2020

PERFORMANCE BEYOND ABILITY: EXPLORING THE RELATIONSHIP BETWEEN MOTIVATION AND MATHEMATICS ACHIEVEMENT AT COMMUNITY COLLEGES

Ezell Wesley Allen

PERFORMANCE BEYOND ABILITY: EXPLORING THE RELATIONSHIP BETWEEN MOTIVATION AND MATHEMATICS ACHIEVEMENT AT COMMUNITY COLLEGES

by

Ezell Wesley Allen

A Dissertation

Submitted in Partial Fulfillment of the

Requirements for the Degree of

Doctor of Philosophy

Major: Educational Research

The University of Memphis

May 2020

Dedication

This dissertation is dedicated to my mother Bertha, son Jeremiah, and partner Ernest, whose unyielding love, support, and encouragement have enriched my soul and inspired me to pursue and complete this research.

Acknowledgements

This work would not have been possible without the financial support of the Southern Regional Education Board and the First Generation Fellowship from the University of Memphis. I am especially indebted to Dr. Leigh Harrell-Williams, chairperson of my dissertation committee, who has been supportive of my ideas, career goals, providing emotional support, and pushing me outside my comfort zone throughout this dissertation process. I am grateful to each of the members of my dissertation committee, Dr. Christian Mueller, Dr. Dale Bowman, and Dr. Karen Kitchens, who have provided me extensive personal and professional guidance and taught me a great deal about both educational research and research in general. A special thanks to a few of my former professors, Dr. Denise Winsor, Dr. Michael Mackey, Dr. James Ford, and Dr. Yonghong Xu, for their guidance and learning opportunities during my coursework.

My completion of this dissertation could not have been accomplished without the support of my classmates – Sara, Jessica, Ashley, Crystal, and Patrick. All of you deserve a standing ovation for supporting me during my low moments throughout this process.

Nobody has been more important to me in the pursuit of this project than the members of my family. I would like to thank my parents, Mrs. Bertha M. Allen and the late Mr. Houston Monk Allen Sr., whose love and guidance are with me in whatever I pursue. I would also like to thank my son (my mini me), Jeremiah H. Allen, who has always been the reason I do the things I do. Most importantly, I wish to thank my loving and supportive partner, Dr. Ernest L. Gibson III, for his love, support, guidance, and patience. His encouragement when the times got rough are much appreciated and duly noted. He is definitely my ultimate role model.

Abstract

Mathematics achievement, both in high school and early in college, is one of the strongest predictors of college completion. Research has shown that math interest, utility, engagement, self-efficacy, and identity are related to mathematics achievement. Hence, this study uses structural equation modeling to evaluate Ford's (2017) empirical model linking mathematics beliefs and achievement, which expanded on Eccles' model of achievement-related choices (2005) and Middleton's model of mathematics achievement (2013). This study also moves beyond the Allen (2019) limitations by exploring institutions that are different in geographic locations. With the new expanded scope, this study adds to the growing body of research specifically dedicated to exploring the elements affecting mathematics achievement at the community college level. This study also surveys students in a broad range of mathematics courses, ranging from developmental/foundational courses to college/transfer level courses. Multiple institutions are used to assess regional differences and to add to the generalizability of the results. Ultimately, this study is dedicated to understanding how student mathematical achievement at the community college level can be better understood through an assessment of five motivational constructs. The results showed that the models all exhibited reasonable model fit to the proposed model for exploring mathematics achievement at the community college level. Results also showed that there were significant differences in three paths. Both the Utility to Self-Efficacy and the Engagement to Achievement pathways were not significant with College A. Additionally, the Self-Efficacy to Engagement pathway was not significant with College A, College C and the Combined college data.

Table of Contents

List of Tables

List of Figures

Chapter 1

Introduction

College mathematics achievement has been tied to college completion and retention, and choice of major and continuation in a major, especially within science, technology and mathematics (STEM) fields (Chen, 2016; Crisp, Nora, & Taggart, 2009; Daempfle, 2002; Seymour & Hewitt, 1997). Research also shows mathematics as a potential gateway major for other STEM majors. Nearly 25% of students initially majoring in mathematics switched their major to one in science, technology or engineering (Chen & Thomas, 2009). Switches like these can speak to a disinterest in mathematics, but mostly point towards how mathematics becomes a feeder for other STEM majors. More importantly, a student's mathematic achievement can directly impact their retention in a major and their success in other STEM fields (Bressoud, 2014; Cass et al., 2011). Bressoud (2014) found that a strong record of previous mathematics achievement often led to more success at the collegiate level, with students enrolled at 2-year educational institutions doing better if they were enrolled in mathematics preparatory courses. Additionally, the authors indicated the importance of looking holistically at mathematics course-taking, not just at remedial course completion. These scholars found success to be more measurable having a larger course slate (Bressoud 2014).

Over the last two decades, researchers have explored college student preparation to highlight reasons for changes or declines in student completion at 2-year and 4-year institutions (Bailey, 2009; CCSSE, 2008; Chen, 2016; Provasnik & Planty, 2008). Most recently, Chen (2016) demonstrated that success in "remedial" math courses had a strong, positive relationship with retention and graduation rates, but that student success and achievement at community colleges pale in comparison to the more traditional 4-year colleges and universities. Specifically, there is a 50% student completion rate for remedial math courses at community colleges in comparison to the nearly 60% rate at public 4-year institutions (and 54% of students at 2-year institutions are enrolled in college-level math in comparison to 85% at the 4-year institutions (Chen, 2016). While Chen (2016) was able to provide statistical information regarding success and failure, there is not much scholarship which focuses specifically on community colleges. As seen by the studies cited below, however, one can look at factors such as gender, race, class and environmental elements to better understand achievement differences. These findings highlight some of the differences between students' mathematics achievement in ways that encourage more research on mathematics achievement at community colleges. Generally, mathematics education researchers have indicated that several types of factors influence surrounding student success and persistence, including student demographics. Although certain limitations are found within research focusing in on demographics, there are fruitful revelations that are still useful. Past research demonstrates the relationship between gender and mathematics performance is often a result of socialization (Ackerman, et al., 2001; Amelink, 2012; Boswell, 1980; Frenzel, 2010; Linn & Peterson, 1986). In a discussion of gender, beliefs, and mathematics achievement, mathematics beliefs proved unrelated to final grades among male students in remedial college-level courses, but there was a significant correlation between beliefs and final grades for female students (Stage & Kloosterman, 1995). Other scholarship examines the disparities between racial groups, often citing the obstacles faced by minority or first-generation college students to achieve similar success (Treisman, 1992; Riehl, 1994; Horn, 1998; Baranchik & Cherkas, 2002). According to one study, racial representation at the instructional level greatly impacted achievement, retention, and attrition, as the gap between White and non-White students shrank with a minority instructor (Fairlie, Hoffmann, & Oreopoulos, 2014). Despite the importance of analyzing achievement along demographic lines, the limits have created a need to research other factors, elements and areas.

