hispanic students. As described above, issues surrounding ethnic differences has been fascinated many researchers. The links among motivation predictors and math outcomes have been explored across different ethnic groups. For the present study, emphases were put on the overall fit for the hypothesized model, and the mediating factor played by educational expectation, in particular, for under-researched African-American and Asian students in comparison with Caucasian students.

Social economic status (SES). Bearing a resemblance with ethnic disparity, SES inequalities exhibit consistent patterns across most studies. Prior research, usually using SES as a control variable, have concluded that higher SES students are more likely to enroll in advanced math courses and have higher math achievement (Byrnes, 2003; Horn

& Nunez, 2000; Van de gaer, Van Landeghem, Pustjens, Van Damme & De Munter, 2007). Specifically, Horn and Nunez (2000) conducted a longitudinal study on eighth graders utilizing the National Education Longitudinal Study of 1988/1994 large scale dataset. They found family SES background played a vital role in students' completion of Algebra courses at eighth grade, course-taking beyond Algebra II at high school, and 4-year college enrollment. Furthermore, Byrnes (2003) revealed that SES presented as a major factor for the achievement discrepancies among ethnic groups.

In terms of motivation constructs, Trusty (2000) indicated that SES had a significant effect on students' expectation. Regarding research using ELS: 2002 dataset, the lowest and second SES quartiles were found negatively associated with math achievement (Griffin, 2008), and the highest SES quartile group widened their advantage over other groups in completing precalculus and calculus (Dalton et al., 2007). In Leek's (2009) dissertation, he found student expectation was particularly important for low SES students in alternative program and schools. Although without a thorough literature review, a large amount of research can be found supporting the significant positive relationships between SES and students' motivation predictors, and academic outcomes. In this sense, SES is also served as a control variable in the present study, as it was the cases in many prior studies.

In summary, with decades of continuous endeavor to flatten group inequality, gender gap in math achievement and advanced math course-taking seems ameliorated at least in terms of secondary school education. Regrettably, ethnic and SES gaps seem exacerbated. Indeed, the above research findings have invoked two furthering research perspectives for the present study. First, gender and ethnic differences in the associations between advanced math course-taking and math achievement need further investigation. Second, patterns of gender and ethnic differences in terms of the links among self-efficacy, task value, and educational expectation remain open questions. Third, whether there are differential roles of SES across gender and ethnic groups worth further examination.

Hypothesized Model and Research Questions

To address the purpose of the present study, a hypothesized model was created based on the literature reviewed above. Specifically, the model examined the following questions, reflecting the concept map demonstrated on Figure 1:

1. Does students' math self-efficacy in 10^{th} grade predict their math achievement and advanced math course-taking in 12^{th} grade?
2. Does students' math intrinsic value in 10^{th} grade predict their math achievement and advanced math course-taking in 12^{th} grade?
3. Does students' utility value of learning in 10^{th} grade predict their math achievement and advanced math course-taking in 12^{th} grade?
4. Does students' educational expectation in 12^{th} grade explain their math achievement and advanced math course-taking in 12^{th} grade?
5. Do students' math self-efficacy and task value (math intrinsic value and utility value, respectively) in 10^{th} grade predict students' educational expectation in 12^{th} grade?
6. Does students' advanced math course-taking by 12^{th} grade predict students' math achievement in 12^{th} grade?

7. Does the model fit for female and male students? Specifically, are the relationships among math self-efficacy, utility value in learning, math intrinsic value, educational expectation, math achievement and advanced math course-taking similar across student gender groups?
8. Does the model fit for Asian, African-American, Hispanic and Caucasian students? Specifically, are the relationships among math self-efficacy, utility value in learning, math intrinsic value, educational expectation, math achievement and advanced math course-taking similar across student ethnic groups?

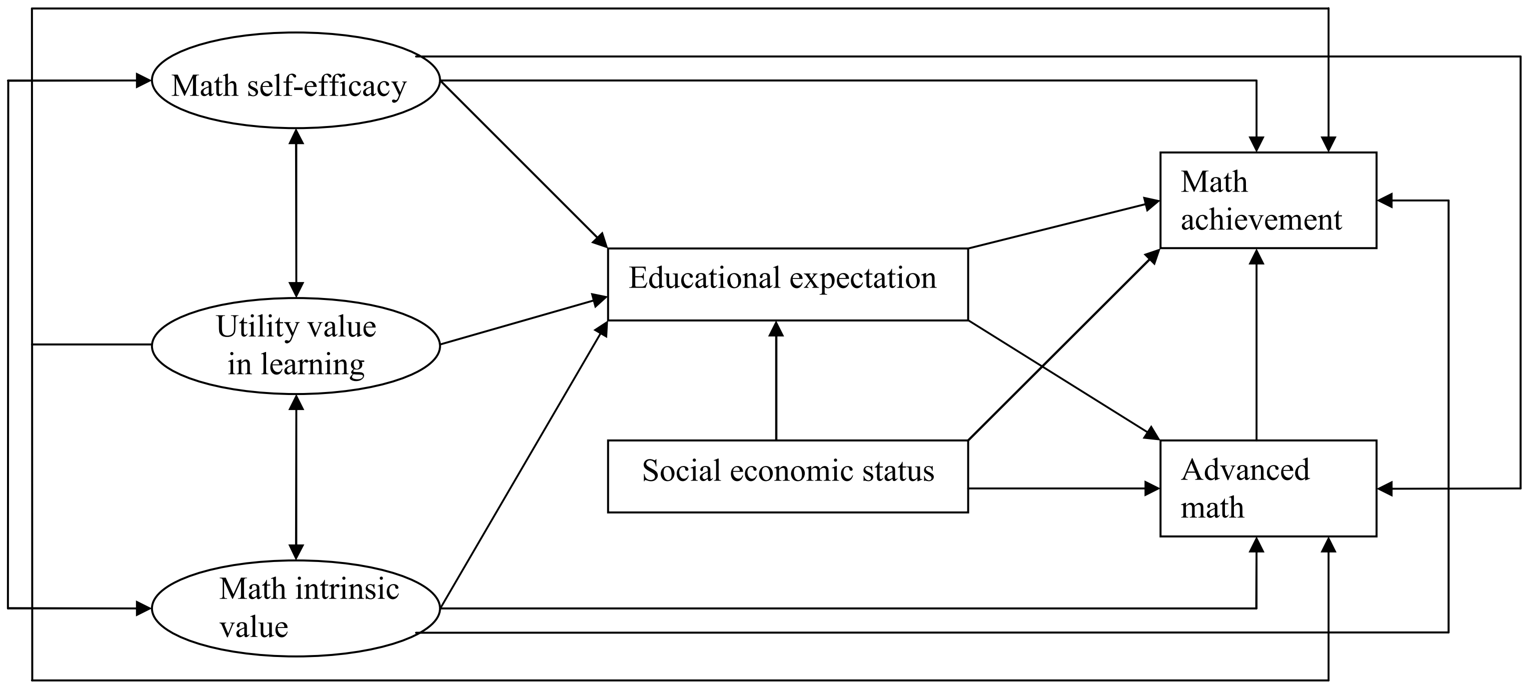

Figure 1: Structural model reflecting the relations among students' motivation, math achievement and advanced math course-taking.

Chapter III: Method

Data Source

The participants were drawn from the Educational Longitudinal Study: 2002/2004 (ELS: 2002/2004), a nationally representative database. This study was conducted by the National Center for Education Statistics (NCES), and the base year and first follow-up data were available for public use (Ingels, Pratt, Rogers, Seigel, Stutts & Owings, 2004, 2005). The base year data consisted of 10th grade high school students in the Spring term of 2002. The ELS: 2002 used a two-stage sampling design. At the first stage, 752 public and private schools with a 10th grade were selected from around 25,000 schools. At the second stage, approximately 26 students per school were randomly selected, with over-sampled Asian and Hispanic students (Ingels et al., 2005). Asian students and some schools were over sampled to ensure that findings could be generalized to the overall population of 10th graders. To compensate for the sampling bias, student weight variable *(f1pnlwt)* and cluster variable *(school_id)* provided by NCES were applied to all analyses for the present study. In Spring 2004, the sample was "freshened" to maintain the representativeness of the entire national 12th grade population. Overall, it is clear that complex sample is one of the main features in the ELS:2002 dataset. Detailed sampling procedure is described in the ELS: 2002 Base-Year Data File User's Manual (Ingels et al., 2004).

In the Spring of 2002, a total sample of 15,976 students completed math assessment; and 13,702 students completed math assessment in the Spring of 2004. All together, a total sample of 13,448 students completed both waves of math assessment. However, 4% ($N = 555$) of selected samples were missing most data including demographic information such as ethnicity, gender and SES. Therefore, a total sample of 12,893 was available for data analysis at this point. For selected dependent variables, 0.8% (*N* = 104) of students did not provide information regarding their advanced math course enrollment, which led to 12,789 participants. Additionally, 8% (*N* = 1,021) of students answered "do not know" on educational expectation question. As a result of listwise deletion, 11,787 students were available for analysis.

Unfortunately, at the same time about 33% (*N* = 4,223) of cases were missing at least one item of selected motivation variables. Subsequently, item correlation substitution (Huisman, 2000) was used to replacing missing item values by the most correlated observed items within the same composite motivation variable. The missing data issue was only slightly ameliorated by this conservative method. Thus, 26% (*N* = 3,299) of participants was missing at least one composite motivation variables among three (self-efficacy, utility value and intrinsic value). Simply speaking, listwise deletion was used for missing single-item variables. Whenever possible, item correlation substitution was used to compute composite variables with at least one observed item. As a result, the final sample consists of 8,976 students after handling missing data.

Handling Missing Values

In consideration of significant percentage of missing data, it was necessary to investigate whether missing data was missing at random. The data was missing at random if the pattern of missing data can not be explained by other variables (Rubin, 1976). The investigation of missing data, on the one hand, reassured the viability of generalization and interpretation of results from students with complete data; on the other hand, the researcher could have a better understanding of the data characteristics. Therefore, students with missing data were coded as “1;” and students with completed data were coded as “0.” A logistic regression analysis was used to capture whether there was a pattern for students missing motivation variables (Rubin, 1976).

The analysis was carried out with AM Statistical Software Beta Version 0.06.03. (American Institutes for Research, 2002). AM software was used mainly because of its advantages for analyzing data from complex samples, especially large-scale assessments in terms of automatically providing appropriate standard errors for complex samples using a Taylor-series approximation (American Institutes for Research, 2002). The results indicated that male, African-American, and low SES students tended to have missing motivation variables, while Caucasian students were less likely to have missing motivation variables than students of other ethnic groups. Odds ratio shows the strength of association between a predictor and the response of interest. Since when odds ratio equals or nearly equals to one, it means that there is no or nearly no association between two variables. Therefore, although the results for math achievement and advanced math course-taking are significant in the present study as indicated in Table 1, their associations with missing odds are nearly zero due to their close-to-one odds ratio. In addition, it is also recommended to interpret odds ratio smaller than one by taking on its inverse (1/ odds ratio) to convert it as an odds ratio larger than one (Uitenbroek, 1997). Consequently, the odds for male students missing at least one of the three motivation variables were about 49% (odds ratio = 1/ 0.67 = 1.49) higher than odds for female students. The odds of African-American students missing one of the three motivation variables were about 52% higher than odds for other ethnic groups. The odds for Caucasian students missing at least one of the three motivation variables were about 52%

(odds ratio = 1/ 0.66 = 1.52) lower than odds for other ethnic groups. Detailed results are presented in Table 1.

Table 1

Logistic Regression Predicting Who Will Miss Motivation Variables (N=12,789)

Variables	*β*	*SE*	*t*	*p*	*Exp(B)*
Female	-.40	.05	-7.40	.00	0.67
Asian	-.09	.13	-0.69	.49	0.91
African-American	.42	.15	2.87	.00	1.52
Hispanic	-.17	.13	-1.29	.20	0.84
Caucasian	-.41	.08	-4.84	.00	0.66
Educational expectation	-.01	.02	-0.60	.55	0.99
Math achievement	-.02	.00	-5.59	.00	0.98
advanced math course-taking	-.06	.03	-1.98	.05	0.94
SES	-.16	.04	-3.67	.00	0.85

Notes. F (9, 12780) = 46.91, $p < .001$; Analysis was weighted by *f1pnlwt*, and *school_id* was used as the cluster variable.

In order to mitigate biases from missing values, missing motivation variables were replaced with linear trend for that point using SPSS version 17.0. With this method, the existing series was regressed on index variables scaled 1 to *n*, and missing values were replaced with their predicted values (SPSS, 2009). However, no matter how good the guess was, the predicted value was inherently biased. Therefore, in the present study, all analyses were carried out on both the original (*N* =8,976) and the imputed datasets (*N* =12,789). In line with Garson's (2009) view, results based on the original dataset were reported with the awareness of possible biases based on the analysis of missing responses. Furthermore, results were also discussed where imputation made a substantive difference in interpreting findings.

Instrument

The questionnaires in ELS: 2002/2004 were typically self-administered, and completed in a group administration in students' schools. Self-reported scales, consisting of eleven likert-type items about self-efficacy and task values from ELS: 2002, were selected from student questionnaires. These items were based on items from the Program for International Assessment (PISA): 2003, which had acceptable psychometric properties as judged by both classical and modern (item response) test theory criteria (Adams & Wu, 2002). Compared to the PISA: 2003 measures, items from ELS: 2002 were more consistent with Bandura's conception of self-efficacy, in which efficacy beliefs were specific to a particular topic and a particular context (Bandura, 2001). For detailed information regarding survey structure and administration, please refer to ELS: 2002 User's Manual (Ingels et al., 2004). Descriptions for all independent, dependent and control variables used in the present study are described below, and individual items are presented in Appendix 1.

Math achievement. Standardized achievement scores in math were obtained at the first follow up in 2004 when students were in 12th grade. Test items were selected from previous national surveys (National Educational Longitudinal Study of 1988 [NELS: 88], National Assessment of Educational Progress [NAEP], and PISA) and modified based on a one-year field test. They employed classical and item response theory techniques, and various psychometric analyses, a pool of 85-item reflecting five math skill levels were used for both waves of math assessment. In this assessment, 90% items were multiple choices, and 10% were open ended questions with right or wrong answers. Students were allotted 26 minutes to take the test, where the majority completed 31-32 items. The standardized T score provided a norm-referenced measurement of achievement that was an estimate of achievement relative to the population (10th graders in 2002 and 12th graders in 2004) as a whole. It provided information on ranks compared with national average. The score ranged from 0 to 100 with a mean of 50 and standard deviation of 10 (Ingels et al., 2005). The scores for the selected sample ranged from 19.82 to 79.85. For the present study, math achievement at 12th grade was used as a dependent variable.

Advanced math course-taking. When students were in 12th grade they were asked to indicate the highest math course of a half year or more she/he had taken by the end of Spring 2004. The math course levels were classified from 1 to 6 (1 = 'No math course or math course is other'; 2 = 'Pre-algebra, general or consumer math'; 3 = 'Algebra I'; 4 = 'Geometry'; 5 = 'Algebra II' ; and 6 = 'Trigonometry, pre-calculus, or calculus'). Within the hypothesized model, advanced math course-taking was dichotomously coded as "1" and "0", indicating students "have taken trigonometry, pre-calculus, or calculus" and "have never taken trigonometry, pre-calculus, or calculus," respectively. The reasons for categorizing courses beyond Algebra II as advanced courses are explained in the Introduction Chapter.

Self-efficacy. Self-efficacy in math assesses 10th grade students' perceptions of their capability for academic achievement in classroom activities (texts, assignments, exams, skills, and class performance) for math. Five self-reported items reflecting self-efficacy in math were selected from student questionnaires (α = .93). This series of items were measured by the question stem "How often do these things apply to you?" The responses ranged from 1-Almost never, 2-Sometimes, 3-Often, to 4-Almost always. An example of an item was "I am confident that I can do an excellent job on my math tests." (*self-efficacy in math*). The factor loadings from the principle component analysis with five self-efficacy items for all students ranged from .87 to .90, indicating acceptable validity for this composite variable. Using IRT scale creation technique, Barber and Torney-Purta (2008) also constructed math self-efficacy with the same items drawn from ELS: 2002 dataset.

Utility value. Utility value in learning assesses students' perceived usefulness in learning. Three items pertaining to utility value in learning were selected from student questionnaires ($\alpha = .85$). This series of items was measured by the question stem "How often do these things apply to you?" The responses ranged from 1-Almost never, 2-Sometimes, 3-Often, to 4-Almost always. An example of an item was "I study to increase my job opportunities." The factor loadings from the principle component analysis with three utility value items for all students ranged from .87 to .90, indicating acceptable validity for this composite variable. Different from the other two motivational variables used in this study, utility value was not measured about math subject but about general learning.

Intrinsic value. Intrinsic value in math assesses students' intrinsic enjoyment of math. Three self-reported items pertaining to intrinsic value in math were selected ($\alpha = .78$). This series of items was measured by the question stem "How much do you agree or disagree with the following statement?" The responses ranged from 1-Strongly agree, 2-Agree, 3-Disagree, to 4-Strongly disagree. An example of an item was, "When I do math, I sometimes get totally absorbed." To be consistent with self-efficacy and utility value, this variable was reverse recoded from the original ELS: 2002 data for the present study to represent higher intrinsic motivation with higher number. The factor loadings from the principle component analysis with three intrinsic value items for all students ranged from .78 to .85, indicating acceptable validity for this composite variable. Using IRT scale creation technique, Barber and Torney-Purta (2008) also constructed math intrinsic value ("intrinsic motivation" in the original text) with the same items drawn from ELS: 2002 dataset.

Educational expectation. Educational expectation assessed students' self-perceptions or judgments of educational level they might obtain later in life. Students' level of educational expectation was measured by students' self-reported answer to the question: "As things stand now, how far in school do you think you will get." This variable was collected when students were in 12^{th} grade, which was two years after motivation variables were assessed. Student responses ranged from 1 to 9 (Less than high school graduation; GED or other equivalent only; High school graduation only; Attend or complete a 2-year school course in a community or vocational school; Attend college, but not complete a 4-year degree; Graduate from college; Obtain a Master's degree or equivalent; Obtain a Ph. D, M.D. or other advanced degree; and Do not know). Within the hypothesized model, educational expectation was dichotomously coded as "1" and "0", indicating students "at least expect to graduate from a four-year college" and "not expect to graduate from a four-year college," respectively. However, it is worth noting that this variable is likely to be inherently biased given the literature that has documented students' over-expectations about college completion (Kirst & Venezia, 2004).

Covariates. Student's prior achievement and SES were used as control variables. Prior achievement was obtained at the base year in 2002, in the same manner as standard math score obtained in 2004. The scores for the selected sample ranged from 19.38 to 86.68. Student SES was a standardized composite, computed by averaging up the standardized scores of students' parents or guardian's education, profession and household income to facilitate better comparison (Ingels et al., 2004). Continuous variable for SES, ranged from -2.11 to 1.82, were used for fitting the hypothesized model in the present study. Specifically, high SES scores indicated that students were from homes with higher levels of wealth, and/or with higher-educated parents/guardian.

Student demographics. Gender was recoded from the original ELS: 2002 data coding (male = “1”; and female = “2”) as “1” for female, and “0” for male to facilitate interpretation of results. The ethnicity variable was obtained from the student questionnaire with seven options: 1) American Indian/Alaska Native, non-Hispanic; 2) Asian, Hawaii/Pacific Islander, non-Hispanic; 3) Black or African-American, non-Hispanic; 4) Hispanic, no race specified; 5) Hispanic, race specified; 6) Multiracial, non-Hispanic; 7) White, non-Hispanic. If missing on the questionnaire, information was pulled from sampling roster, or parent questionnaire (Ingels et al., 2004). Ethnicity groups were recoded as Asian, African-American, Hispanic, Caucasian and Others in the present study. The “Hispanic” category included both race specified and non-specified Hispanic students. The “Others” category included students selected 1) American Indian/Alaska Native, non-Hispanic, and 6) Multiracial, non-Hispanic.

Plan of Analysis

Prior to main analyses, descriptive statistics including mean, standard deviation, and frequency for all variables of interest were reported. As a preliminary analysis, two series of *t*-tests were used to examine the existence and magnitude of gender and ethnic differences. All motivation predictors and outcome variables served as dependent variables in *t*-tests, respectively. Since group differences were detected, further analyses of structural equation modeling regarding group differences were carried out.

Structural equation modeling. Since fitting a hypothesized model with complex relationships between latent factors and observed variables was the aim of the present study, structural equation modeling (SEM) was used to answer the research questions. SEM is a statistical technique for testing and estimating causal relations using a combination of statistical data and qualitative causal assumptions (Muthén & Muthén, 2007). As a synthesis of measurement models and path models, SEM had the following advantages. First, SEM allowed the researcher to trace complex paths by assessing direct and indirect effects of some variables (Meyers, Gamst, & Guarino, 2006, p. 586). Therefore, the indirect effect of task value through educational expectation, as an example, could be tested. Second, SEM measured the strength and direction of a hypothesized causal influence (Meyers et al., 2006, p. 586), so the contribution of different motivation predictors towards math achievement and advanced math course-taking could be compared. As the third advantage, SEM involved latent variables by incorporating a measurement model, which could assess and control measurement errors (Meyers et al., 2006, p. 636).

As in many statistical analyses, the use of SEM requires satisfying some important assumptions. First, relationships between variables should be linear. Second, the variables included in the hypothesized model should be free of multicollinearity (strong correlation: $r > .80$). In the present study, the correlation between prior achievement and current achievement was .90, so the variable “prior achievement” was dropped from the hypothesized model. Finally, SEM requires large sample sizes, which was well-satisfied in the present study.

SEM analysis was carried out in two steps (Muthén & Muthén, 2007). First, the validity of measurement model was tested by confirmatory factor analysis (CFA). The purpose of CFA was to determine whether the observed items measure the corresponding latent motivation factors. The initial hypothesized measurement model consisted of three latent variables and their respective observed variables: math self-efficacy with five indicators; utility value and math intrinsic value each with three indicators.

Second, in the hypothesized model, fifteen structural regression paths and three correlation paths were created to test the validity of associations between latent factors, as demonstrated on Figure 1. In response to the research questions, the hypothesized paths were as follows: 1) self-efficacy to achievement and course-taking; 2) intrinsic value to achievement and course-taking; 3) utility value to achievement and course-taking; and 4) mediating effects of educational expectation towards the relationships between motivation predictors and achievement/course-taking. After testing the hypothesized model with all participants, two sets of parallel SEM were applied to investigate potential gender and ethnic group differences.

Specifically, the hypothesized SEM models were assessed based on the following criteria or procedures. First, the overall model fit was tested with the Chi-square test of model fit. The Chi-square test assessed the relationship between expected and observed values. If the expected and the observed values are close, then Chi-square value is not significant indicating that the model fits the data (Meyers et al., 2006, p. 665). However, Chi-square test is very sensitive to sample size and non-normality in the input variables. A large sample size often returns statistically significant Chi-square values, which was the case in the present study. Therefore, researchers can only be informed that the hypothesized model fits better than baseline model if Chi-square value decreases in comparison with the baseline model.

Hence, the model was also evaluated by three fit measures: 1) the comparative fit index (CFI); 2) Tucker-Lewis index (TLI); 3) the root mean square error of approximation (RMSEA). The CFI and TLI measure a relative fit comparing the hypothesized model with the null model. Conventionally, the cutoff criterion for acceptable values is greater than .95 (Hu & Bentler, 1999a, 1999b). Not as sensitive to large sample size, the RMSEA measures the discrepancy between the sample coefficients and the population coefficients, with values closer to zero indicative of a well-fitting model (Hu & Bentler, 1999a, 1999b; Loehlin, 2004). Specifically, less than .08 reflects an acceptable fit (Hu & Bentler, 1999a, 1999b), and less than .06 reflects a satisfying fit (Kline, 2005). Since all the models demonstrated good fits in the present study, no techniques were used to diagnose or revise the model. The path coefficients reflecting research questions were assessed for statistical significance at $p < .05$. The positive path coefficients revealed positive relations, while negative coefficients indicated inverse associations.

Software. Overall, three statistics software were utilized in the present study. All the data preparation procedures (e.g. data recoding, composite variables computation, data error-checking, etc) were conducted with all-purpose statistics software SPSS Version 17.0 (2009). All the preliminary analyses (e.g. descriptive statistics, correlation matrix, t-tests, etc) were carried out with AM Statistical Software Beta Version 0.06.03. (American Institutes for Research, 2002). AM software was used mainly because of its advantages for analyzing data from large-scale complex samples in terms of automatically providing appropriate standard errors for complex samples using a Taylor-series approximation (American Institutes for Research, 2002). More specifically, AM software is particularly designed for statistical analysis for large-scale national representative dataset collected by NCES, such as ELS: 2002. In addition, *t*-tests were used instead of ANOVA (Analyses of Variances) because the usual *F*-test was not valid for complex samples as recommended by Cohen (2005). SEM was carried out by Mplus Version 6.0 (Muthén & Muthén, 2007) because of its specialization in modeling structural equation modeling with latent variables, and its capability to handle complex samples. As mentioned above, the student weight variable *(f1pnlwt)* and cluster variable *(school_id)* provided by NCES were applied to all analyses to compensate the sampling bias for the present study.

Chapter IV: Results

This chapter is laid out in six sections. First, a general view of data was obtained by computing basic descriptive statistics for all variables. Second, inter-correlational statistics for motivation and dependent variables were presented. Third, the first to sixth research questions were assessed by fitting the hypothesized model in terms of structural equation modeling for the total sample. Fourth, to answer the seventh research question, a series of seven *t*-tests were used to evaluate the existence of gender differences. All motivation predictors and outcome variables served as dependent variables in *t*-tests, respectively. Then two parallel structural equation modeling were conducted for both male and female groups. Fifth, to answer the eighth research question, three series of seven *t*-tests were used to examine the existence of ethnic differences between minority student groups and Caucasian student group with regard to all variables. Then four parallel structural equation modeling were carried out for Asian, African-American, Hispanic and Caucasian student groups. Lastly, the results produced by the above SEM analyses were compared with results from the same SEM analyses, but with alternative method of dealing with missing data.

Description of Participants

In the aforementioned data screening indicated in Chapter III, a total of 8,976 participants from 743 schools were available for subsequent analyses. Table 2 shows the frequency and percent for all categorical variables, and Table 3 presents the mean, standard deviations, and ranges for all continuous variables. As indicated in Table 2, 53% of the participants were female, and the remaining 47% of participants were male students. In terms of the composition of students' ethnicity, 63% of students were

Caucasians, 12% were Hispanic, 10% were Asian, 10% were African-American, and 5% of participants described themselves as multiracial, or American Indian/Alaska Native. Overall, the gender and ethnicity composition of this selected sample remained similar percentage pattern of the original data before dealing with missing data. As for the advanced math course-taking, around 54% of students had taken at least a half-year course on trigonometry, pre-calculus or calculus by the time when they were in 12th grade. Also 80% of the students expected to achieve a bachelor degree or higher. Among the three motivation variables as indicated in Table 3, students on average reported moderately positive assessment towards their self-efficacy (M = 2.58), intrinsic value (M = 2.42) and utility value (M = 2.76) on the basis of a four-point scale.

Table 2

Descriptive Statistics for Categorical Variables (N = 8,976)

Variable	Response	*n*	%
Gender	Female	4,220	47
	Male	4,756	53
Ethnicity	Asian	900	10
	African-American	895	10
	Hispanic	1,054	12
	Caucasian	5,669	63
	Others	458	5
Advanced math courses	Yes	4,849	54
	No	4,127	46
Educational expectation	High	7,152	80
	Low	1,824	20

Notes. Yes = Students reported having taken advanced math course; No = Students reported not yet taking any advanced math course; High = Students expected to graduate from a four-year college; Low = Students did not expect to graduate from a four-year college.

Table 3

Descriptive Statistics for Continuous Variables (N = 8,976)

Variable	*M*	*SD*	*Min.*	*Max.*
Self-efficacy	2.58	0.83	1	4
Intrinsic value	2.42	0.70	1	4
Utility value	2.76	0.84	1	4
Math achievement	52.09	9.74	19.82	79.85
SES	0.16	0.73	-2.11	1.82

Note. Possible range for "math achievement" is from 0-100.

Inter-Correlations among Variables

Pearson correlations were used to look at the associations among motivational beliefs and dependent variables. Based on the criteria described by Cohen (1988), math self-efficacy had medium positive correlations with math intrinsic value (r = .50), and utility value (r = .39). The correlation between math intrinsic value and utility value was relatively weak, with a coefficient of .24. As expected, in terms of correlations with math achievement, the highest positive correlation was with advanced math course-taking (r = .56), followed by the relationships with educational expectation (r = .40), and with self-efficacy (r = .38). The detailed results are presented in Table 4. All motivational predictors were positively correlated with math outcome variables, presenting the initial evidence in support of viability of the hypothesized conceptual model.

Structural Equation Modeling on the Total Sample

Subsequent to the descriptive and correlational statistics, the hypothesized model described in Chapter II (Figure 1) was first fitted to the overall sample (N = 8,976). The model fit criteria for the measurement model indicated a satisfying (CFI = .96; TLI = .95; RMSEA = .05) fit for the hypothesized model. Furthermore, the results demonstrated that $\Delta x^2[14]$ = 28,720.76 (p < .001), which indicated the hypothesized model (x^2[41] =

1,129.82, $p < .001$) was greatly improved from the baseline model (Baseline $x^2[55] = 29,850.58$, $p < .001$). For reference, the baseline model is a null model where all measurement paths from the latent variables to the observed indicators are one; and all the variances of the latent variables are set to zero. As shown in Figure 2, all factor loadings from observed items to respective latent variables were statistically significant; and all values were greater than .80 except two items for math intrinsic value (bys87a = .59, and bys87f = .79) and one item for utility value (bys89d = .76).