Additionally, previous mathematics course taken impacts student mathematics achievement in college. Specifically, the student population at community colleges is less likely to have taken gateway courses prior to enrollment (Adelman, 2005; Bettinger & Long, 2005). Within that group, Hispanic and African American students are represented disproportionately. There is also evidence which shows how minority students carry certain disadvantages into collegiate mathematics that are influenced by the combination of social demographic factors, such as race/ethnicity, and previous mathematics history (Bahr, 2010).

In addition to student demographics and level of preparedness for college, research influenced by expectancy value theory indicates that student attitudes, beliefs, and dispositions impact mathematics achievement (Bandura, 1994; Brown, et al., 2008; Porchea, et al, 2010; Fredericks & Eccles, 2002; Wigfield & Eccles, 2000; Middleton, 2013; Morris, 2016; Ford, 2017; Allen, 2018). Research which proposes to look at the relationships previously mentioned might consider three very important models of educational achievement: Eccles (1983), Middleton (2013), and Ford (2017). The Eccles et al. model of achievement-related choices (1983) introduced four elements of subjective task value which held direct impacts on achievement motivation: attainment value, intrinsic value (interest), utility value (usefulness), and cost. The model suggests a positive direct relationship exists between a student's expectancy beliefs (the perceptions they had surrounding their ability to perform a task), their task values (the thoughts surrounding the significance, usefulness, and interestingness of task) and their degree of engagement, participation, learning and achievement. The Middleton model of mathematics achievement (2013) builds off the work of Eccles (1983) and specifically looks at the relationship among various elements within expectancy value theory and mathematics achievement. The Middleton model (2013) does offer new insight into how certain task values directly influence/impact others and how that then affects mathematics achievement. Lastly, the Ford empirical model of mathematics achievement (2017) builds off of both the model of achievement related choices proposed by Eccles, et al (1983; 2002) and the Middleton model (2013). Ford (2017) maintains the work of Eccles by studying the relationship between expectancy values and achievement, keeps the specificity of Middleton (2013) by focusing on mathematics achievement, and expands on their studies by modifying the structural equation model to examine the relationship between mathematics achievement and race or ethnicity.

As the Middleton and Ford's models have mostly been explored with K-12 students, Allen (2019) investigated whether the Ford empirical model of mathematics achievement would fit for first-year community college students enrolled in a gateway math course using a sample of 346 students. These students were enrolled in multiple sections of two algebra focused remedial or gateway courses at a community college near an urban southern city within the United States. The findings of the study were in keeping with the previous research, which showed a positive direct correlation between expectancy beliefs, task values and achievement. However, the Allen (2019) and Ford (2017) results differed in the correlations between different constructs' influence on each other. For example, in Ford's model, the relationship between self-efficacy and engagement had a positive correlation, where in Allen (2019) they were not significant. This can point to the unique roles self-efficacy and engagement play in different educational settings. More specifically, it highlights how they do not function in precisely the same ways for community colleges that they do when controlling for race or ethnicity. As demonstrated by Ford's (2017) results and the positive correlation between self-efficacy and engagement, we can deduce that the relationship between racial or ethnic identity and achievement is affected by that particular pathway. Conversely, and this is perhaps because the Allen (2019) study did not focus specifically on race or ethnicity, we do not see the same direct effects or correlations in this study.

Current Study

This study broadens the scope of Allen (2019, 2020) by looking at students across a variety of math courses, not just remedial or preparatory courses, enrolled at multiple 2-year institutions. This study also moves beyond another limitation of Allen (2019, 2020) by exploring institutions that are different in geographic type by including urban and rural locations. With the new expanded scope, this study adds to the growing body of research specifically dedicated to exploring the elements affecting mathematics achievement at the community college level.

The study examines the impact different motivational constructs have on mathematics performance and achievement for students enrolled at community colleges. It utilizes the following constructs: (1) Math Identity – a person's personal or intellectual relationship to mathematics; (2) Math Self-Efficacy – a person's perception of their ability to perform within the subject; (3) Math Interest – a person's attentiveness and participatory behavior to mathematics; (4) Math Utility – a person's sense of value relating to the subject or tasks associated with it; and (5) Engagement – a person's behavioral, emotional, and cognitive interaction with the subject and its teaching or application. The study utilizes structural equation modeling to explore the fit of Ford's empirical model of mathematics achievement across community colleges, focusing on how math identity, self-efficacy, interest, utility and engagement affect a student's achievement or success in mathematics. Addressing one limitation of Allen (2019), the study surveys students in a broad range of mathematics courses, ranging from gateway courses to more advanced courses. Multiple institutions are used to assess regional differences and to add to the generalizability of the results. Ultimately, this study is dedicated to understanding how student mathematical achievement at the community college level can be better understood through an assessment of five motivational constructs.

Chapter 2

Literature Review

The following literature summarizes relevant research for understanding the larger framework of the project, the various constructs within the theory, and the model evaluated in this study. It should be noted that little research has been done on constructs in this study at two-year colleges, so the studies presented focus on findings with high school and 4-year college students. Though this study will utilize research focusing on the various types of institutions, it is important to note some of the significant differences in institutional type.

The most obvious difference is that between high school and collegiate education. For high school students, curriculum is relatively fixed with little to no room for variance, whereas collegiate curriculums offer more opportunity for choice and exploration. The high school educational experience is therefore substantially more structured than that experienced at both community colleges and traditional four-year colleges and universities. Beyond this, the age demographic is a clear difference, with high school students usually being younger than students at the other two types of institutions.

Though community colleges and traditional colleges and universities tend to share the same type of student in terms of age, they differ along lines of curriculum, enrollment, cost, and campus life. Differences among degree types are critical, as community colleges tend to offer associate degrees (including certifications and technical specialties), whereas traditional colleges and universities offer Bachelor of Arts and Science degrees. Community colleges tend towards open enrollments, where four-year institutions often have requirements and stipulations based on grade point averages and standardized test scores. Nationally, community colleges are often significantly more affordable than their four-year counterparts. And lastly, where four-year colleges and universities are predominantly residential, community colleges are more frequently commuter based. While the differences between the three types of institutions surveyed by the research cited in this study are significant, the particular focus on motivational constructs and their relationships to achievement are useful despite institutional type.

The motivational constructs utilized in the study have been informed by different but interrelated schools of thought. My framework is largely informed by expectancy value theory, which is rooted in social cognitive theory. Students form their academic identities in many of the same ways they form their larger personal identities – through interactions in the world. Social cognitive theory foregrounds the role of environment and social interaction in the formation of identities, so that a person comes to know things and themselves through observing and interacting within situations and the world (Schunk, 2012). According to Schunk (2012), individuals react from their own personal loci and less from the perceived consequences of their behavior. Schunk's (2012) work comes from the foundations laid by the noted theorist Albert Bandura. In his groundbreaking work, Bandura (1986) introduces the idea of reciprocal determinism, which is not the central concept of social cognitive theory. Reciprocal determinism states how the relationship between an individual's behaviors and personal factors or social environments is determined by mutual influencing (Bandura, 1986). Bandura's work in social cognitive theory describes these three components (behavior, personal and environment) as the cornerstone of reciprocal determinism, and those ideas inform what we know about expectancy value theory. Understanding this, social cognitive theory adds significance to a study looking at motivational constructs because expectancy value theory is a product of Bandura's work and the larger social cognitive theory field.

Expectancy value theory is concerned with the relationship between achievement and motivation, broadly considered. It is informed by social cognitive theory and can be traced to three major figures in terms of its development. Beginning in the 1950s and 60s, Atkinson pioneered the scientific study of the relationship between achievement, motivation and behavior. According to Atkinson (1950), in an environment is stable, motivation can both vacillate and become measurable. Though Atkinson was critical for introducing scientific measurement of motivation, Martin Fishbein is credited for giving the actual idea of expectancy-value theory. His idea is usually cited from his collaboration with Icek Ajzen, where he proposes that there is a connection between beliefs and attitudes, which subsequently affects behaviors (Fishbein; Ajzen 1975). Lastly, Jacquelynn Eccles (1983) would broaden the reach of expectancy-value theory by incorporating it in the field of educational studies. Within her research, she showed how the relationship between student achievement and the choices made about achievement were motivated by expectancies or expectations for success and what the field knows as subjective task values. All of the models within this study are informed by Eccles (1983) research and test different variables with expectancy-value theory.

Math Identity

The construct of math identity is concerned with the personal/intellectual relationship a student holds with the subject or their perception of whether they are, for example, a "math person." Historically, scholarship used the language of "self-concept" to describe what more contemporary scholars see as identity (Kinch, 1963). Self-concept relates to the ways in which a student conceives of their ability to learn the material of a given subject matter or to learn the behaviors associated with it (Brookover, Thomas & Paterson, 1964). Going beyond basic conception, self-concept also includes specific attitudes or understandings rooted in knowledge about one's abilities (Shavelson, Hubner & Stanton, 1976). Researchers have often associated positive self-concepts to positive results or gains within a particular activity or endeavor (Marsh & Craven, 1997). Even as there are correlations between the ideas of self-esteem and self-concept, over time studies have made distinctions between the two (Branden, 1994). Today, thanks to continued research in the field of educational and cognitive psychology, there is a much more focused understanding of self-concept, self-esteem, and self-worth as related to the larger construct of a student's academic identity (Bandura, 1977; Covington, 1984; McClellan, 2011). For the purposes of this study, math identity will be defined as the personal or intellectual relationship a person has with mathematics based on self-concept. The esteem of a student can be folded into the construct of self-efficacy, to be described later in this paper. Therefore, math identity might be understood as the extent to which a student understands themselves as a math person, asking if they believe it to be a part of their intellectual makeup.

While there is a substantial amount of research on the role of math identity, it is filtered through more specific aspects of identity, such as race, ethnicity, and gender. Specifically, earlier research explored identity only insofar as it allowed us to better understand the achievement gap. There has been extensive study on the relationship of certain identity markers and mathematical identity and how that affects achievement (Eccles, 1986; Jones, Irvin & Kibe, 2012; Riegle-Crumb & Grodsky, 2010; Robinson & Biran, 2006; Ronfeldt, Loeb & Wyckoff, 2013; Swinton et al., 2012; Werblow & Duesbery, 2009). For instance, both Riegle-Crumb & Grodsky (2010) and Swinton et al. (2011) investigated how racial identity impacts math or academic identity. Student's perception of themselves are mediated by the positive or negative views they hold about their racial identity. Depending on social factors and how those racial identities have been formed, the student's math identity can correlate to success or poor performance.

There are several studies regarding math identity or self-concept and achievement in high school students. Race or ethnicity plays a role in this relationship. Jones, Irvin, and Kibe (2012) explored how African American students' math identity is shaped by environment and geographic setting. One of the strongest factors determining whether a student's environment will have a positive or negative influence on math identity was the student's social network. When surrounded by students who they feel will be high achievers, students were more likely to have a greater self-concept related to math. In similar fashion, Robinson and Biran (2006) highlight the specific impact of racial or ethnic culture on perceptions of academic identity. Looking specifically at students who identify as African American, those students with strong cultural ties or who possess a community-based ethos are likely to have a stronger math identity.

Where race is often included in discussions of math achievement, student gender also affects students' math identity. Swinton et al. (2011) found that perceptions of achievement varied by gender within the same racial group and the change from a positive to negative math identity often occurs during the period of high school education for African Americans. Eccles (1986) studied the role of gender on math identity as gender-specific achievement is often the byproduct of how men or women see themselves in relation to the subject. For women, math identity is shaped by narratives asserting math as a field they are ill-equipped to succeed in academically and professionally (Eccles, 1986).

While race and gender are important to the shaping of students' math identity, their perception of ability is also influenced by school location, and size (Jones et al., 2012; Werblow & Duesbery, 2009). Research often indicated there were benefits to attending smaller high schools. Because of this suggestion, it is important to see if there are any direct correlations between size, location and completion/retention or dropout rates. Werblow and Duesbery (2009) found that the benefits leaned heavily towards smaller schools, as dropout rates were lower at smaller schools in comparison to larger schools. There were notable differences in how living in rural, urban or suburban communities affects students' attitudes about academic learning and achievement (Jones et al., 2012). According to Jones et al. (2012), African American students who had a greater perception of their peer group's achievement potential had a greater math self-concept themselves. The study, when looking specifically at race, found no significant difference in the relationship between math self-concept and perception of peer group across geographic lines (Jones, 2012). However, despite the fact that rural, urban, and suburban geographies had consistency in regards to race and perception, there was a very significant difference as it relates to gender. Suburban female students had a lower math self-concept in comparison to their male counterparts. Additionally, there was no significant difference in urban settings as it relates to perceptions across gender differences (Jones, 2012). Additionally, the consistency of teachers within the school impacts student performance and beliefs. College students graduating from high schools with poor teacher retention had lower academic confidence and this turnover negatively affected math identities (Ronfeldt, Loeb, & Wyckoff, 2013).

Math Self-Efficacy

Self-efficacy, or the perception of one's ability to perform or achieve, is a concept emerging from social cognitive theory that is often associated with a person's confidence. As a central construct in Bandura's (1993) social cognitive theory, it helps us to understand one of the fundamental relationships between students and their achievement. Where math identity addresses how the student views their orientation to mathematics, self-efficacy has to do more specifically with how they view their ability to perform or achieve within the subject. Operating within a certain set of conditions, Bandura (1997) outlined four elements affecting a person's self-efficacy: mastery experiences, social modeling, social persuasion, and physiological responses (1997).

The research on mathematical self-efficacy is both substantial and wide-ranging, and often provides multiple ways of understanding how critical self-efficacy is to mathematical achievement for college students (Ayotola & Adedeji, 2009; Kitsantas, Cheema & Ware, 2011; May, 2009; Prescott, 2017; Todor, 2014). Greater self-efficacy equates to higher mathematical achievement, specifically among college students (May, 2009). Just as self-efficacy has a direct effect on achievement, achievement also had a direct effect on self-efficacy (Parajes & Kranzler, 1995). For example, it was found that students who completed calculus at the collegiate level had a higher math self-efficacy than those enrolled in gateway or entry level math courses (Hall & Ponton, 2005), prompting the suggestion that developmental math curriculum should include a focus on increasing math self-efficacy.