Table 4

Correlation Matrix among Motivation and Dependent Variables (N = 8,976)

Variable	1	2	3	4	5	6
2. Self-efficacy	--	.50	.39	.29	.38	.20
3. Intrinsic value		--	.24	.19	.18	.10
4. Utility value			--	.19	.16	.21
5. Advanced math courses				--	.56	.36
6. Math achievement					--	.40
7. Educational expectation						--

Notes. "Advanced math courses" is dichotomously coded as 1 and 0 (1= Students reported having taken advanced math course; 0 = Students reported not yet taking any advanced math course); "Educational expectation" is dichotomously coded as 1 and 0 (1 = Students expected to graduate from a four-year college; 0 = Students did not expect to graduate from a four-year college).
All coefficients are significant at $p < .01$

The structural model with a standardized path parameter estimates is presented in Figure 3. The model fit criteria (CFI = .96; TLI = .95; RMSEA = .03) for the structural model indicated a satisfying fit for the hypothesized model. Furthermore, the results demonstrated $\Delta x^2[3] = 4,823.71$, $p < .001$, indicating the hypothesized model ($x^2[19] = 189.85$, $p < .001$) was greatly improved from the baseline model (Baseline $x^2[16] =$

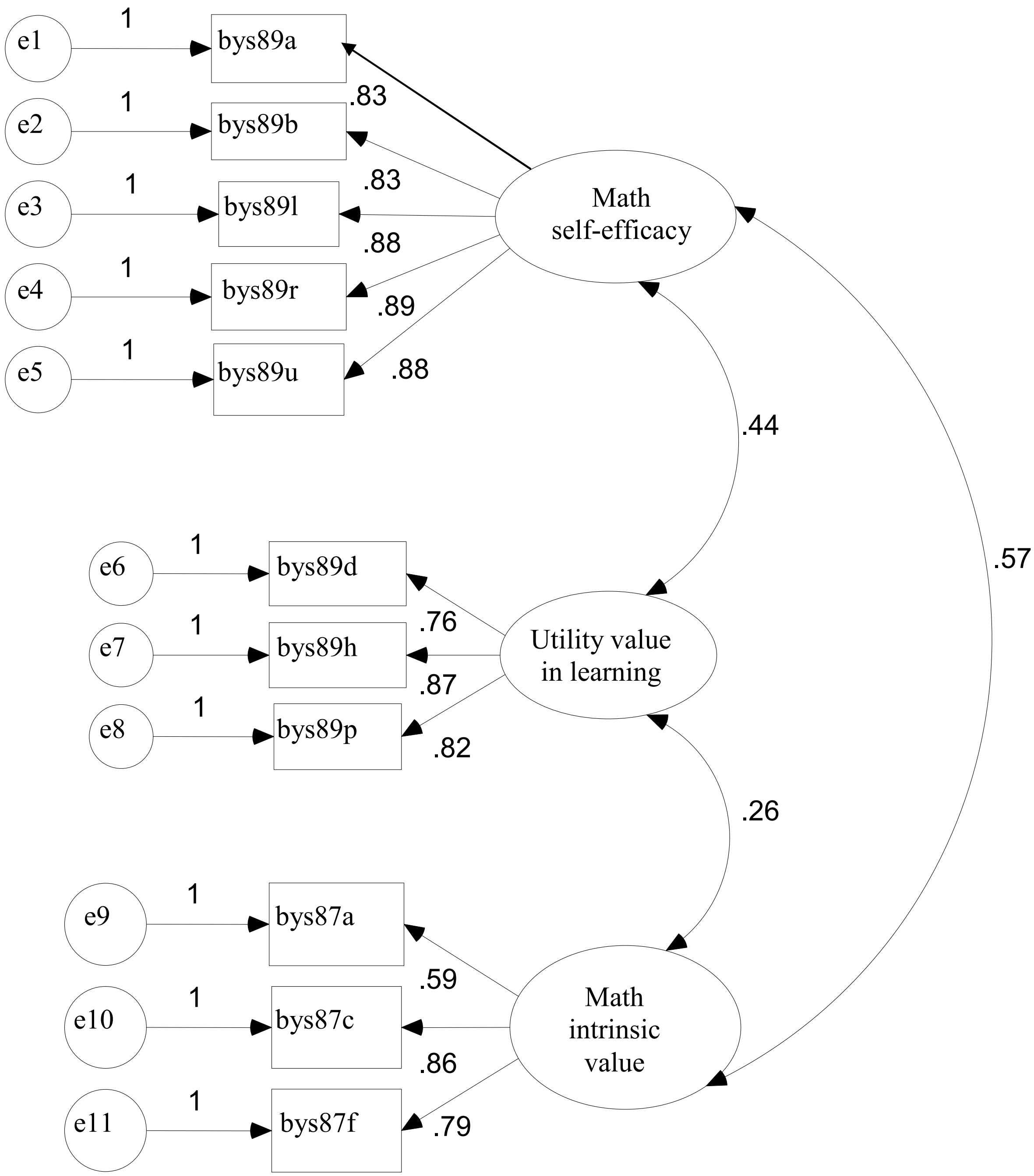

Figure 2. Measurement model of latent motivation variables. Latent constructs are shown in ellipses, and observed items are shown in rectangles. All parameter estimates are significant at $p < .001$ level.

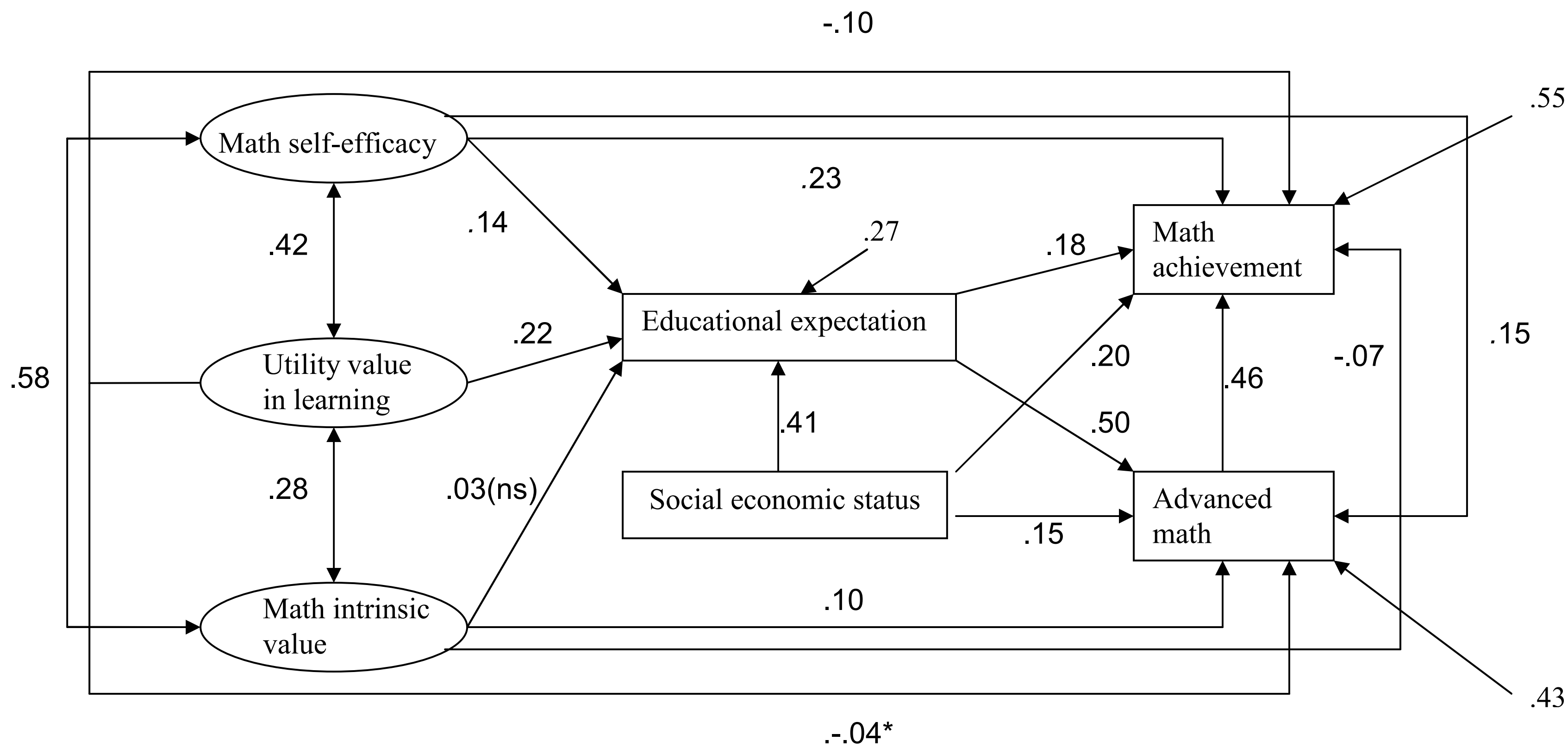

Figure 3: Parameter estimates of the structural regression model for total participants. “(ns)” indicates non-significant path coefficient; * indicates p < .05; and all other path coefficients are significant at < .001 level.

5,013.56, $p < .001$). For reference, baseline model is a null model where all of the structural paths are assumed to be zero. Overall, the model accounted for 55% and 43% of the variance in math achievement and advanced math course-taking, respectively.

Research question 1: Does students' math self-efficacy in 10th grade predict their math achievement and advanced math course-taking in 12th grade? On the one hand, consistent with a large number of previous studies (Crombie et al., 2005; Pajares & Graham, 1999; Stevens et al., 2007), the present study also found math self-efficacy was able to predict students' math performance ($\beta = .23$, $p < .001$). Specifically, when students expressed one standard deviation higher levels of math self-efficacy in 10th grade, their math achievement scores would increase .23 standard deviation when tested in 12th grade. On the other hand, although most reviewed studies only supported that math self-efficacy predicted students' enrollment intention (Lent et al., 2001; Stevens et al., 2007), the present study held up their findings by revealing a statistically significant positive association between students' self-reported math self-efficacy and their actual advanced math course-taking ($\beta = .15$, $p < .001$). Specifically, for a one standard deviation increase in students' math self-efficacy, their odds of taking advanced math courses would increase about 16% (odds ratio = $e^{(.15)} = 1.16$). In other words, as students reported higher math self-efficacy in 10th grade, they were more likely to take advanced math courses beyond Algebra II by 12th grade. Overall, the present study reiterated the important role of self-efficacy in expectancy-value model by demonstrating the significant predictive power of students' self-reported math self-efficacy in 10th grade for math outcomes in 12th grade.

Research question 2: Does students' math intrinsic value in 10th grade predict their math achievement and advanced math course-taking in 12th grade? The results indicated math intrinsic value was inversely associated with math achievement (β = -.07, p < .001) and positively associated with advanced math course-taking (β = .10, p < .001). Specifically, with a one standard deviation increase in students' math intrinsic value, math achievement would decrease .07 standard deviation, and their odds of taking advanced math courses would increase about 11% (odds ratio = $e^{(.10)}$ = 1.11). In other words, students who reported higher math intrinsic value in 10th grade were more likely to take advanced math courses beyond Algebra II by 12th grade, while they were slightly outperformed in math standardized tests in 12th grade by students reported lower math intrinsic value. In terms of the negative association between intrinsic value and math achievement, the present study confirmed Griffin's (2008) dissertation findings using the same ELS: 2002 dataset. Additionally, it was noteworthy that the small coefficient reflected nearly no practical influence on students' math achievement. However, this result was different from some previous studies, which found positive associations between math intrinsic value and achievement for both high school students (Wigfield & Eccles, 2000) and college students (Lent et al., 2001).

Research question 3: Does students' utility value of learning in 10th grade predict their math achievement and advanced math course-taking in 12th grade? The results indicated a significant negative relationship of utility value with math achievement (β = -.10, p < .001) and advanced math course-taking (β = -.04, p < .05). Specifically, for a one standard deviation increase in students' utility value, math achievement would decrease .10 standard deviation, and their odds of taking advanced math course would decrease about 4% (odds ratio = $e^{(.04)}$ = 1.04). For example, if a student's utility value increases from 3.0 to 3.84 (one standard deviation increase), then the student's expected math achievement would decrease about one point (.10 standard deviation decrease) out of 100, and theoretically this student's odds of taking advanced math course would decrease around 4%. Obviously, these small coefficients reflected nearly zero practical influence on students' math achievement and advanced math course-taking. Overall, when students reported higher external value in academic learning, their math achievement and advanced math course-taking tended to be slightly lower than, if not the same as those who reported lower utility value.

Research question 4: Does students' educational expectation in 12th grade explain their math achievement and advanced math course-taking in 12th grade? The results indicated significant positive paths between educational expectation and math achievement, and advanced course-taking (β = .18 and .50, respectively, *p's* < .001). Specifically, when students expected to complete four-year college, their achievements were .18 standard deviation higher; and their odds of taking advanced math courses were about 65% (odds ratio = $e^{(.50)}$ = 1.65) higher than those for student who did not expect to complete four-year college. Simply speaking, students' educational expectation indicated a small positive effect on math achievement, and a medium to large positive effect on advanced math course-taking.

Research question 5: Do students' math self-efficacy, math intrinsic value and utility value in learning in 10th grade predict students' educational expectation in 12th grade? Among the three motivation variables, math self-efficacy (β = .14, p < .001) and utility value in learning (β = .22, p < .001) demonstrated significant positive relationships with educational expectation. For a one standard deviation increase in students' utility value would result in 25% (odds ratio = $e^{(.22)} = 1.25$) increase in their odds of expecting to graduate from a four-year college, and for a one standard deviation increase in students' math self-efficacy would result in 15% (odds ratio = $e^{(.14)} = 1.15$) increase in their odds of expecting completing four-year college. In other words, when students reported higher math self-efficacy or utility value in 10^{th} grade, they were more likely to express expectation of completing four-year college in 12^{th} grade, although the effect sizes seemed quite small practically. On students' educational expectation, the present study failed to detect significant influence of math intrinsic value. Overall, the hypothesized model only accounted for 27% of the variance in educational expectation. It indicated that students' self-reported motivational beliefs examined in the present study (math self-efficacy, utility value and math intrinsic value) could only explain a small portion of students' educational expectation two years later. Many other factors beyond the scope of the present study were assumed to largely attribute to students' educational expectation.

Research question 6: Does students' advanced math course-taking by 12^{th} grade predict their math achievement in 12^{th} grade? Consistent with prior studies (Leow et al., 2004), students' advanced math course-taking demonstrated a statistically significant positive prediction towards students' achievement on standardized math assessment ($\beta = .46$, $p < .001$). Specifically, when students took at least half-a-year advanced math course by 12^{th} grade, their predicted math achievement would increase .46 standard deviation. Similarly, when students took any courses beyond Algebra II, they tended to master higher math ability, which led to better performance in standardized math tests.

Gender Differences

Research question 7: Does the model fit subgroups of female and male students? Specifically, are the relationships among math self-efficacy, utility value in learning, math intrinsic value, educational expectation, math achievement and advanced math course-taking different across student gender groups? As preliminary analyses, seven *t*-tests were used to examine the existence of gender differences among student SES, motivation and dependent variables. The results of *t*-tests for gender differences, along with descriptive statistics for all the variables in both female and male groups, are reported in Table 5. Females reported higher utility value in learning, higher educational expectation than males. Males expressed higher math self-efficacy, intrinsic value and performed better in standardized math achievement tests. The effect size for differences in math self-efficacy was the largest with a Cohen's d of .87, indicating a large difference between the means of females and males' math self-efficacy when divided by the pooled standard deviation. In addition, the patterns of correlations between the variables for females and males are very similar for most interrelationships as presented in Table 6. However, males showed stronger associations between math self-efficacy and advanced math course-taking (r = .33), math achievement (r = .43), and educational expectation (r = .28) than those for females (r = .28, r = .33, r = .18, respectively).

The overall model fit criteria for females (CFI = .97; TLI = .98; RMSEA = .02) and males (CFI = .95; TLI = .96; RMSEA = .03) indicated a satisfying fit for the hypothesized model. The measurement model for both female and male students

Table 5

Mean, Standard Deviation, and Independent T-tests between Gender Groups

	Female (n = 4,756)		Male (n = 4,220)				Cohen's
Variable	*M*	*SD*	*M*	*SD*	*t(741)*	*p*	*d*
Math self-efficacy	2.45	0.82	2.70	0.82	-11.85	***	.87
Math intrinsic value	2.35	0.69	2.45	0.71	-5.44	***	.40
Utility value in learning	2.77	0.83	2.68	0.85	3.66	***	.27
Advanced math courses	0.50	0.50	0.50	0.50	0.35		
Math achievement	50.60	9.37	52.54	9.92	-7.49	***	.55
Educational expectation	0.81	0.39	0.73	0.45	7.55	***	.55
SES	0.09	0.72	0.16	0.69	-3.40	**	.25

Notes. Significant positive *t*-value indicates higher scores for females; significant negative *t*-value indicates higher scores for males. Cohen's d was calculated in terms of *t*-Statistics and degree of freedom.
** $p < .01$, *** $p < .001$.

Table 6

Correlation Matrix among Variables across Gender Groups

Variable	1	2	3	4	5	6
1. Math self-efficacy	--	.53	.36	.28	.33	.18
2. Math intrinsic value	.45	--	.21	.18	.15	.10
3. Utility value in learning	.44	.26	--	.18	.16	.20
4. Advanced math courses	.32	.19	.18	--	.56	.34
5. Math achievement	.43	.16	.15	.56	--	.41
6. Educational expectation	.28	.13	.23	.39	.44	--

Notes. Correlations above the diagonal are for females (n = 4,756); and below the diagonal are for males (n = 4,220).
All correlations are statistically significant at $p < .01$.

demonstrated almost identical parameter estimations. All factor loadings from the observed items to their respective latent variables were statistically significant, and all the coefficient values were greater than .80 except one item for math intrinsic value (bys87a = .58/.58) and one item for utility value in learning (bys89d = .74/.77).

Detailed path coefficients are reported in Figure 4 and Figure 5 for female and males. Despite numerous gender differences in mean levels of the variables detected by preliminary *t*-tests as indicated above, the interrelationships among investigated factors were similar in terms of path coefficients from structural equation modeling. One noticeable difference is the relationship between utility value and advanced math course-taking. Self-reported utility value did not indicate a statistically significant effect on females' advanced math course-taking, while demonstrated statistically significant influences (albeit negative) on males' (β = -.06, $p < .05$). In other words, reporting high or low value in learning made no differences for girls in their choice of taking advanced math course. Interestingly, when boys reported higher utility value, they were slightly less likely to take advanced math course. Despite the statistically significant result, this finding of gender difference was practically meaningless due to the small coefficient.

Ethnic Differences

Research question 8: Does the model fit subgroups of Asian, African-American, Hispanic and Caucasian students? Specifically, are the relationships among math self-efficacy, utility value in learning, math intrinsic value, educational expectation, math achievement, advanced math course-taking, and student SES different across student ethnic groups? As preliminary analyses, *t*-tests were used to examine the existence of ethnic differences between each minority student (comparison groups) and

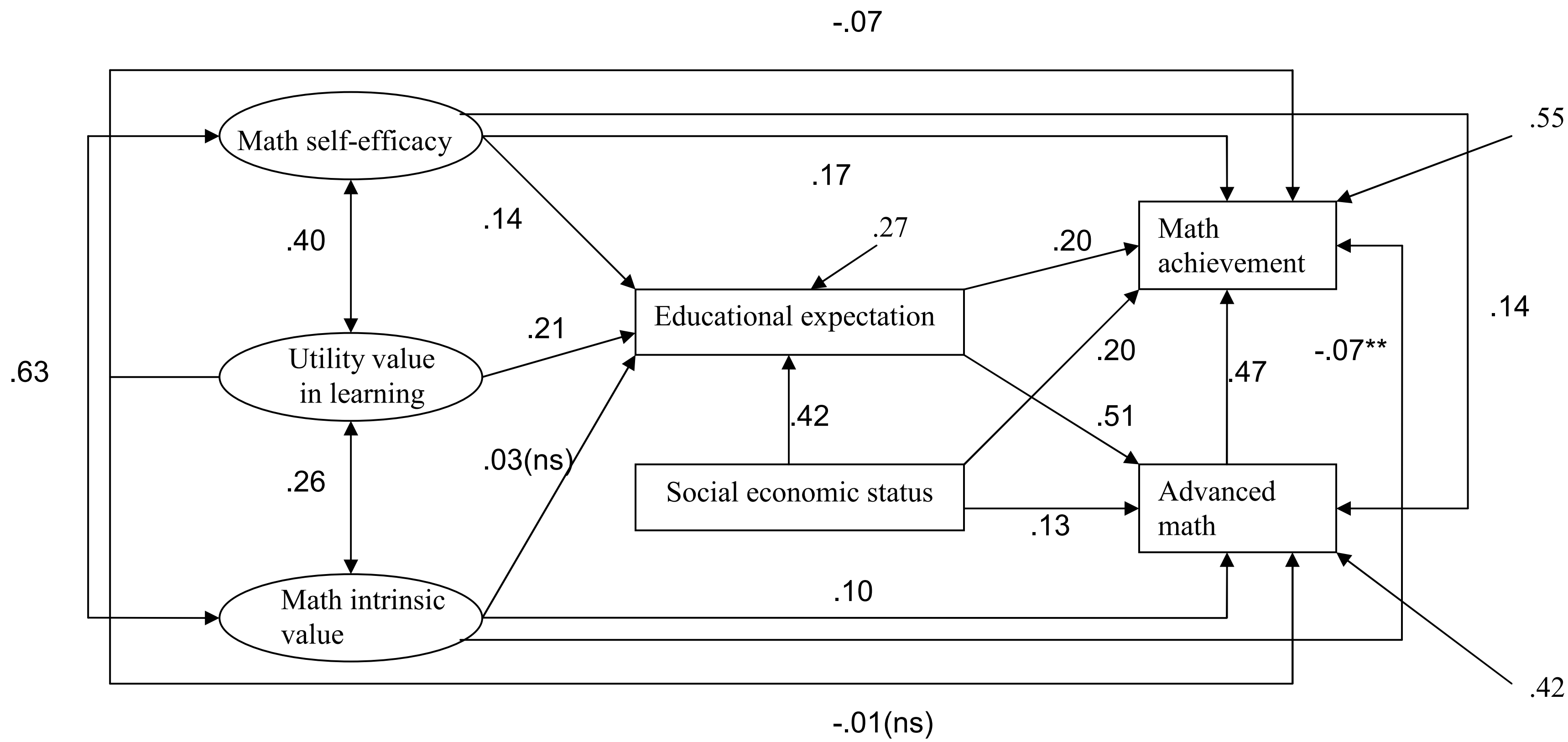

Figure 4: Parameter estimates of the structural regression model for females. "(ns)" indicates non-significant path coefficient; ** indicates $p < .01$; and all other path coefficients are significant at < .001 level.

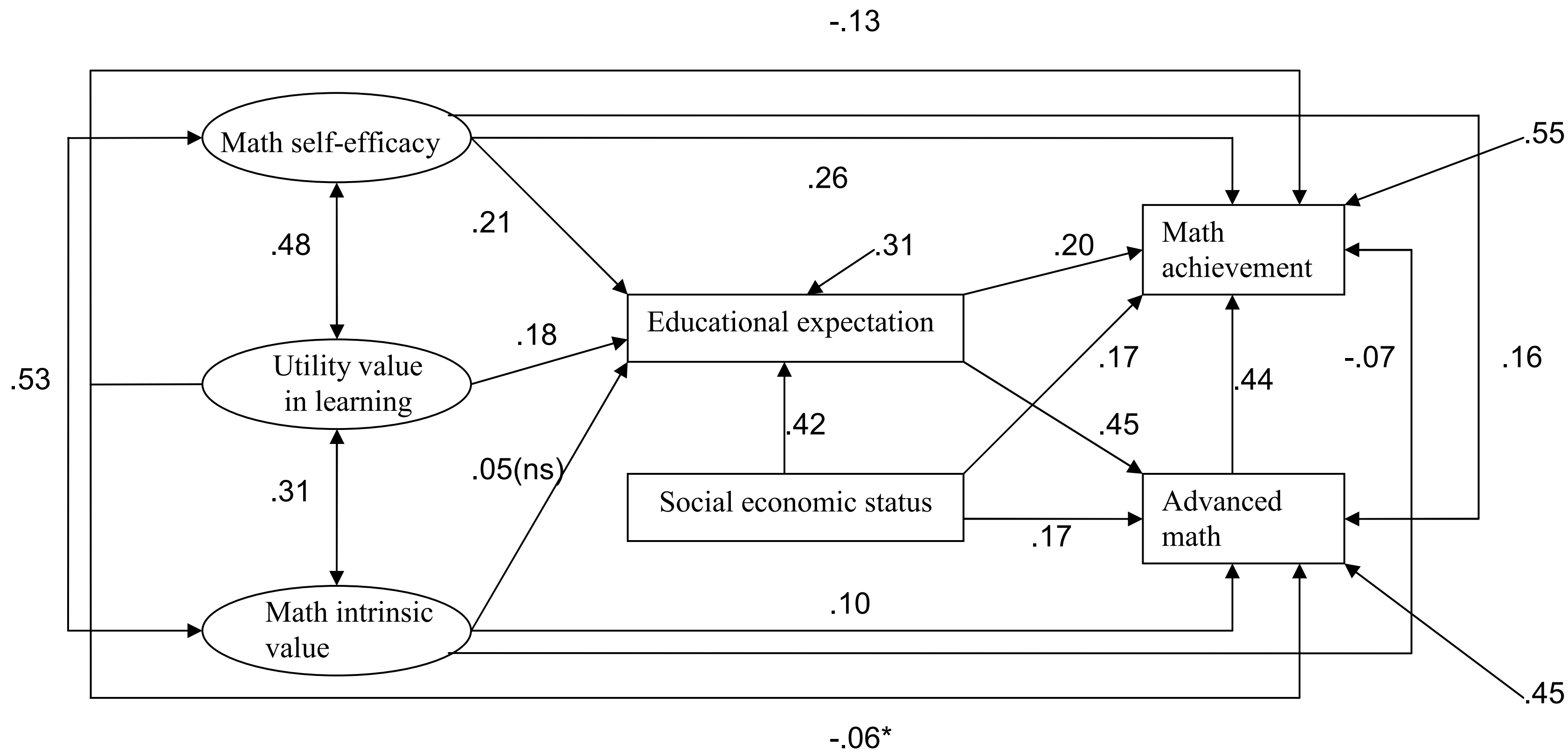

Figure 5: Parameter estimates of the structural regression model for males. "(ns)" indicates non-significant path coefficient; * indicates $p < .05$, and all other path coefficients are significant at < .001 level.

Caucasian student (reference group). The results of *t*-tests for ethnic differences, along with descriptive statistics for all variables are reported in Table 7. As indicated in Table 7, Asian students reported higher math self-efficacy, math intrinsic value, utility value in learning, and higher educational expectation than their Caucasian counterparts. In addition, Asian students showed higher math achievement and higher likelihood to take advanced math course than Caucasian peers. African-American students reported higher math intrinsic value than Caucasian students, while indicated lower math achievement, and were less likely to take advanced math courses than their Caucasian peers. Similar to the results for differences between African-American and Caucasian students, Hispanic students also reported higher math intrinsic value than Caucasian students, while had lower math achievement and were less likely to take advanced math courses than their Caucasian peers.

The entire model fit criteria for Asian, African-American, Hispanic and Caucasian students are presented in Table 8. The overall fit of the hypothesized model for all ethnic groups was satisfying in terms of RMSEA criteria; and acceptable in terms of CFI criteria, while the overall fit for Asian, Hispanic and Caucasian students indicated some room for improvement in terms of TLI criteria. The patterns of standardized path coefficients for the measurement model across ethnic groups were similar with the pattern of measurement model for overall participants, as indicated in Figure 2. Consistently, the lowest loading item was for math intrinsic value "When I do math, I sometimes get totally absorbed *(bys87a)*." Their respective loadings across Asian, African-American, Hispanic and Caucasian students were .60, .40, .47, .63, respectively.

Table 7

Means, Standard Deviations, and Independent t-tests Between Minority Student Groups (Focus Groups) and Caucasian Student Group (Reference Group)

Variable	Caucasian (n = 5,669)		Asian (n = 900)					African-American (n = 895)				
	M	*SD*	*M*	*SD*	*t*(693)	*p*	Cohen's *d*	*M*	*SD*	*t*(708)	*p*	Cohen's *d*
Math self-efficacy	2.58	0.84	2.71	0.83	2.83	**	.22	2.56	0.79	-0.60		
Math intrinsic value	2.34	0.70	2.61	0.67	7.84	***	.60	2.59	0.69	8.18	***	.61
Utility value in learning	2.72	0.84	2.89	0.83	4.57	***	.35	2.76	0.84	1.30		
Advanced math courses	0.53	0.50	0.68	0.47	5.82	***	.44	0.43	0.50	-3.88	***	.29
Math achievement	53.31	9.09	55.63	10.42	3.15	**	.24	44.60	8.09	-21.86	***	1.64
Educational expectation	0.78	0.41	0.88	0.33	4.44	***	.34	0.77	0.42	-0.52		
SES	0.25	0.65	0.15	0.82	-2.02	*	.15	-0.17	0.68	-11.69	***	.95

Notes. Significant positive *t*-value indicates higher scores for minority groups; and significant negative *t*-value indicates higher scores for Caucasian students group. Cohen's *d*s were calculated in terms of *t*-Statistics and degree of freedom.
* $p < .05$, ** $p < .01$, *** $p < .001$

Table 7 (continued)

Means, Standard Deviations, and Independent t-tests Between Minority Student Groups (Focus Groups) and Caucasian Student Group (Reference Group)

Variable	Hispanic (n = 1,054)				
	M	*SD*	*t(705)*	*p*	Cohen's *d*
Math self-efficacy	2.50	0.80	-2.45	*	.18
Math intrinsic value	2.48	0.65	5.03	***	.38
Utility value in learning	2.74	0.82	0.74		
Advanced math courses	0.35	0.48	-7.66	***	.58
Math achievement	46.49	9.34	-15.51	***	1.17
Educational expectation	0.67	0.47	-4.71	***	.35
SES	-0.36	0.72	-15.13	***	1.14

Notes. Significant positive *t*-value indicates higher scores for minority groups; and significant negative *t*-value indicates higher scores for Caucasian students group; Cohen's *d*s were calculated in terms of t-Statistics and degree of freedom.
* $p < .05$, *** $p < .001$.

Table 8

Fit Criteria for the Hypothesized Models across Ethnic Groups

Variable	CFI	TLI	RMSEA
Asian	.95	.93	.01
African-American	.99	.99	.01
Hispanic	.95	.94	.01
Caucasian	.95	.94	.03

Notes. CFI = the comparative fit index, TLI = Tucker-Lewis index, RMSEA = the root mean square error of approximation.

By investigating the standardized coefficients of structural models indicated in Figure 6-9, some findings were similar across ethnic groups. To be specific, statistically significant positive associations were found across Asian, African-American, Hispanic and Caucasian students for the relationships between 1) advanced math course-taking and math achievements, 2) math self-efficacy and math achievement, 3) educational expectation and advanced math course-taking, 4) SES and math achievement, and 5) SES and educational expectation. In addition, non-significant relationships were noted between math intrinsic value and educational expectation. However, some findings were different across ethnic groups, which are delineated below.

Math self-efficacy. First, math self-efficacy indicated no effects on advanced math course-taking for minority students while indicated a significant positive effect on advanced math course-taking for Caucasian students ($\beta = .17$, $p < .001$). Second, African-American and Hispanic students' math self-efficacy did not demonstrate significant relationships with educational expectation, while indicated a statistically significant positive influence on Asian ($\beta = .31$, $p < .001$) and Caucasian ($\beta = .17$, $p < .001$) students' educational expectation.

Utility value in learning. First, utility value in learning indicated no significant influence on minority students' math achievement and advanced math course-taking, while revealed a significant effect on Caucasian students' math achievement ($\beta = -.12$, $p <.001$) and advanced math course-taking ($\beta = -.05$, $p < .05$). Second, the results failed to detect a statistically significant association between utility value and educational expectation for Asian students, while demonstrated significant positive relationships with

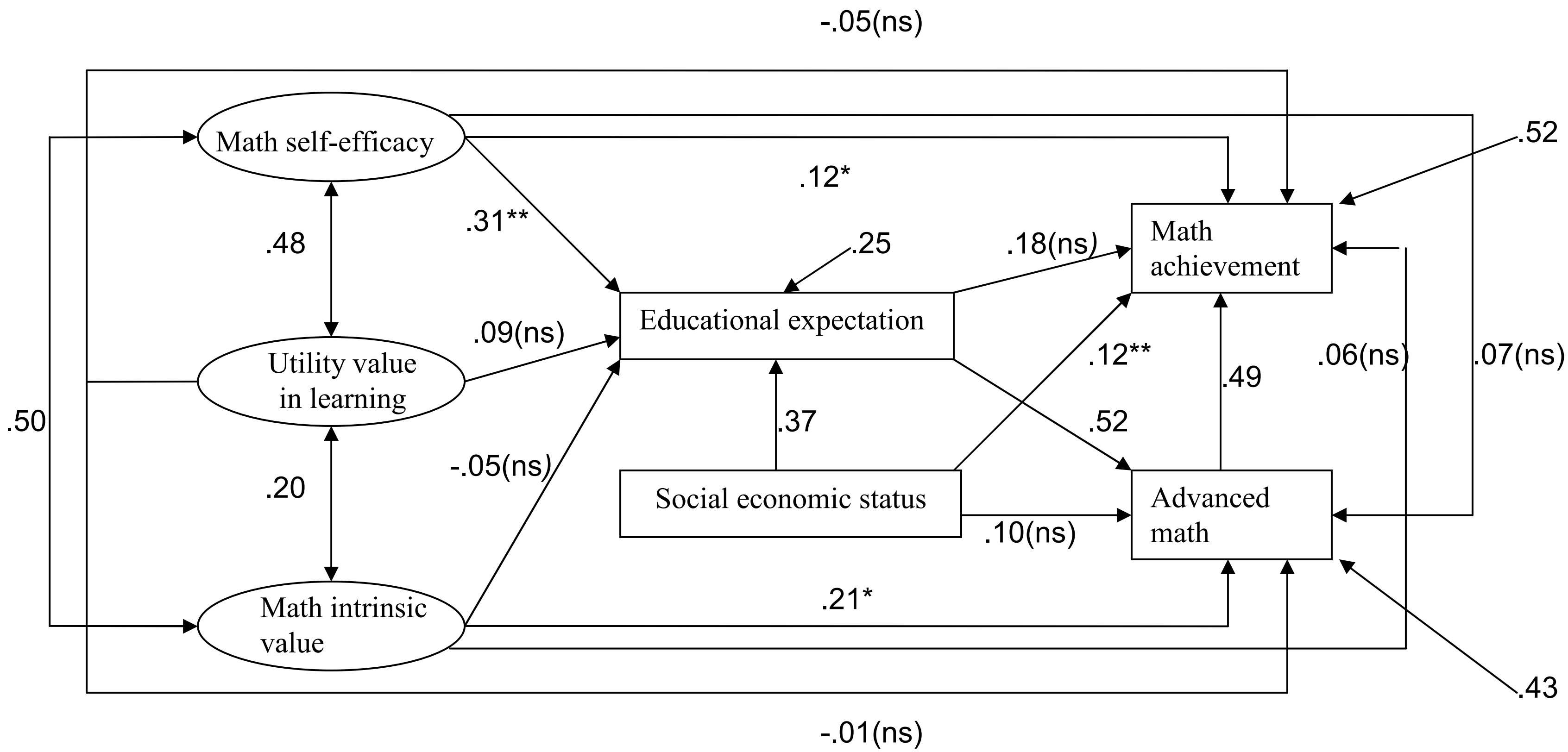

Figure 6: Parameter estimates of the structural regression model for Asian students. "(ns)" indicates non-significant path coefficient; * indicates $p < .05$; ** indicates $p < .01$; and all other path coefficients are significant at <.001 level.