Similar to identity, research has shown that self-efficacy is impacted by gender and race. High school students of color who fall under the category "underserved" or from lower income classes had lower self-efficacy in STEM fields than their White or more affluent peers (Garibay, 2016). Reid (2013) found that African American men who were high achievers in high school reported higher self-efficacies and achieved better performances in college.

Math Interest

Interest can be defined as both a "psychological state of attention and affect" and as a "predisposition to reengage" a topic, subject or element (Harackiewicz, Smith, & Priniski, 2016). Following this definition, interest is both cognitive and affective. Research indicates that interest in mathematics in general (not specific to educational level) leads to stronger academic achievement (Farooq & Shah, 2008; Grigg, et al., 2018; Singh, Granville & Dika, 2002). At the community college level, in particular, research found that the student's prior instructional experience had a direct impact on their interest in the subject (Wheeler & Montgomery, 2009). Regardless of demographic differences, students who participated in the study viewed the instructor as the most important element in the learning experience (Wheeler & Montgomery, 2009). This study suggests two things: that it is fruitful to examine math interest as a construct prior to the collegiate experience, and that interest cannot be completely separated from other variables.

Looking at high school students and the pre-college student population can help in understanding the math interest of community and traditional college students. The relationship between interest and achievement is often mediated by other variables. For instance, interest in math and attitudes toward math have a direct effect on participation, which, in turn, affects achievement (Farooq & Shah, 2008). Research directly points to how the correlation between interest and achievement/performance increases over time (Kim, Jiang, & Song, 2015). A more significant finding in this study was how interest proved to be a stronger predictor of achievement than utility or value expectancy, and how that correlation increased as the students got closer to college (Kim, Jiang, & Song, 2015). Despite the strong correlation between interest and achievement for the general population, race and/or ethnicity can moderate the relationship between interest and achievement, particularly across the minority-majority divide (Safavian & Conley, 2016). In examining Hispanic youth, this study found the relationship between interest and achievement to be weaker than in non-Hispanic pre-college students (Safavian & Conley, 2016). Critical to both studies was a discussion of engagement, which was accounted for differently, where one dealt with the student's educational level or progress and the other dealt with their racial or ethnic identity. Overall, however, it was found that there is a positive relationship between interest and classroom engagement as well (Kim, Jiang, & Song, 2015).

Math Utility

Utility, in foundational educational research, is often understood through the idea of task value. Mainly shaped by expectancy-value theory (Eccles et al., 1983), utility or task value is defined as the measure or value a student applies to a task in their conception of if it is worth pursuing. More specifically, math utility focuses on student perceptions about the usefulness and importance of math in their personal, academic, and/or professional lives (Eccles-Parsons, et al., 1983).

Overall, a greater belief in utility relates to a stronger performance (Kim, Jiang & Song, 2015). There is a direct relationship between utility or task value corresponding to greater achievement, as student's interest in the subject-matter grows and they take more challenging courses (Haraackiewicz, Barron, Tauer & Elliot, 2002). Math utility can positively affect success and achievement by fostering interest in a subject, and that interest can help the student become more consistent with learning the material (Harackiewicz & Hulleman, 2010). When looking at the roles played by cultural elements or other identity markers, like gender or race, representative task-value or utility has an even stronger correspondent relationship with achievement (Nagy, Trautwein, Baumert, Koller & Garrett, 2006; Shechter, Durik, Miyamoto, & Harackiewicz, 2011).

Engagement

Engagement is a complex construct to define, partially due to its multidimensionality. While some studies focus solely on one aspect of engagement (such as completing homework), engagement is widely recognized as having behavioral, emotional, and cognitive components

(Fredricks et al., 2004). Behavioral engagement can be defined as expressions of positive conduct, involvement in the academic process, and extracurricular participation. Emotional engagement deals with different forms of affect and how it shows up in the classroom. This might include a displaying of interest, boredom, or fear. Cognitive engagement "stresses investment in learning" and comes "from the literature on learning and instruction" (Fredricks et al., 2004, p. 63).

There has been extensive research on the role of engagement in achievement (Shearman et al., 2012; Lawson & Lawson, 2013; Newmann, et al., 1992; Skinner, et al., 2009; Wang, et al., 2011). Engagement often is the strongest predictor of achievement when assessing college students (Singh, Granville & Dika, 2002). Research focusing on the collegiate success and achievement of first and second-year students demonstrates the positive effects of engagement on retention and future graduation rates (Kuh, Cruce, Shoup, Kinzie & Gonyea, 2008). The positive relationship between engagement and achievement is consistent, regardless of racial, ethnic or gender differences; however, the role and nature of the environment is key to success (Moller, Stearns, Mickelson, Bottia, & Banerjee, 2014; Montt, 2011). Research indicates that students of color, students from low-income families, or those from underserved communities do not succeed because of impediments to full engagement (Boykin, 2014; Greene, Marti, & McClenney, 2008).

While there is substantial research on engagement and achievement in college, there is not much research that looks specifically at the community college setting. Greene, Marti & McClenney (2008) examined the relationships between engagement and academic performance for African American and Hispanic students enrolled at two-year colleges. Despite indicating a greater level of engagement, African American students performed poorly in comparison to their

White counterparts While Hispanic students' performance was also poor in comparison to White students, their reported levels of engagement did not differ consistently from White students (Greene, Marti & McClenney, 2008). The authors suggest African American students have to put in more effort to overcome larger social, racial, and systemic barriers, indicating the role of race as a moderator in the relationship between effort and achievement.

Motivational Constructs in Community College Setting

Although much of the scholarship on the five motivational constructs within this study look predominantly at traditional 4-year colleges and universities or make no distinction about how they operate within distinct college environments, some speculative attention can be given to how they might be impacted specifically in community college contexts. The relationship between community college students and their identity and self-efficacy is distinct because of the role community colleges play in the larger academic world. Research suggests a focus on math course placement might better help with the construct of identity or self-efficacy, as it will give students an opportunity to communicate elements not picked up by placement exams. It also highlights how students' ability to self-select into a class gives them a way to express their perceived relationship to the subject and allows them to communicate their confidence to succeed within it (Royer & Gilles, 1998).

The curriculum of community colleges is notably smaller and different from traditional 4-year colleges and universities. Students are therefore entering an environment where the study of mathematics is overshadowed by the college's culture of preparing them for specific fields. Students often take mathematics courses as gateways to other STEM majors and rarely with the intention to study mathematics beyond the required courses (Hagedorn & Purnamasari, 2012). Based on a limited mathematics curriculum in community colleges, constructs like interest and engagement can be approached from a different angle. Instructors must find innovative ways of stimulating interest, and this might mean highlighting the importance of mathematics to other areas more central to the community college educational model.