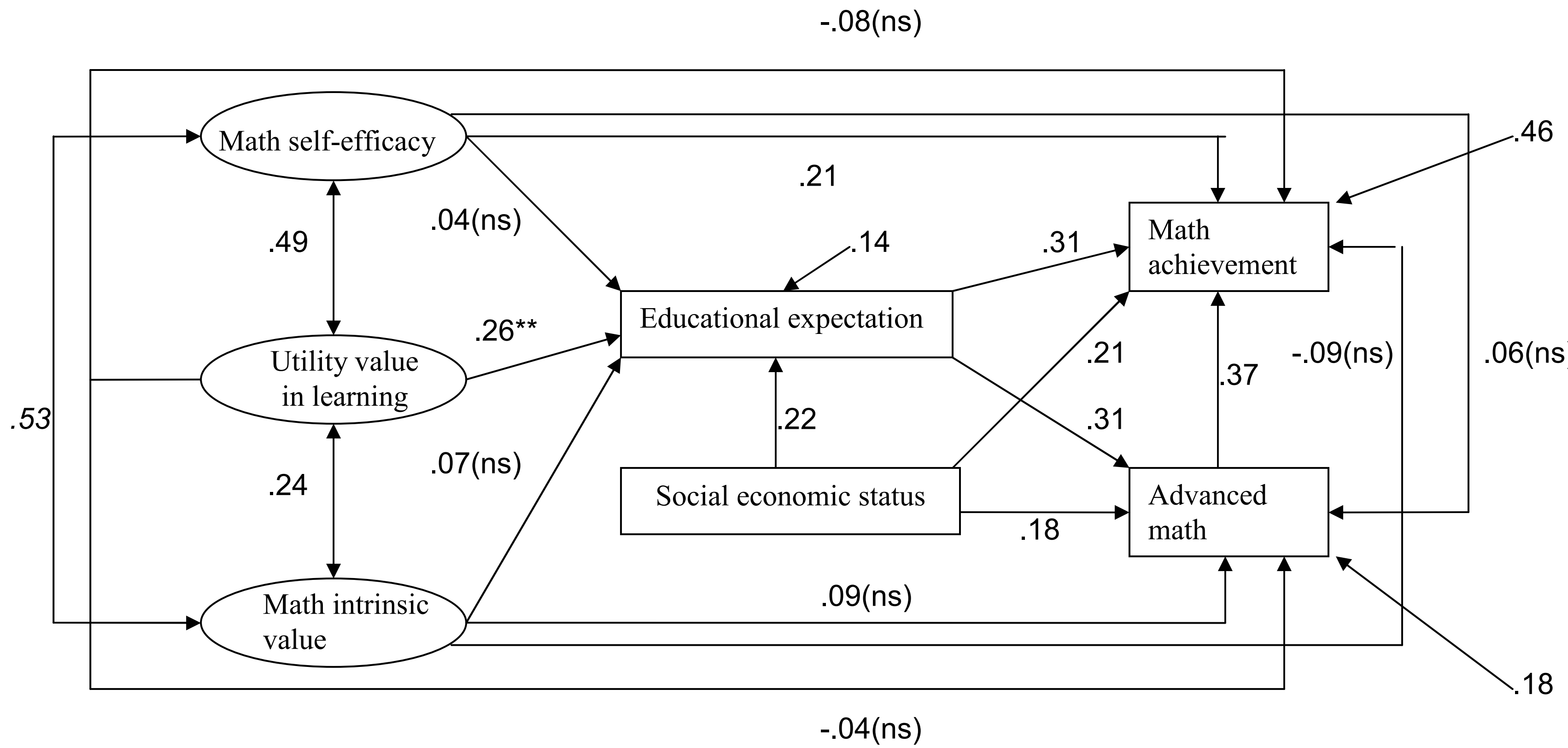

Figure 7: Parameter estimates of the structural regression model for African-American students. "(ns)" indicates non-significant path coefficient; ** indicates $p < .01$; and all other path coefficients are significant at <.001 level.

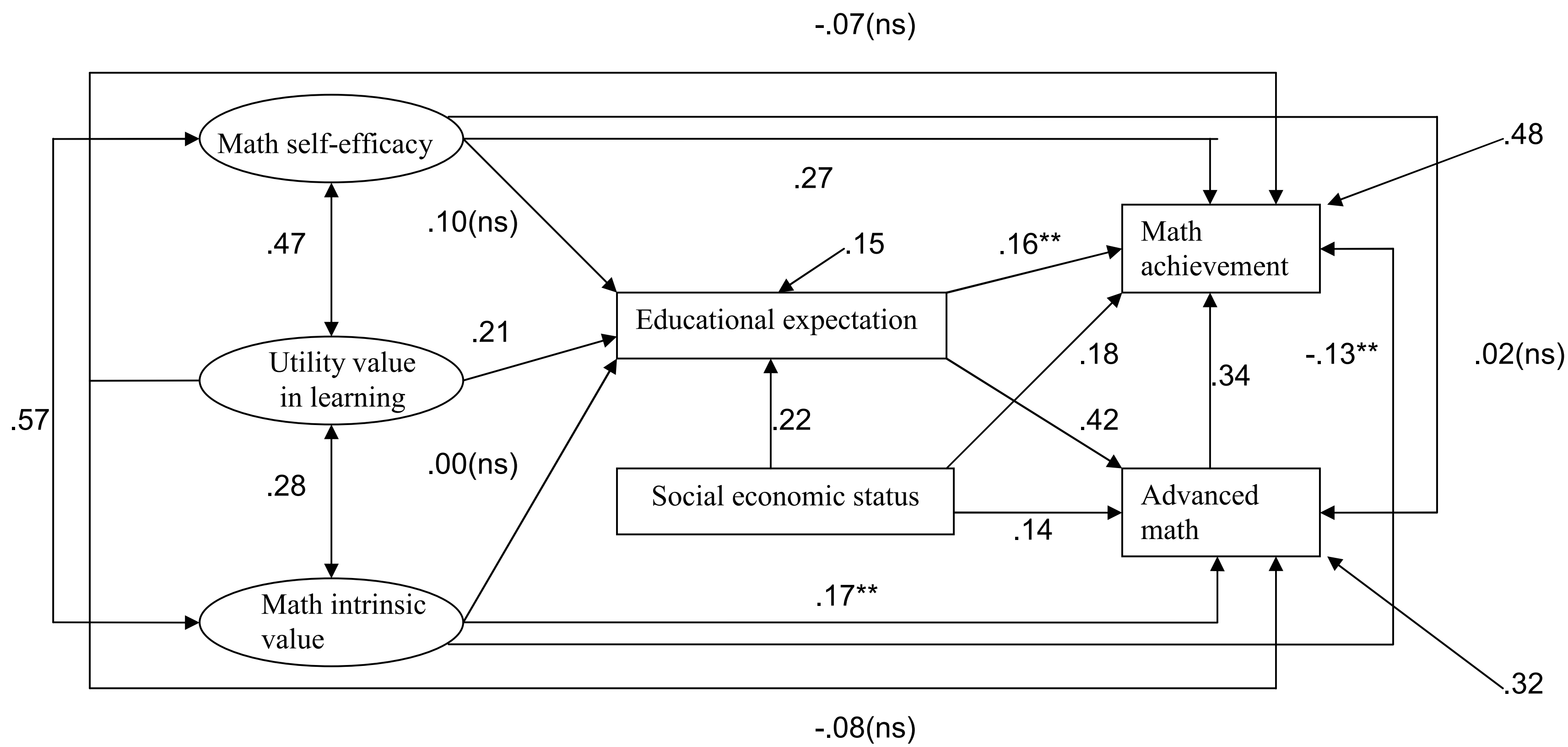

Figure 8: Parameter estimates of the structural regression model for Hispanic students. "(ns)" indicates non-significant path coefficient; ** indicates $p < .01$; and all other path coefficients are significant at < .001 level.

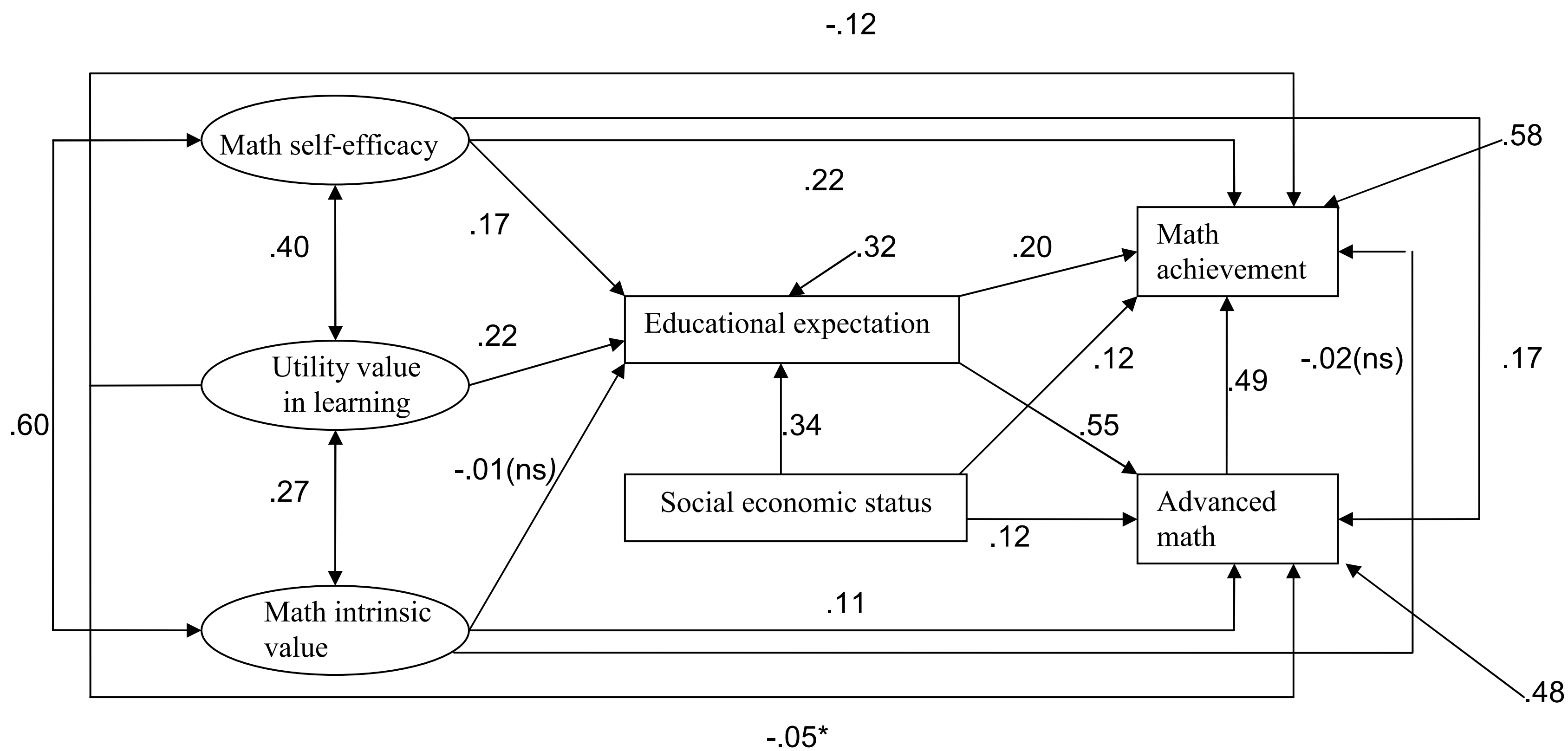

Figure 9: Parameter estimates of the structural regression model for Caucasian students. “(ns)” indicates non-significant path coefficient; * indicates $p < .05$; and all other path coefficients are significant at < .001 level.

African-American (β = .26, p < .01), Hispanic (β = .21, p < .001) and Caucasian (β = .22, p < .001) students' educational expectation.

Math intrinsic value. Four interesting findings emerged regarding math intrinsic value across ethnic groups. First, math intrinsic value was inversely associated with Hispanic students' math achievement (β = -.13, p < .01), while no significant relationships with other ethnic groups' math achievement. Second, math intrinsic value did not show statistically significant influence on African-American students' advanced math course-taking, while showed a significant positive association with advanced math course-taking for Asian (β = .21, p < .05), Hispanic (β = .17, p < .01), and Caucasian (β = .11, p < .001) students. In other words, math intrinsic value was not as important an index for African-American students' advanced math course-taking as for other ethnic groups. Third, students' educational expectation indicated statistically significant positive influence on math achievement for African-American (β = .31, p < .001), Hispanic (β = .20, p < .001), and Caucasian students (β = .16, p < .01), while not for Asian students.

Finally, SES demonstrated a statistically significant prediction toward students' advanced math course-taking for African-American (β = .18, p < .001), Hispanic (β = .14, p < .001) and Caucasian (β = .12, p < .001) students, except for Asian students. In other words, SES was not as an influential index for Asian students' advanced math course-taking as for other ethnic groups.

Alternative Method

As mentioned in Chapter III, due to large percentage of missing data, an alternative method with imputed data was used to re-answer all the research questions in the present study. With the linear trend method to substitute missing data (N = 12,789), the findings were essentially the same as those generated from the original data (N = 8,976), although some minor differences were detected as indicated in Table 9. The first column of the table below indicates the SEM model being tested, the second column indicates structural paths between two variables, and the last two columns list standardized path coefficients and significant levels from analyses using the original data and the imputed data, respectively.

At first glance, it was noted that five, out of seven different findings, concerned utility value in learning. It might indicate that data discrepancy between the original and the imputed dataset in utility value were relatively larger than that in other variables. Nevertheless, the reason was hard to determine. More importantly, despite some statistically significant different results were detected; the differences were ignorable or not difficult to make judgments in consideration of practical significance. For instance, the association between utility value and advanced math course-taking were found significant for the overall original data, while non-significant for the overall imputed sample. However, the standardized path coefficient was too small to actually present significant meaning. Therefore, a conservative conclusion should be drawn as no significant association between utility value and advanced math course-taking. In the same vein, judgments or decisions can be made for other different findings without substantial controversial arguments.

Table 9

Differences between Findings from the Original and Imputed Dataset.

SEM models	The relationship between	The original data (N = 8,976)		The imputed data (N = 12,789)	
		β	p	β	p
Total sample	Utility value and advanced course taking	-.04	*	.01	
Male group	Utility value and advanced course taking	-.06	*	-.03	
Asian group	Educational expectation and achievement	.18		.18	*
Hispanic group	Utility value and achievement	-.07		-.08	*
	Utility value and advanced course taking	.08		.09	*
Caucasian group	Intrinsic value and achievement	-.02		-.05	**
	Utility value and advanced course taking	-.05	*	-.01	

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

Chapter V: Discussion

The purpose of the present study was to obtain a better understanding of high school students' math achievement and advanced math course-taking to help ease the concern for U.S. students' math competence and preparation for higher education. Consonant with the research questions, the present study privileges the expectancy-value model by explaining students' academic achievement and choices. More distinctively, the investigation of high school students' actual math course-taking within the framework of expectancy-value model bridges the gaps left by previous research. Likewise, the present study delves more deeply into the interrelationships among math self-efficacy, utility value in learning, math intrinsic value and educational expectation, which has also shed insights on the accumulation of knowledge in the expectancy-value model of achievement motivation. Conceptual framework can then be extended, and potential educational implications can be pursued.

The discussion chapter consists of seven sections. The first section, as one of the main focuses of the present study, discusses findings related to three motivational constructs in the order of math self-efficacy, math intrinsic value, and utility value in learning. The second section discusses findings related to educational expectation. The third section, as a derivative finding, clarifies the relationship between advanced math course-taking and math achievement. The above three sections are based on results of analyses for overall participants. The fourth section reviews different findings in terms of gender. The fifth section, as another focus of the present study, attempts to explain different findings in terms of ethnic groups in the order of Asian, African-American and Hispanic students in comparison with Caucasian students. The sixth section points out the limitations of the present study, and offers some suggestions for future research. The seventh section, as the last section, is a brief summary of this paper.

Math Self-Efficacy

Consistent with many prior studies (Crombie et al., 2005; Stevens et al., 2007), the result for the first research question of the present study also revealed statistically and practically significant influence of math self-efficacy on math achievement, but in terms of large-scale national representative data. More importantly, as an expansion from prior studies (Lent et al., 2001; Stevens et al., 2004, 2007), the present study supports a positive effect of math self-efficacy on high school students' actual advanced math course-taking (only for Caucasian students, as detailed in the Ethnic Differences section), instead of solely on students' course-taking intentions. Generally, the above positive findings confirm the validity and critical role of subject-specific efficacy element played in the expectancy-value model.

There may be many reasons why math self-efficacy is positively associated with students' math outcomes. One possible explanation can be that students generally are able to realistically estimate their capability of solving math problems. Students' proper calibration may strengthen their ability to self-regulate academic goals and behaviors, which, as a result, may positively affect math achievement and advanced math course-taking (Stevens et al., 2007). In other words, students' self-reported math self-efficacy can fairly reflect their actual math course-taking choice and achievement in near future. Therefore, the present study suggests that self-reported math self-efficacy can be used as a viable alternative tool, besides math test scores, to evaluate and monitor students' math outcomes. To be more specific, math teachers may normally give students a short quiz to test and monitor students how they master the contents of one chapter. Instead, teachers could consider occasionally substitute the quiz with a content-specific self-efficacy questionnaire. In this way, students can experience an indirect and less intimidating test format. Furthermore, sense of autonomy and self-determination can be fostered, which will be beneficial for students' learning in the long run. At the same time, math teachers can still obtain scores reflecting students' performance close to those from regular math quizzes. Overall, the present study replicated findings and reemphasized the importance of students' math self-efficacy to math outcomes (Crombie et al., 2005; Stevens et al., 2007). Therefore, the educational implication for educators is to ensure that sufficient attentions are directed to foster students' optimal math self-efficacy.

Math Intrinsic Value

Replicating findings from previous studies (Ma, 2001; Wigfield & Eccles, 2000), the results for the second research question of the present study also demonstrated that math intrinsic value was a significant positive predictor for advanced math course-taking (except African-American students, as detailed in the Ethnic Difference section). What is important to note is that the present study has also expanded previous findings because past studies either using lower grade students, and different definition of advanced mathematics (Ma, 2001; Wigfield & Eccles, 2000) or a smaller sample of participants (Wigfield & Eccles, 2000). In other words, the present study has contributed the extant repertories of empirical evidence by adding a robust finding derived from a different research design in terms of participants, sampling errors and measurement method. Overall, this result suggests that students opt for advanced math courses when students explicitly identify importance and experience enjoyment when doing math work.

However, the present study revealed a small negative relationship between math intrinsic value and math achievement (only for Hispanic students, as detailed in the Ethnic Difference section), which conflicts with many prior studies (Köller et al., 2001; Lent et al., 2001; Wigfield & Eccles, 2000). Evidently, Köller et al.'s (2001) study shares the most similarity with the present study. Both studies are investigating 10th graders' math intrinsic value on 12th graders' math achievement using large-scale longitudinal data. Two apparent differences are the selected sample and measurements. First, Köller et al.'s (2001) study used a sample of German students. Second, the measurements for intrinsic value in Köller et al.'s (2001) study included an item on self-determination measuring students' sense of autonomy, besides measuring students' self-reported importance, affect and flow experience while doing math task. Whereas in the present study, participants were American students, and no item on self-determination was covered by the measurement. Thus, the different findings may result from different cultural tendencies between German and American students, and the effects of autonomy in giving up other commitments or time to engage in math activities.

Despite surprise, the negative association between math intrinsic value and achievement found in the present study confirms results from Griffin's (2008) dissertation utilizing the same dataset as the present study. One possible explanation is that although higher intrinsic value would bring more positive psychological consequences such as higher enjoyment in doing math tasks, there may be no additional room for intrinsic value to initiate and maintain math activities when other motivational characteristics (i.e. extrinsic motivation, self-efficacy, etc) has already dominated the initiation and maintaining learning activities in math (Stevens, Olivarez, & Hamman, 2006). Based on the findings of the present study, students' intrinsic value apparently is a more powerful predictor for students' advanced math course-taking than math achievement. It is implied that the facilitation of math intrinsic value can be transformed into course choices. This finding is corresponding with arguments by Eccles and her colleagues (2004) that the effects of motivational factors are often stronger on broader outcomes than academic achievement.

In comparison to the differential impact of math self-efficacy and math intrinsic value on math outcomes, the present study also highlights a greater importance of the role played by students' math self-efficacy than intrinsic value on math achievement, lending support to some previous findings (Stevens et al., 2006). Stevens et al. (2006) even suggest that risks may be taken by students to increase self-efficacy at the possible cost of intrinsic value. Intuitively, however, intrinsic value comes from genuine enjoyment, functions not only as a motivating process, but also an outcome. Indeed, the higher alignment of students' intrinsic value with advanced course-taking is a representation of psychological fulfillment from a wellbeing perspective. Therefore, the present study still suggests the importance of intrinsic value due to its positive influence on advanced course-taking. Although speculative, as the effects of students' math intrinsic value are supported and distinct from other motivation factors, a feasible overarching educational implication is to create and integrate programs in nurturing math intrinsic value in curriculum. Hopefully, the mechanism of the relationship between math intrinsic value and achievement can be eventually changed into a positive association when the positive influence of students' intrisic value on advanced math course-taking is sufficiently large.

Utility Value in Learning

Corresponding with the third research question, the present study failed to identify neither a statistically significant positive effect of utility value in learning on advanced math course-taking nor a practical significant positive prediction toward math achievement. Specifically, the present study does not support the notion that students' perceived importance, perceived usefulness in learning can be utilized to help improve students' math achievement or math course choices. These findings are not consistent with the expectancy-value model of achievement motivation theory (Wigfield & Eccles, 2000), but they support some prior research results (Long et al., 2007) that utility value measured by self-reported interest and importance toward learning in math, science, reading and history emerged as a significant negative predictor toward their overall achievement: a composite GPA. Although the results are inconsistent with many other studies (Malk & Convington, 2005; Wigfield & Eccles, 2002), the present study is different from their studies in several aspects. For instance, Malk and Convington (2005) used college students' graded performance in psychology courses as the outcome variable, and used a global measurement of task value instead of independent measurement of utility value. Wigfield and Eccles (2002) applied a global measurement of task value in mathematics instead of utility value in general learning. One reasonable explanation is that students may attribute their beliefs that learning is useful for future career and earning to other subjects than math, such as reading, writing etc. For instance, a students' willingness to pursue a teaching or nursing job would not necessarily empower their academic engagement in math. Given this, despite a moderate positive correlation between math self-efficacy and utility value in learning, differences are highlighted between these two psychological concepts in the present study. Accordingly, another plausible explanation can be that students, at least at high-school level, place more emphasis on what they are capable of doing at a specific subject instead of thinking about future career at a very practical level. In other words, students are not trained or accustomed to transfer their general value toward learning into academic engagement in math. As a result, it is explicable that no positive influence of students' utility value in learning on their math outcomes was found in the present study.

Educational Expectation

Supporting previous findings (Andres et al, 2007; Gonzales, 2007; Ma, 2001), educational expectation, to answer the fourth and fifth research questions of the present study, was found positively associated with both students' math achievement (except Asian students, as detailed in the Ethnic Difference section) and advanced math course-taking. It is clarified that students' overall educational expectancy is an important motivational component within expectancy-value model. Generally, the results imply that parents, teachers, or schools should help students set higher educational expectation, completing four-year college per se. Although it is unrealistic that all high school graduates would complete a four-year college, all students should have a clear understanding of a viable expectation and are aware that they are offered viable resources and strategies. Additionally, increasing students' expectation can be a challenging task in some cases when influenced by many surrounding factors such as parents' and teachers' expectations, learning resources etc (Franklin, 2003). Nevertheless, it is worth efforts from educators advocating completing four-year college degrees as their educational expectation during high school in order to maximize students' academic potential.

Among the three identified independent motivation variables, the present study supports a strong positive association between utility value and educational expectation (except African-American students, as detailed in the Ethnic Difference section), a moderate positive association between math self-efficacy and educational expectation (only for Asian and Caucasian students, as detailed in the Ethnic Difference section), while fails to support a statistically significant relationship between math intrinsic value and educational expectation. Bear in mind that educational expectation is attributable to higher math achievement and more advanced math course-taking, as discussed in the previous paragraph. Therefore, the present study complements the existing literature by demonstrating the positive mediating influences of educational expectation between utility value and math outcomes, and between math self-efficacy and math outcomes. It is note that utility value has no (for African-American and Hispanic students) or even negative (for Caucasian students) direct associations with math achievement and advanced course-taking as explained above. However, utility value demonstrates indirect positive relations with math outcomes via educational expectation. First, not much endeavor is needed to understand the positive linkage between utility value and educational expectation, given the fact that both concepts attach students' perceptions towards future. Specifically, when students have higher value in learning because of potential advantages for future career and life, students may be more determined to obtain higher education, which normally helps to secure future career and financial situation. Second, the positive association between math self-efficacy and educational expectation appears to indicate that students do consider math competence playing a critical role towards obtaining opportunity to enter college and increasing probability of completing college education.

Although the present study fails to uphold the hypothesis that math intrinsic value is positively related to educational expectation, the result is explicable due to several related factors. First, the relationship between math intrinsic value and educational expectation may be diluted due to that fact that the majority of students reported expectation of completing four-year college. Second, educational expectation was measured generally while intrinsic value was measured specifically within math domain. So, the effect of intrinsic value on educational expectation in the present study may have been limited. Lastly, it is also possible that the force of intrinsic value on educational expectation is only associated with intrinsic value in other subjects (e.g. reading, writing etc.), or students simply do not associate math intrinsic value with overall academic success.

Linkage between Advanced Math Course-Taking and Math Achievement

The positive relation between advanced math course-taking and math achievement is often assumed to be positive. For this reason, although not one of the main purposes of the present study, it is necessary to examine this relationship empirically, particularly with the large-scale national representative data. Hence, the linkage between advanced math course-taking and math achievement is listed as the sixth research question of the present study. In line with past research (Lee et al., 1998; Leow et al., 2004), the present study extends the present literature by supporting a strong positive relationship between students' advanced math course-taking and math achievement at 12th grade. Furthermore, this positive association has persisted after addressing the concern for previous studies lacking control for students' motivation and expectations (Leow et al., 2004). Since taking more advanced math courses will benefit students' math achievement substantially, it is potentially implied that students, regardless from high or low SES, should offer equal opportunity to access and learn advanced math courses.

Gender Differences

The purpose of investigating gender differences, which is the seventh research question of the present study, is to identify different learning characteristics generated by gender to help reduce inequity in accessing learning and educational opportunities. Since traditionally female students are considered a disadvantaged group in math studies, particularly in terms of math achievement and advanced math course-taking. In the present study, the focus group is the female group, and the reference group is the male group. In terms of mean level differences, female students demonstrated higher utility value in learning, educational expectation; but lower math self-efficacy, math intrinsic value and math achievement than those of male students. Apparently, female students value overall learning and school education, while not in favor of math subject. This pattern of gender differences appears supporting the continued presence of gender gaps associated with math (Byrnes & Takahira, 1993; Catsambis, 1994; Köller et al., 2001).

However, in terms of associations between math outcomes and motivation variables investigated in the present study, no significant gender differences were found. Consistency of patterns in the relationships between motivation variables and math achievement indicates the hypothesized conceptual model is equally viable for both genders. Generally speaking, the conceptual framework and educational implications discussed above for overall participants also apply to both gender groups separately and equally. If taking self-efficacy as an example, both girls and boys tend to have higher math achievement when they report higher math self-efficacy. In turn, this conclusion explains the fact that girls expressed lower self-efficacy, and were outperformed by boys. Accordingly, one possible approach to close the gender math gap is to focus on increasing girls' math self-efficacy, instead of other motivation factors such as utility value in learning, math intrinsic value or educational expectation.

Ethnic Differences

In line with Dee's (2004) encouragement, the purpose of investigating ethnic differences, which is the eighth research question of the present study, is to find out what differential interactions exist. Then based on this valuable information, educators and researchers may be aware of, and even utilize the differences to facilitate producing optimum academic outcomes for students across ethnic groups. Similarly, to initiate and sustain students' positive task value, self-efficacy, and educational expectation, students of different ethnicity may need different combinations of support. Non-Asian minority groups are traditionally considered disadvantaged groups in accessing learning opportunity and academic outcomes. Additionally, as per review in Chapter II, Asian and African-American students are relatively understudied in comparison with Hispanic and Caucasian students. Therefore, the focus groups were Asian, African-American and Hispanic groups, and the reference group was the Caucasian group. As expected, substantial ethnic differences emerged in the present study.

Asian students. Regarding mean level differences, Asian students reported higher math self-efficacy, math intrinsic value, utility value in learning, and higher educational expectation than their Caucasian counterparts. When considering associations between math outcomes and motivation variables investigated in the present study, Asian students were found different from Caucasian students in the following four aspects. First, math self-efficacy had no significant associations with advanced math course-taking for Asian students, while math self-efficacy demonstrated a significant positive effect for Caucasian students' advanced math course-taking, Second, the present study failed to support significant associations of utility value with math achievement, advanced math course-taking and educational expectation for Asian students, while statistically significant for Caucasian students. Third, educational expectation failed to demonstrate a significant association with math achievement for Asian students, whereas educational expectations presented significant positive associations with math achievement for other ethnic groups. Fourth, SES did not show a significant effect on Asian students' advanced math course-taking, whereas SES demonstrated strong effects on other ethnic students' advanced math course-taking. Evidently, the expectancy-value model does not work the same or is not as viable for Asian students as for Caucasian students by failing to support the aforementioned linkage among motivation and outcome variables.