Math Utility might be the most difficult of the constructs to address in a community college setting, but it also holds the greatest promise for affecting the others in positive ways. Research has shown mathematics to be a major roadblock for student success in and completion of community college programs (Jenkins et al., 2009). While part of the failure is undoubtedly tied to notions of identity and self-efficacy, or to the level of preparation the student enters college with, it also points to how students value the subject of mathematics. Again, given how community colleges do not have a curricular culture which allows mathematics its own space, the significance of mathematics pales in comparison to how it is valued at a 4-year college. Thus, if instructors are going to overcome the relatively poor pass rates within major community colleges (Rosin, 2012), they will need to find ways of instilling value into the study of mathematics and mathematics education.

Models of Mathematics Achievement

Several researchers have proposed models related to achievement in general and mathematics achievement in particular. Foremost, Eccles et al.'s (2005) Model of Achievement-Related Choices explores the relationship between expectancy-value, subjective task value and choice with performance across various educational levels (see Figure 1). Ultimately asserting choice to be directly influenced by expectations of success and the importance/relevance assigned to a task or endeavor, Eccles et al. (2005) provide a model which helps to better understand achievement. Within the model, there are direct correlations between a student's perception of ability, intelligence or skill and their actual achievement. The student's belief and expectation for success affects how they perform in a given task.

The model also demonstrates the interaction between choice, performance and motivation. For Eccles, motive or motivational value directly influences the choices a student makes and their level of commitment. If a student can identify usefulness or utility, their effort is increased, along with the expectations for success. In addition, the student assesses the relative cost of the task, and uses it as a motivational factor for performance. Ultimately, Eccles' model provides a way to better understand how expectancy value is determined by or corresponds to the student's perception of benefit, utility or cost. It also highlights the significance of student interest and motivation, and how the process of valuing has a direct impact on achievement.

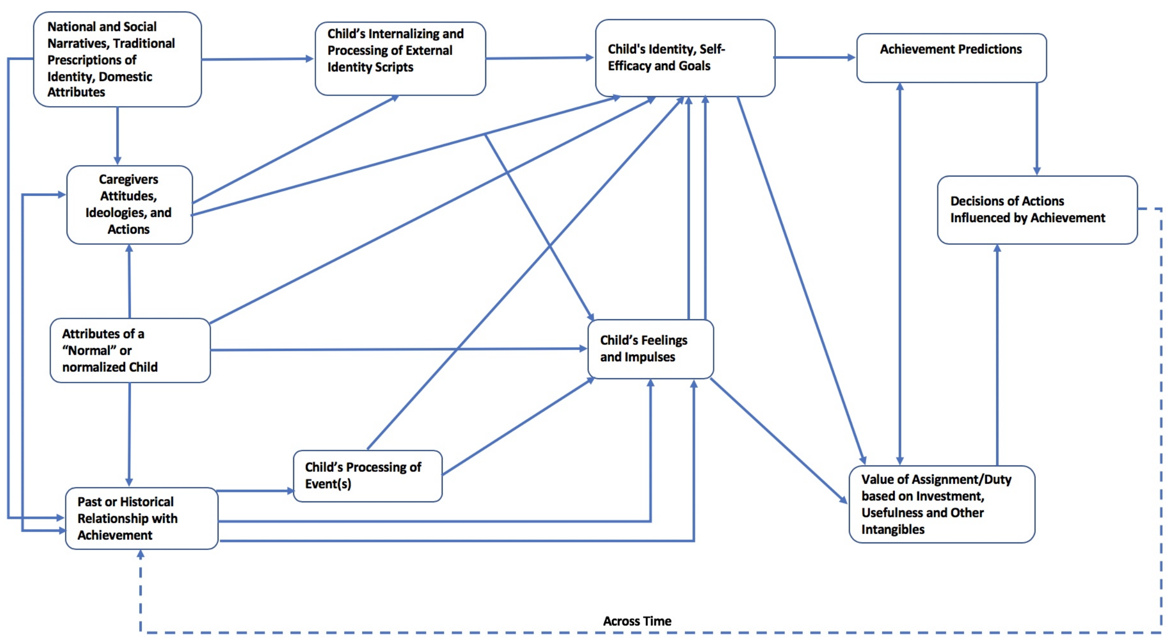

Figure 1. Eccles (2005) Model of Achievement-Related Choices.

Middleton's (2013) model of mathematics achievement builds off the Eccles's model of achievement-related choices (see Figure 2). For instance, in both models, there is a strong connection between belief or perceptions and resulting achievement. Like Eccles et al. (2005), Middleton sees a relationship between expectancy (or expectancy-value) and performance. However, Middleton focused specifically on mathematics achievement. Although the Middleton model maintains the essential components of Eccles model, it goes further in showing how variables, like utility and effort, are mediated by interest in their relationship to achievement.

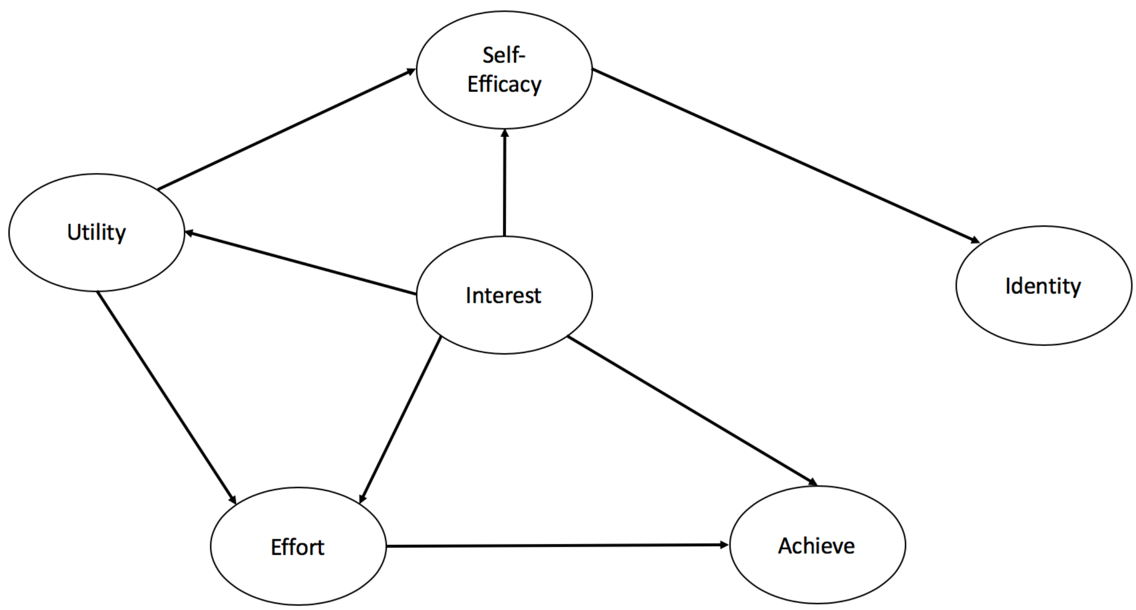

Figure 2. Middleton (2013) Model of Mathematics Achievement.