The above results are inter-related and more appropriate to be interpreted as a global phenomenon. In other words, the four aforesaid findings can be more efficiently interpreted and evaluated together than separately. Parallel with explanations provided by previous studies (Ho, Dona, Sud, & Schwarzer, 2002; Lee, 2009; Scholz et al, 2002; Wilking, 2004), the different findings can be explicated from a cultural perspective. Asian cultural influences impose value on academic and school achievement with higher parental educational expectation for their children. Their sense of pride and achievement encompass success in school system and in academia, which are not necessarily true for other ethnic cultures (Ho et al., 2002). Students who grow up in an Asian culture or background tend to evaluate their performance and capabilities with strict and high standards (Ho et al., 2002; Wilking, 2004). Accordingly, Asian students may calibrate their self-efficacy more conservatively than other ethnic students, and at the same time they may also tend to set higher educational expectation. Thus, one possible explanation for the non-significant findings for Asian students may be that strong SES, self-efficacy, and educational expectation influences are diminished by cultural norms and standards (Lee, 2009). In other words, the predicting effects of SES, self-efficacy, and educational expectation toward math achievement and advanced course-taking for Asian students are not as significant or important as for other ethnic students. Lastly, it is particularly worth stressing the flattened SES gap among Asian students because SES did not show a significant effect on Asian students' advanced math course-taking, whereas SES demonstrated strong effects on other ethnic students' advanced math course-taking. Leveling learning field gap generated by SES has been an enduring mission and concern for educators and policy-makers. Therefore, a potential answer to flattening SES gap in America could be advocating of nurturing a culture that values education or create an academic-orientated atmosphere, regardless of SES, as prevailed in traditional Asian community and Asian norms (OECD, 2010).

African-American students. African-American students reported higher math intrinsic value, but also indicated lower SES, less advanced math course-taking and lower math achievement than Caucasian students in terms of mean level differences. In addition, different from balanced gender composition for other ethnic groups, a significantly more female than male American-American students were included in the analysis. As revealed by the missing data analysis in Chapter III, male African-American students were more likely to skip motivation items in the survey. Further qualitative research is needed to find out the reasons for this missing pattern. From the perspective of associations between math outcomes and motivation variables examined in the present study, African-American students were found different from Caucasian students mainly from the following three aspects.

First, African-American students' math self-efficacy did not indicate a significant relationship with advanced math course-taking, while math self-efficacy indicated a statistically significant positive influence on advanced math course-taking for Caucasian students. Despite surprise, this finding is in line with some previous studies (Vancouver & Kenndal, 2006; Vancouver, Thompson, Tischner, & Putka, 2002; Vancouver, Thompson & Williams, 2001), which even revealed a negative relationship between self-efficacy and performance. The possible explanation may be that African-American students with higher self-efficacy may tend to have a lower estimate of resources and external effort needed to be successful on exams (Vancouver & Kenndal, 2006). For instance, students with higher self-efficacy may devote less study time, or view learning materials simpler and easier than students with lower self-efficacy. Underlying this logic, students with higher math self-efficacy may be less likely to take advanced math course (Vancouver et al., 2001). Another possible explanation could be that African-American students are less likely to have access to resources including advanced math courses needed to be successful on exams in comparison with Asian and Caucasian students.

Obviously, in this scenario, students' advanced math course-taking is not associated with their levels of math self-efficacy,

Second, utility value in learning indicated no significant influence on African-American students' math achievement, while revealed a significant effect on math achievement for Caucasian students. More information are needed to well account for this finding, which, at least on the surface, indicates that African-American students are less likely to associate utility value with domain specific value (e.g. math intrinsic value). Consequently, no significant influence on domain specific (e.g. math) achievement would be detected.

Third, math intrinsic value did not indicate a statistically significant influence on African-American students' advanced math course-taking: conversely math intrinsic value indicated a significant positive association with advanced math course-taking for Caucasians students. More importantly, it is noticeable that African-American students reported higher math intrinsic value than that reported by Caucasian peers. Theoretically, higher intrinsic value leads to higher performance and higher likelihood of choosing advanced courses (Wigfield & Eccles, 2000; Eccles et al., 2004). In view of that, high self-reported math intrinsic value by African-American students could be utilized as a premise to increase their math outcomes. Hence, educators should focus on how to establish positive associations between math intrinsic value with advanced math course-taking, and with math achievement. However, the specific methods of transferring math intrinsic value into positive math engagement, and higher educational expectation, require further investigation and beyond the scope of the present study.

Hispanic Students. Similar to findings for African-American students, Hispanic students also reported higher math intrinsic value than Caucasian students; while they had lower math achievement, and lower likelihood to take advanced math courses than Caucasian peers. These findings seem to be contradictory to the expectancy-value theory that higher intrinsic value leads to higher achievements and higher likelihood of course-taking; however, these findings are consistent with some previous research on Hispanic students (Stevens et al., 2006). Actually, these results highlight the unique fit for Hispanic students on the general expectancy-value theory. As suggested by Stevens et al. (2006), educators should take advantage of Hispanic students' higher levels of math intrinsic value. They argue that with increasing demands for higher standardized test scores, Hispanic students' math intrinsic value in low autonomy classroom environments may reduce students' engagement in math activities, which results in lower achievement. Additionally, Hispanic students also reported lower educational expectations than Caucasian students. Therefore, fostering Hispanic students of higher educational expectation can be one of the feasible avenues to increase students' math outcomes. To promote higher educational expectation, Hispanic students should be explicitly assured of a clear understanding that they are offered viable resources to complete four-year college.

In terms of associations between math outcomes and motivation variables investigated in the present study, Hispanic students were found different from Caucasian students in the following three aspects. First, math self-efficacy indicated no effect on advanced math course-taking and educational expectation for Hispanic students, while conversely indicated significant positive effects for Caucasian students. Second, utility value indicated no significant influence on Hispanic students' math achievement, while again conversely revealed a significant negative influence on Caucasian students' math achievement. The two above different aspects are identical with the characteristics of African-American students. Hence, the findings can be explained in the same way as discussed in the previous African-American Students section. Third, math intrinsic value was inversely associated with Hispanic students' math achievement, while no significant relationship with math achievement for other ethnic groups. Similar to the results and findings for African-American students, educators should also particularly focus on establishing positive associations between math intrinsic value with advanced math course-taking, and with math achievement for Hispanic students.

Above all, it is necessary to underline that ethnic differences are usually perceived as a confluence of complex cultural differences (Byrnes, 2003; Gonzalez, 2007). However, culture brings out unique family contexts and individual acculturation levels, which attribute largely to within-group differences. For example, it is found that the time parents reside in America greatly influences students' educational expectation (Carpenter, 2008). Residence accretion of parents in America is just one among many contributing factors for individual acculturation levels.

Limitations and Future Research

There are three main limitations of the present study that should be noted and addressed in future research. First, despite the utilization of two waves of data and structural equation modeling, the correlational nature of this study could not draw causal inferences. As being said, experiment studies with random sampling are usually difficult to implement in social science. Second, although commonly used by previous research (Andres et al., 2007; Dalton et al., 2007; Trusty, 2000), educational expectation measured by only one item may not be the best indicator of students' actual expectation (Kirst & Venezia, 2004). Unfortunately, an unavoidable disadvantage of using archived data is the lack of flexibility in measurement. In addition, the fact that usually majority of students expect to go to college by 12th grade while reality often indicates differently, may cause dilution in revealing significant results. Third, as mentioned in the scope of the present study, many contributing factors at school, teacher, and parents' levels are excluded from the present study. Although the overall fits are acceptable or satisfying, the hypothesized models should be greatly improved if a broader range of explanatory factors are included in the present study.

Conclusion

In sum, the present study upholds and expands the viability of expectancy-value model of achievement theory with a large-scale national representative high school sample. Generally, the positive effects of math self-efficacy are reemphasized on students' advanced math course-taking and achievement across gender and ethnic groups. Nevertheless, math intrinsic value and utility value in learning have shown limited and differential linkage to students' math outcomes across ethnic groups. In light of the findings of the present study, implications of increasing students' math self-efficacy, establishing alignment between intrinsic value and course choice is highlighted, along with associating utility value with math subject, fostering a culture that values education, and creating an academic-orientated atmosphere disregard of student SES, gender and ethnicity.

References

Adams, R. J., & Wu, M. L. (2002). *PISA 2000 technical report.* Paris: OECD Publications.

Adelman, C. (2006). *The toolbox revisited: Paths to degree completion from high school through college.* Washington, DC: U. S. Department of Education.

Ainley, M., Hidi, S., & Berndorff, D. (2002). Task value, learning, and the psychological processes that mediate their relationship. *Journal of Educational Psychology, 94,* 545-561.

American Institutes for Research. (2002). *AM software* (version 0.06.03 beta) [Computer software]. Washington, DC: Author.

Andres, L., Adamuti-Trache, M., Yoon, E., Pidgeon, M., & Thomsen, J. P. (2007). Educational expectations, parental social class, gender, and postsecondary attainment: A 10-year perspective. *Youth & Society, 39,* 135-163.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84,* 191-215.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist, 28,* 117-148.

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

Bandura, A., & Locke, E. A. (2003). Negative self-efficacy and goal effects revisited. *Journal of Applied Psychology, 88,* 89–99.

Barber, C., & Torney-Purta, J. (2008). The relation of high-achieving adolescents' social perceptions and motivation to teachers' nominations for advanced programs. *Journal of Advanced Academics, 19,* 412-443.

Bong, M. (2002). Predictive utility of subject-, task-, and problem-specific self-efficacy judgments for immediate and delayed academic performances. *Journal of Experimental Education, 70,* 133-162.

Bong, M. (2001). Role of self-efficacy and task value in predicting college students' course performance and future enrollment intentions. *Contemporary Educational Psychology, 26,* 553-370.

Byrnes, J. P. (2003). Factors predictive of mathematics achievement in Caucasian, African-American, and Hispanic 12th graders. *Journal of Educational Psychology, 95,* 316-326.

Byrnes, J. P., & Takahira, S. (1993). Explaining gender differences on SAT-math items. *Developmental Psychology, 29,* 805-810.

Byrnes, J. P., & Wasik, B. A. (2009). Factors predictive of mathematics achievement in kindergarten, first and third grades: An opportunity-propensity analysis. *Contemporary Educational Psychology, 34,* 167-183.

Carpenter, D. M. II. (2008). Expectations, aspirations, and achievement among Latino students of immigrant families. *Marriage & Family Review, 43,* 164-185.

Catsambis, S. (1994).The path to math: Gender and racial-ethnic differences in mathematics participation from middle school to high school. *Sociology of Education, 67,* 199-215.

Cohen, J. (2005). *AM Software Support*. Retrived from http://am.air.org/amfaqs.asp on May 15, 2010.

Crombie, G., Sinclair, N., Silverthorn, N., Byrne, B. M., Dubois, D. L., & Trinneer, A. (2005). Predictors of young adolescents' math grades and course enrollment intentions: Gender similarities and differences. *Sex Roles, 52,* 351-367.

Dalton, B., Ingels, S. J., Downing, J., & Bozick, R. (2007). *Advanced math and science course taking in the Spring high school senior classes of 1982, 1992, and 2004 (NCES 2007-312).* Washington, DC: U. S. Department of Education, National Center for Education Statistics.

Durik, A. M., Vida, M., & Eccles, J. S. (2006). Task values and ability beliefs as predictors of high school literacy choices: A developmental analysis. *Journal of Educational Psychology, 98*, 382-393.

Eccles, J. S. (1983). Expectancies, values, and academic behaviors. In J. T. Spence (Ed.), *Achievement and achievement motivation* (pp.75-146). San Francisco: Freeman.

Eccles, J. S., Wong, C. A., & Peck, S. C. (2006). Ethnicity as a social context for the development of African-American adolescents. *Journal of School Psychology, 44,* 407-426.

Eccles, J. S., Vida, M. N., & Barber, B. (2004). The relation of early adolescents' college plans and both academic ability and task-value beliefs to subsequent college enrollment. *Journal of Early Adolescence, 24,* 63-77.

Eccles, J. S., & Wigfield, A. (1995). In the mind of the actor: The structure of adolescents' achievement task values and expectancy-related beliefs. *Personality & social psychology bulletin, 21,* 215-225.

Erickan, K., McCreith, T., & Lapointe, V. (2005). Factors associated with mathematics achievement and participation in advanced mathematics courses: an examination of gender differences form an international perspective. *School Science and Mathematics, 105,* 5-15.

Finn, J. D., Gerber, S. B., & Wang, M. C. (2002). Course offerings, course requirements, and course taking in mathematics. *Journal of Curriculum and Supervision, 17,* 4, 336-366.

Flores, L. Y., Navarro, R. L., & DeWitz, S. J. (2008). Mexican American high school students' postsecondary educational goals: Applying social cognitive career theory. *Journal of Career Assessment, 16,* 489-501.

Franklin, J. (2003). *Unlocking mathematics for minority students*. Retrieved November 29, 2010 from http://wiki.updc.org/initiatives/math/research/math%20minorities.pdf

Garson, D. (2009). *Data Imputation for Missing Values.* Retrieved February 28, 2010 from http://faculty.chass.ncsu.edu/garson/PA765/missing.htm

Gottfried, A. E., Marcoulides, G. A., Gottfried, A. W., Oliver, P. H., & Guerin, D. W. (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.

Gonzalez, L. M. (2007). College choice of Latino high school students: Influence of demographics, academic preparation, and academic self-efficacy beliefs on intended level of post-secondary institution. *Dissertation Abstract International* 69(03) (UMI No. AAT 3306587). Retrieved January 11, 2010, from Dissertations and Theses database.

Graham, S., & Weiner, B. (1996). Theories and principles of motivation. In D. C. Berliner & R. C. Calfee (Eds.), *Handbook of educational psychology* (pp. 63-84). New York: Macmillan.

Griffin, J. G. (2008). Student attitude and activities that influence student achievement. *Dissertation Abstract International,* 68(8), 3335A. (UMI No. AAT 3275013). Retrieved November 20, 2009, from Dissertations and Theses database.

Gutman, L. M. (2006). How student and parent goal orientations and classroom goal structures influence the math achievement of African Americans during the high school transition. *Contemporary Educational Psychology, 31,* 44-63.

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6,* 1-55.

Huisman, M. (2000). Imputation of missing item responses: some simple techniques. *Quality & Quantity, 34,* 331-351.

Horn, L., & Nunez, A. (2000). Mapping the road to college: First-generation students' math track, planning strategies, and context of support. *Education Statistics Quarterly, 2,* 81-86.

Ho, H. Z., Senturk, D., Lan, A. G., Zimmer, J. M., Hong, S., Okamoto, Y., et al. (2002). The affective and cognitive dimensions of math anxiety: A cross-national study. *Journal of Research in Mathematics Education, 31,* 362–379.

Ingels, S. J., Pratt, D. J., Rogers, J. E., Siegel, P. H., Stutts, E. S., & Owings, J. A. (2005). *Education longitudinal study of 2002: Base year to first follow-up data file* *documentation* (No. NCES 2006-344). Washington, DC: U.S. Department of Education. National Center for Education Statistics (NCES).

Ingels, S. J., Pratt, D. J., & Rogers, J. E., Stutts, E. S., & Owings, J. A. (2004). *Education longitudinal study of 2002: Base year data file user's manual.* (No. NCES 2004-405). Washington, DC: U.S. Department of Education. *National Center for Education Statistics (NCES).*

Jones, L. V., Davenport, E. C., Bryson, A., Berkhus, T., & Zwick, R. (1986). Mathematics and science test scores as related to courses taking in high school and other factors. *Journal of Educational Measurement, 23,* 197-208.

Kadijevich, D. (1998). Can mathematics students be successful knowledge engineers? *Journal of Interactive Learning Research, 9,* 235-248.

Kirst, M. W., & Venezia, A. (2004). *From high school to college: Improving opportunities for success in postsecondary education.* San Francisco: Jossey-Bass Publishers.

Kline, R. B. (2005). *Principles and Practice of Structural Equation Modeling Methodology in the Social Sciences.* New York: the Guilford Press.

Koller, O., Baumert, J., & Schnabel, K. (2001). Does task value matter? The relationship between academic task value and achievement in math. *Journal for Research in Math Education, 32,* 448-470.

Lee, J. (2009). Universals and specifics of math self-concept, math self-efficacy, and math anxiety. *Learning and Individual Difference, 19,* 355–365.