The Ford (2017) Empirical Model of Mathematics Achievement includes elements from both the Eccles and the Middleton (see Figure 3). The Ford model incorporates a few noticeable and substantial pathway changes by adding new pathways to account for recent findings surrounding relationship between mathematical identity and mathematical achievement and removing paths connecting utility to engagement, and interest to achievement due to "low standardized direct effects and variance explained found in Middleton's model" (Ford, 2017, p. 21). Ford explored the relationships among the constructs in his model in the study of mathematics achievement using a nationally representative sample of high school students in the US (HSLS: 09; Ingels et al., 2011). In terms of direct effects, Math Interest had positive, significant effects on Math Utility, Math Self-Efficacy, and Engagement. Higher levels of interest in math lead to an increased value in math, higher perceptions of self-efficacy in math, and higher levels of engagement in school. Math Utility directly impacted Math Self-Efficacy, which indicated that higher levels of math value lead to higher levels of self-efficacy. Similarly, Math Self-Efficacy had a positive impact on Engagement. Math Self-Efficacy also had a positive direct effect on Math Identity, meaning more efficacious beliefs translated into higher perceptions of one's math self-concept. Finally, Math Identity and Engagement, because of the negative direct effects, inversely relate to math assessment scores, suggesting that a student's higher sense of math identity and greater levels of student engagement translated to better performance on the math assessment. In Ford's model, 19% of the variance in math performance was explained by math interest, utility, efficacy, and identity and student engagement.

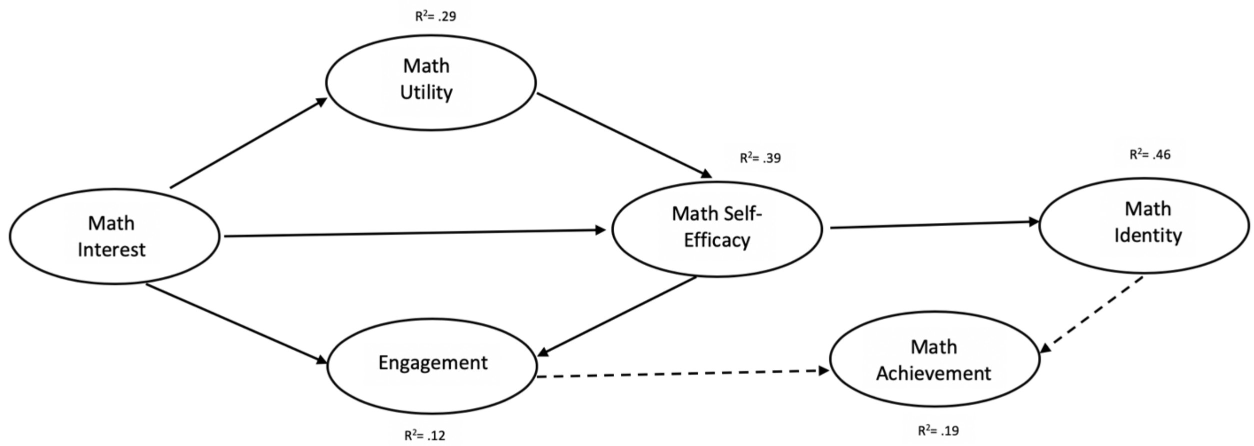

Figure 3. Ford (2017) Empirical Model of Mathematics Achievement with Standardized Estimates (Dashed line indicates negative estimate)

Exploring Mathematics Achievement in Community College Students

Given the importance of mathematics achievement and the impact of remedial course completion in collegiate success (Chen, 2016), Allen (2019, 2020) focused on evaluating the use of Ford's model with community college students enrolled in remedial math courses. Structural equation modeling was implemented using the MPlus software version 8 (Muthén & Muthén, 2011). The model resulted in all paths except Math Self-Efficacy to Engagement and Math Identity to Achievement being significant. As seen in Figure 4, most of the direct effects were positive. Math Interest had positive effects on Math Utility, Engagement, and Math Self-Efficacy. This suggests a greater interest in math produced a greater understanding of math's usefulness, greater levels of engagement in school, and greater beliefs in or perceptions of self-efficacy in math. Math Utility had a positive direct effect on Math Self-Efficacy, which indicates greater perception of math's usefulness translated to greater beliefs in or perceptions of self-efficacy in math. Additionally, Math Self-Efficacy had a positive direct effect on Math Identity, indicating greater perceptions in math ability or mathematical self-efficacy meant a greater identification with and through mathematics. Math Self-Efficacy also had an insignificant effect on Engagement. Similarly, Math Identity had an insignificant effect on Math Achievement. Lastly, Engagement had an inverse relation with Math Achievement, indicating that higher performance and achievement leads to greater mathematical engagement. Approximately 2.7% of the variance in math achievement was explained by math identity, self-efficacy, interest, utility and engagement.

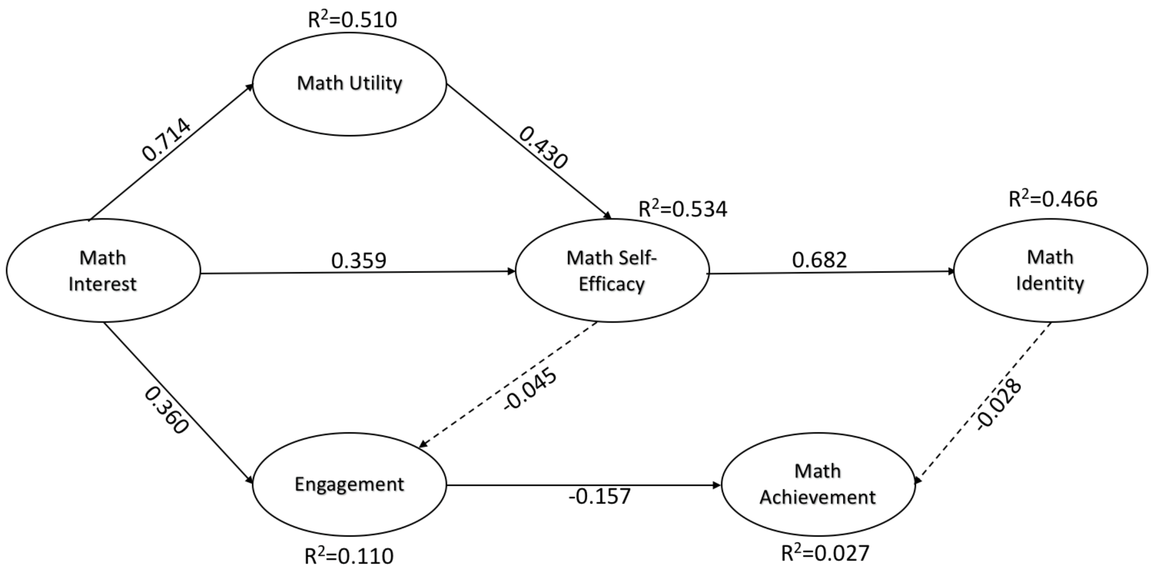

Figure 4. Allen (2019, 2020) Structural Model with Standardized Estimates
Note: Solid line indicated significance at 0.05 and dash lines indicate non-significance.

There were two major limitations in Allen (2019). The first was the population that was sampled. In only looking at students in "remedial" courses, the study was limited in scope. Additionally, the students all attended one urban community college in the South, possibly limiting the generalizability to other similar types of institutions. Secondly, the measure of engagement only focused on behavioral engagement, in order to mirror the Ford (2017) study.

Hence, this study addresses the need to examine how well the Ford model is supported in a community college setting while addressing the limitations in Allen (2019). The study collects data at three different community colleges in the southern United States, to broaden the diversity of the population. Students in both Developmental/Foundational and College/Transfer Level mathematics courses are included (see Appendix A). Additionally, the measure of engagement will be changed to include cognitive and affective in addition to behavioral. By broadening the focus of the study, comparisons across locations can be made for students enrolled in any type of math course.

Chapter 3

Methodology

This study focused on students enrolled in any undergraduate math course at three different community colleges in the southern United States.

Procedure

After IRB approval from the University of Memphis and each of the three community colleges, an email was sent to all instructors teaching a mathematics course soliciting their participation in the study. The instructors then asked their students to participate in the study. All students enrolled in a mathematics course (Developmental/Foundational or College/Transfer Level) in the Summer and Fall 2019 term were solicited to participate. The participants completed the consent form and the survey online via the University of Memphis' Qualtrics system, which was open for two specific weeks each during the Summer 2019 and Fall 2019 semesters. The participants received extra credit in their course when they presented their instructor with proof of completion.

Participants

There were a total of 6,315 students enrolled in one of 47 mathematics courses taught at the three different community colleges (See Table 1). Of the 6,315 students, 1,458 (23.1%) attempted the survey. However, only 1,234 students (84.6% of respondents) completed both the online survey and mathematics assessment during the Summer and Fall semester of 2019 (See Table 2).

Table 1. Mathematics Course Enrollment

	Summer 2019	Fall 2019	Summer and Fall 2019	Number of Courses
Developmental/Fundamental	6	77	83	
College/Transfer Level	56	237	293	
College A Totals	62	314	376	11
Developmental/Fundamental	147	1091	1238	
College/Transfer Level	437	1492	1929	
College B Totals	584	2583	3167	17
Developmental/Fundamental	184	658	842	
College/Transfer Level	637	1293	1930	
Support Course Enrollment *	113	661	774	
College C Totals	934	2612	3546	19
Total	**1467**	**4848**	**6315**	**47**

Note: *Support course students were removed from the total enrollment. These students were enrolled in a math course as well as a math support course.

Table 2. Survey Attempts vs. Completion

	Summer 2019		Fall 2019		Summer and Fall 2019	
	Survey Attempts	Complete Surveys	Survey Attempts	Complete Surveys	Survey Attempts	Complete Surveys
College A	35	32	149	123	184	155
College B	79	71	298	233	377	304
College C	245	224	652	551	897	775
Total	**359**	**327**	**1099**	**907**	**1458**	**1234**

More female students (59.3%) participated than male students (36.2%). Most students self-identified as White (65.0%) or Black or African American (25.0%) (see Table 4). Approximately 28.3% of the students were enrolled in a Developmental/Foundational mathematics course and 70.3% were enrolled in a College/Transfer level mathematics course; 1.4% of the students did not respond on which mathematics course they were enrolled. Most students were aged 20 or younger. Demographics surrounding ethnicity, as reflected in Table 4, highlight distinct differences between the three institutions. The significance is largely traceable between those student participants who identify as Black or African American and those who identify as White. In relation to ethnicity, College A had the largest percentage of Black participants (52.9%), followed by College B (32.2%) and College C (16.5%). Alternatively, College C reported the largest percentage of White participants (73.8%), followed by College B (54.6%) and College A (41.3%). It is important to note that the demographic percentages of students who participated in the voluntary survey closely reflect the ethnic demographics of the institution (See Table 3).

In relation to the type of course taken, developmental/fundamental or college/transfer level, the last two rows in Table 3 seem to mirror the last three rows in Table 4. The percent of participants in the sample reflects the percent of courses taken by the student at each school.

Table 3. Institutional Demographics

Variable	**College A** Percent	**College B** Percent	**College C** Percent
Gender			
Female	61%	60%	48.6%
Male	39%	40%	51.4%
Other	NR	NR	NR
Ethnicity			
Asian or Pacific Islander	NR	1.1%	1.33%
Black or African American	55%	30.6%	21.7%
Hispanic or Latino	2%	4.2%	1.97%
Native American American Indian	NR	0.2%	0.207%
Other	NR	0.6%	NR
White	39%	61%	71.9%
Two or more races	NR	2.3%	1.51%
Mathematics Course Enrolled (Summer and Fall 2019)			
Developmental/Foundational	22.1%	39.1%	30.4%
College/Transfer Level	77.9%	60.9%	69.6%

Note: NR denotes data not reported by institution

Table 4. Summary of Sample Demographics

	College A		College B		College C		Combined Data	
Variable	*n*	Percent	*n*	Percent	*n*	Percent	*n*	Percent
Gender								
Female	108	69.7%	203	66.8%	421	54.3%	732	59.3%
Male	40	25.8%	80	26.3%	327	42.2%	447	36.2%
Other	2	1.3%	7	2.3%	7	0.9%	16	1.3%
Prefer not to say	1	0.6%	11	3.6%	11	1.4%	23	1.9%
Transgender	4	2.6%	3	1.5%	9	1.2%	16	1.3%
Ethnicity								
Asian or Pacific Islander	1	0.6%	4	1.3%	15	1.9%	20	1.6%
Black or African American	82	52.9%	98	32.2%	128	16.5%	308	25.0%
Hispanic or Latino	5	3.2%	20	6.6%	29	3.7%	54	4.4%
Native American American Indian	0	0.0%	1	0.3%	7	0.9%	8	0.6%
Other	3	1.9%	15	4.9%	24	3.1%	42	3.4%
White	64	41.3%	166	54.6%	572	73.8%	802	65.0%
Age								
20 and under	86	55.5%	191	62.8%	552	71.2%	829	67.2%
21 to 30	40	25.8%	70	23.0%	172	22.2%	282	22.9%
31 to 40	17	11.0%	24	7.9%	22	2.8%	63	5.1%
41 to 50	11	7.1%	9	2.7%	6	0.7%	26	2.1%
50 and above	1	0.6%	4	1.3%	3	0.4%	8	0.6%
Missing/Unanswered	0	0.0%	6	2.0%	20	2.6%	26	2.1%
Mathematics Course Enrolled								
Developmental/Foundational*	35	22.6%	128	42.1%	186	24.0%	349	28.3%
College/Transfer Level *	113	72.9%	167	54.9%	588	75.9%	868	70.3%
Unanswered/ Missing	7	4.5%	9	3.0%	1	0.1%	17	1.4%

Note: * Developmental Mathematics courses include basic arithmetic, pre-algebra, elementary algebra, and intermediate algebra. For students who scored low on math placement exams, these courses must be passed before a student can enroll in a transfer-level college mathematics course, such as, pre-calculus, calculus, trigonometry, or statistics. (See Appendix A for list of courses at each school.)