Lee, V. E., Burkam, D. T., Chow-Hoy, T., Smerdon, B. A., & Geverdt, D. (1998). *High school curriculum structure: Effects on course-taking and achievement in* *mathematics for high school graduates.* Washington, DC: U. S. Department of Education, Office of Educational Research and Development, National Center for Education Statistics.

Leek, M. S. (2009). Contributions of student characteristics that lead to success in alternative learning settings in American public schools. *Dissertation Abstract International,* 70(05), 639A (UMI No. AAT 3360951). Retrieved January 11, 2010, from Dissertations and Theses database.

Lent, R. W., Brown, S. D., Brenner, B., Chopra, S. B., Davis, T., Talleyrand, R., & Suthakaran, V. (2001). The role of contextual supports and barriers in the choice of math/science educational options: A test of social cognitive hypothesis. *Journal of Counseling Psychology, 48,* 474-483.

Leow, C., Marcus, S., Zanutto, E., & Boruch, R. (2004). Effects of advanced course-taking on math and science achievement: Addressing selection bias using propensity scores. *American Journal of Evaluation, 25*, 461-478.

Loehlin, J. C. (2004). *Latent variable models: An introduction to factor, path, and structural analysis* (2nd ed.). Mahwah, NJ: Erlbaum.

Long, J. F., Monoi, S., Harper, B., Knoblauch, D., & Murphy, P. K. (2007). Academic motivation and achievement among urban adolescents. *Urban Education, 42,* 196-222.

Longden, B. (2006). An institutional response to changing student expectations and their impact on retention rates. *Journal of Higher Education Policy and Management, 28,* 173–187.

Looker, D. E. (1997). In search of credentials: Factors affecting young adults' participation in postsecondary education. *Canadian Journal of Higher Education, 27*(2/3), 1-36.

Ma, X. (2001). Participation in advanced mathematics: Do expectation and influence of students, peers, teachers, and parents matter? *Contemporary Educational Psychology, 26,* 132-146.

Marcoulides, G. A., Gottfried, A. E., Gottfried, A. W., Oliver, P. H., & Guerin, D. W. (2008). A latent transition analysis of academic intrinsic motivation from childhood through adolescence. *Educational Research and Evaluation, 14,* 411-427.

Malka, A., & Covington, M. V. (2005). Perceiving school performance as instrumental to future goal attainment: Effects on graded performance. *Contemporary Educational Psychology, 30,* 60-80.

Meece, J. L., Wigfield, A., & Eccles, J. S. (1990). Predictors of math anxiety and its influence on young adolescents' course enrollment intentions and performance in math. *Journal of Educational Psychology, 82,* 60-70.

Meyers, L. S., Gramst, G., & Guarino, A. J. (2006). *Applied multivariate research: Design and interpretation.* Thousand Oaks: Sage publications, Inc.

Morgan, S. L. (1998). Adolescent educational expectations: Rationalized, fantasized or both? *Rationality and Society, 10,* 131 - 162.

Muthén, L. K., & Muthén, B. O. (2007). *Mplus user's guide.* Fifth Edition. Los Angeles, CA.

Oakes, J., Muir, K., & Joseph, R. (2000). *Course taking and achievement: inequalities that endure and change.* A keynote presentation at the National Institute for Science Education Annual Meeting, Detroit, MI.

OECD (2010). *PISA 2009 Results: What students know and can do – Student performance in reading, mathematics and science (Volume I).* Retrieved December 12, 2010 from http://dx.doi.org/10.1787/9789264091450-en

Osborne, J. W. (2001). Testing stereotype threat: Does anxiety explain race and sex differences in achievement? *Contemporary Educational Psychology, 26,* 291-310.

Özyürek, R. (2005). Informative sources of math-related self-efficacy expectations and their relationship with math-related self-efficacy, task value, and preference. *International Journal of Psychology, 40,* 145-156.

Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of Educational Research, 66,* 543–578.

Pajares, F., & Graham, L. (1999). Self-efficacy, motivation constructs, and mathematics performance of entering middle school students. *Contemporary Educational Psychology, 24,* 124-139.

Parsad, B., & Lewis, L. (2003). *Remedial education at degree-granting postsecondary institutions in Fall 2000.* Washington D. C.: National Center for Education Statistics.

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

Pintrich, P. R., & Schunk, D. H. (2002). *Motivation in education: Theory, research, and applications* (2nd ed.). Upper Saddler River, NJ: Merrill/Prentice Hall.

Renninger, K. A. (2000). Individual task value and its implications for understanding intrinsic motivation. In C. Sansone & J. M. Harackiewicz (Eds.), *Intrinsic and extrinsic motivation: The search for optimal motivation and performance* (pp. 373-404). San Diego, CA: Academic Press.

Rubin, D. B. (1976). Inference and missing data. *Biometrika, 63,* 581-592.

Rose, H., & Betts, J. R. (2001). Math matters: The links between high school curriculum, college graduation, and earnings (ISBN 1-58213-029-9). *Public Policy Institute of California.* Retrieved January 12, 2010 from http://www.ppic.org/content/pubs/report/R_701JBR.pdf

Rottinghaus, P. J., Lindley, L. D., Green, M. A., & Borgen, F. H. (2002). Educational aspirations: The contribution of personality, self-efficacy, and task values. *Journal of Vocational Behavior, 61,* 1-19.

Scholz, U., Dona, B. G., Sud, S., & Schwarzer, R. (2002). Is general self-efficacy a universal construct? Psychometric findings from 25 countries. *European Journal of Psychological Assessment, 18,* 242–251.

Schunk, D. H. (2004). *Learning theories: An educational perspective.* (4th Ed.). Pearson Education Inc., NJ: Merrill-Prentice Hall.

Schunk, D. H., & Zimmerman. B. J. (2006). Competence and control beliefs: Distinguishing the means and ends. In P. A. Alexander, & P. H. Winne (Eds.), *Handbook of educational psychology,* 349-367.

Spinath, B., & Steinmayr, R. (2008). Longitudinal analysis of intrinsic motivation and competence beliefs: Is there a relation over time? *Child Development, 79,* 1555-1569.

SPSS Inc. (2009). *SPSS base 17.0 for windows user's guide.* SPSS Inc., Chicago IL.

Stevens, T., Olivárez, A. J., & Hamman, D. (2006). The role of cognition, motivation, and emotion in explaining the mathematics achievement gap between Hispanic and Caucasian students. *Hispanic Journal of Behavioral Sciences, 28,* 161-186.

Stevens, T., Olivarez, A. J., & Lan, W. Y. (2004). Role of math self-efficacy and motivation in math performance across ethnicity. *Journal of Educational Research, 97,* 208-221.

Stevens, T., Wang, K., Olivarez Jr. A., & Hamman, D. (2007). Use of self-perspectives and their sources to predict the math enrollment intentions of girls and boys. *Sex Roles, 56,* 351-363.

Tang, M., Pan, W., & Newmeyer, M. D. (2008). Factors influencing high school students' career aspirations. *Professional School Counseling, 11,* 285-295.

Trusty, J. (2000). High educational expectations and low achievement: Stability of educational goals across adolescence. *Journal of Educational Research, 93,* 356-365.

Uitenbroek, D. G. (1997). *SISA Binomial.* Southampton: D.G. Uitenbroek. Retrieved October 05, 2010, from website at http://www.quantitativeskills.com/sisa/statistics/t-thlp.htm

Usher, E. L., & Pajares, F. (2009). Source of self-efficacy in mathematics: A validation study. *Contemporary Educational Psychology, 34,* 89-101.

U. S. Department of Education (n. d.). *The economic imperative for improving education*. Issue Papers. Retrieved January 12, 2010 from the Office of Vocational and Adult Education web site at http://www.ed.gov/about/offices/list/ovae/pi/hsinit/papers/econimp.pdf

Van De Gaer, E., Van Landeghem, G., Pustjens, H., Van Damme, J., & De Munter, A. (2007). Impact of students' and their schoolmates' achievement motivation on the status and growth in math and language achievement of boys and girls across grades 7 through 8. *Psychologica Belgica, 47,* 5-29.

Vancouver, J. B., & Kendall, L. N. (2006).When self-efficacy negatively relates to motivation and performance in a learning context. *Journal of Applied Psychology, 91,* 1146-1153.

Vancouver, J. B., Thompson, C. M., Tischner, E. C., & Putka, D. J. (2002). Two studies examining the negative effect of self-efficacy on performance. *Journal of Applied Psychology, 87,* 506–516.

Vancouver, J. B., Thompson, C. M., & Williams, A. A. (2001). The changing signs in the relationship among self-efficacy, personal goals, and performance. *Journal of Applied Psychology, 86,* 605–620

Wang, J. (2010). *Investigating high school students' course-taking in advanced mathematics within the framework of Expectancy-Value model: A multilevel analysis.* Paper presented on the annual conference of Southern Education Research Association, LA, New Orleans.

Wigfield, A., & Eccles, J. S. (2002). Introduction. In A. Wigfield & J. S. Eccles (Eds.), *Development of achievement motivation* (pp.1-11). San Diego: Academic Press.

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

Wilkins, J. M. (2004). Mathematics and science self-concept: An international investigation. The *Journal of Experimental Education, 72,* 331–346.

Wolters, C. A. (2003). Regulation of motivation: Evaluating an underemphasized aspect of self-regulated learning. *Educational Psychologist, 38,* 189-205.

Wolters, C. A. (1999). The relation between high school students' motivational regulation and their use of learning strategies, effort, and classroom performance. *Learning and Individual Differences, 11,* 1-16.

Zimmerman, B. J., Bandura, A., & Martinez-Pons, M. (1992). Self-motivation for academic attainment: The role of self-efficacy beliefs and personal goal setting. *American Educational Research Journal, 29,* 663–676.

APPENDIX A

VARIABLE CONSTRUCTION AND CLASSIFICATION

Appendix A

Variable Construction and Classification

Variables from the National Educational Longitudinal Study: 2002 (ELS: 2002) (Ingels, et al, 2004; 2005).

Dependent Variable Categorization

Advanced math course-taking (di_crs): Whether students have taken advanced math course. This variable is dichotomously coded from F1HIMATH: highest math course taken by the end of spring 2004.

Achievement (F1TXMSTD) is the standardized achievement score in math obtained at first follow up in 2004 for 12th graders.

*Educational Expectation (*di_exp*):* Whether students expect to complete four-year college. This variable is dichotomously coded from F1STEXP: students' self-reported educational expectation as they stand right now at 12th grade in 2004.

Independent Variable Categorization

Self-efficacy in math (s_eff) assesses students' perceptions of their capability for academic achievement in classroom activities (texts, assignments, exams, skills, and class performance) for math (α = .93).

1. bys89a-I'm confident that I can do an excellent job on my math tests.
2. bys89b-I'm certain I can understand the most difficult material presented in math tests.
3. bys89l-I'm confident I can understand the most complex material presented by my math teacher.
4. bys89r- I'm confident I can do an excellent job on my math assignments.

5. bys89u-I'm certain I can master the skills being taught in my math class.

Utility value (uti_v) assesses students' perceived importance, perceived usefulness in learning (α = .85).

1. bys89d- I study to get a good job.
2. bys89h-I study to increase my job opportunities.
3. bys89p-I study to ensure that my future will be financially secure.

Intrinsic value in math (int_v) measures students' intrinsic interest, enjoyment of math, and perceived personal importance of math (α = .78). The following items are reversely coded from the original dataset.

1. bys87a-When I do math, I sometimes get totally absorbed.
2. bys87c- Because doing math is fun, I wouldn't want to give it up.
3. bys87f- Math is important to me personally.

Prior achievement (BYTXMSTD) *is* the standardized achievement score in math obtained at base year survey in 2002 for 10th graders.

Female is coded 1 for female, 0 for male (recoded from BYSEX).

Socioeconomic status (SES) is a National Center for Education Statistics (NCES)–constructed composite variable computed by averaging up the standardized scores of students' parents or guardian's education, profession and household income to facilitate better comparison (BYSES1)(Ingels et al., 2004).

*Ethnicity (*BYRACE)*:* 1& 6 were dropped out; 4 & 5 were combined to indicate "Hispanic" for analyses associated with ethnicity in this study.

1 American Indian/Alaska Native, non-Hispanic

2 Asian, Hawaii/Pacific Islander, non-Hispanic

3 Black or African American, non-Hispanic

4 Hispanic, no race specified

5 Hispanic, race specified

6 Multiracial, non-Hispanic

7 White, non-Hispanic

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EDUCATION

- Aug. 2005-- May 2011 University of Houston, Houston, USA
  Ph.D in Educational Psychology and Individual Differences 3.7/4.0

- Aug. 2003 -- May 2005 Baylor University, Waco, Texas, USA.
  M.S. in Educational Psychology, GPA: 3.8/4.0

- Sep. 1996 -- Jul. 2000 Changsha University of Electric Power, P. R. China
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RESEARCH EXPERIENCE

- Aug.2007-- Aug.2010 Research assistant, Department of Educational Psychology, University of Houston, Houston TX. (Supervised by Dr. Weihua Fan) Research projects concerns investigation of students' achievement, teacher and school effectiveness using large-scale national data.

- Aug.2005 -- May 2007 Research assistant, Department of Educational Psychology, University of Houston, Houston TX. (Supervised by Dr. Chris Wolters) Research projects concerns the associations of student achievement with student motivation, cognition, particularly self-regulated learning strategies.

- Aug.2003 -- May 2004 Research assistant, Department of Educational Psychology, Baylor University, Waco, TX. (Supervised by Dr. Julie Ivey) Major research responsibility is to plan and implement team-building activities at two middle schools, Waco, TX.

GRANTS ACTIVITY

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TEACHING EXPERIENCE

- Aug. 2006 -- May 2010 Teaching assistant, Department of Educational Psychology, University of Houston, Houston, TX.

  SAER 8321 Survey Methods in Educational Research (Spring, 2010)
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DISSERTATION

- Wang. J., Wolters, C., Fan, W., Yu. S., & Horn, C. L. (2011). *Untangling the relations among students' motivation, achievement and advanced course-taking in mathematics: Using structural equation modeling with complex samples.* Unpublished Doctor of Philosophy Dissertation, University of Houston.

PRESENTATIONS & PUBLICATIONS

- Wang, J. (2010). *Investigating high school students' course-taking in advanced mathematics within the framework of Expectancy-Value model: A multilevel analysis.* Paper presented at the Annual Meeting of the Southwest Educational Research Association, New Orleans, LA.

- Wang, J. (2010). *A comparison of American to HK-Chinese students' motivation in learning mathematics: An application of structural equation modeling.* Paper accepted at the Annual Meeting of the National Council of Measurement in Education, Denver, CO.

- Wang, J., & Fan, W. (2009). *Role of self-efficacy and interest in educational expectation: A perspective from school effect.* Paper presented at the Graduate Student Organization Research Symposium, University of Houston, Houston, TX.

- Wang, J., Wolters, C. A., Fan, W., & Mueller, S. A. (2009). *Self-regulated learning strategies* *reported by college students in distance and face-to-face courses*. Paper presented at the Annual Meeting of the American Educational Research Association, San Diego, CA.

- Mueller, S. A., Wolters, C. A., Horn, C. L., Yu S. L., & Wang, J. (2009). *Investigating sense of school belonging among college students.* Paper presented at that Annual Meeting of the American Educational Research Association, San Diego, CA.

- Wang, J., & Fan, W. (2009). *Teacher factors and students' academic achievement: a national investigation across subject areas.* Paper presented at the Annual meeting of the Southwest Educational Research Association, San Antonio, TX.

- Wang, J., & Merritt, H. (2004). *University school psychology students' role in behavior intervention for middle school students*. Paper presented at the 12th Annual Professional Conference. Texas Association of School Psychologists. San Antonio, TX, USA.

- Wang, J. (2002). Application of attention regulation in college English instruction. *Journal of Yueyang Staff and Workers' College,* 3, 57-58.

- Wang, J. (2002). Improving English learning to meet the demand of China's participation in World Trade Organization. *Journal of Yueyang Economy*, *133*, 25.

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