Measures

Motivation. This study utilized four motivation scales (Math Identity, Math Self-Efficacy, Math Interest, and Math Utility). The scales were taken from the High School Longitudinal Study of 2009 (HSLS: 09; Ingels et al., 2011), which were used by both Middleton (2013) and Ford (2017). Table 5 presents the items on each scale. All of the motivation items used a 4-point response scale, from Strongly Disagree to Strongly Agree. Scores from these scales, showed acceptable to good internal consistency, ranging from α = 0.75 to 0.89, for all three community colleges (see Table 5). In the Ford (2017) study, a total of 18,214 students were utilized in the analysis compared to 346 students in the Allen (2019, 2020) study. In the current study a total of 1,234 students completed both the online survey and mathematics assessment during the Summer and Fall semester of 2019.

Table 5. Motivation Scale Items and Cronbach's Alpha Estimates

	Cronbach's Alpha		
Prompt and Item	**Ford (2017)**	**Allen (2019, 2020)**	**This Study Coll. A / Coll. B / Coll. C / Combined**
Math Identity How much do you agree or disagree with the following statements? 1. You see yourself as a math person. 2. Others see you as a math person.	0.84	0.87	0.83 / 0.89 / 0.87 / 0.87
Math Self-Efficacy How much do you agree or disagree with the following statements about your math course this semester? 1. You are confident that you can do an excellent job on tests in this course. 2. You are certain that you can understand the most difficult material presented in the textbook used in this course. 3. You are certain that you can master the skills being taught in this course. 4. You are confident that you can do an excellent job on assignments in this course.	0.90	0.87	0.83 / 0.87 / 0.85 / 0.85
Math Interest How much do you agree or disagree with the following statements about your math course this semester? 1. You think this class is a waste of your time.	0.78	0.76	0.80 / 0.75 / 0.78 / 0.78

Table 5. Motivation Scale Items and Cronbach's Alpha Estimates (cont.)

	Cronbach's Alpha		
Prompt and Item	**Ford (2017)**	**Allen (2019, 2020)**	**This Study Coll. A / Coll. B / Coll. C / Combined**
2. You think this class is boring.			
3. You are enjoying this class very much.			
Math Utility	0.78	0.74	0.75 / 0.75 / 0.76 / 0.76
How much do you agree or disagree with the following statements about the usefulness of your math course this semester?			
1. What students learn in this course will be useful for everyday life.			
2. What students learn in this course will be useful for college.			
3. What students learn in this course will be useful for a future career.			

Engagement. Both Ford (2017) and Allen (2019, 2020) used a single behavioral engagement scale from the 2009 HSLS baseline survey. Ford (2017) reported an acceptable Cronbach alpha estimate for the engagement scale (.67) with high school students, while Allen (2019, 2020) found somewhat lower reliability ($\alpha = 0.48$) with a sample of community college students enrolled in a remedial math class (alpha estimates are not shown in the Table 5, as I used a new engagement scale for this study). Hence, this study used the Student Course Engagement Questionnaire (SCEQ; Handelsman et al., 2005), which measures four aspects of engagement (Skills, Emotional, Participation/Interaction, and Performance) and was created specifically for use with college students. Table 6 presents the items, broken down by subscale. The items use a 5-point frequency scale (Not at all characteristic of me, Not really characteristic of me, Moderately characteristic of me, Characteristic of me, Very characteristic of me). Table 6 summarizes the subscales results from Handelsman et al. (2005), which included acceptable reliability estimates ranging from 0.76 to 0.82. The sample used in Handelsman et al. (2005) consisted of 266 undergraduate students (90 men and 176 women) with ages ranging from 18 to 56. Participants were from a variety of classes that represented two levels (upper division and lower division) in each of the following three disciplines: psychology, political science, and mathematics. The subscales result from this study included some acceptable reliability estimates. The Skills subscale ranged from 0.61 to 0.70, Emotional subscale ranged from 0.46 to 0.52, Participation/Interaction subscale ranged from 0.46 to 0.55, and the Performance subscale ranged from 0.55 to 0.68 (See Table 6).

Table 6. Student Course Engagement Questionnaire Items and Cronbach's Alpha Estimates

	Cronbach's Alpha	
Items by Subscale	**Handelman (2005)**	**This Study Coll. A / Coll. B / Coll. C / Combined**
Skills	0.82	0.61 / 0.70 / 0.62 / 0.64
Making sure to study on a regular basis		
Putting forth effort		
Doing all the homework problems		
Staying up on the readings		
Looking over class notes between classes to make sure I understand the material		
Being organized		
Taking good notes in class		
Listening carefully in class		
Coming to class every day		
Emotional	0.82	0.46 / 0.52 / 0.52 / 0.51
Finding ways to make the course materials relevant to my life		
Applying course materials to my life		
Finding ways to make the course interesting to me		
Thinking about the course between class meetings		
Really desiring to learn the material		
Participation/Interaction	0.79	0.55 / 0.47 / 0.46 / 0.48
Raising my hand in class		
Asking questions when I don't understand		
Having fun in class		
Participating actively in small-group discussions		
Going to the professor's office hours …		

Table 6. Student Course Engagement Questionnaire Items and Cronbach's Alpha Estimates (cont.)

	Cronbach's Alpha	
Items by Subscale	**Handelman (2005)**	**This Study Coll. A / Coll. B / Coll. C / Combined**
Helping fellow students		
Performance	0.76	0.55 / 0.68 / 0.57 / 0.60
Getting a good grade		
Doing well on the tests		
Being confident that a can learn and do well in the class		

***Math Achievement*.** As a means of assessing students' performance in Algebra, a 15-item, criterion-referenced forced choice mathematics assessment was used. These questions are similar in content and wording to the College Board Accuplacer College-Level Math Test (The College Board, 2016) administered by the community college, also used in Allen (2019, 2020), prior to student registration in order to place students into the appropriate mathematics course. The test measured the student's ability to solve problems that involve college-level mathematics concepts. The math questions covered: *Algebraic operations,* which included simplifying rational expressions, factoring, and expanding polynomials; *Solutions of equations and inequalities,* which included solving linear and quadratic equations and inequalities and equation systems; and *Coordinate geometry,* which included plane geometry, the coordinate plane, and straight lines. Math Achievement for all three community colleges and combined data showed an acceptable to good reliability ranging from $\alpha = 0.74$ to 0.77, which is an improvement over the .63 observed for students enrolled in remedial math Allen (2019, 2020).

Analysis

Structural equation modeling was implemented using the MPlus software version 8 (Muthén & Muthén, 2011) to assess the mathematics achievement model proposed by Ford

(2017) (see Figure 5). Model fit was assessed using multiple measures: the Chi-square test, standardized root-mean-square (SRMR), root-mean-square error of approximation (RMSEA), and comparative fit indices (CFI). The assessment values were evaluated based on CFI greater than .95, SRMR less than or equal to .10, and RMSEA less than or equal to .06, with an upper bound confidence interval less than .1 (Matsunaga, 2010). The study involved four different analyses. The first model was estimated using all of the student responses together, irrespective of institution. The remaining three analysis were estimated models for each institution to identify relationships or findings unique to each.

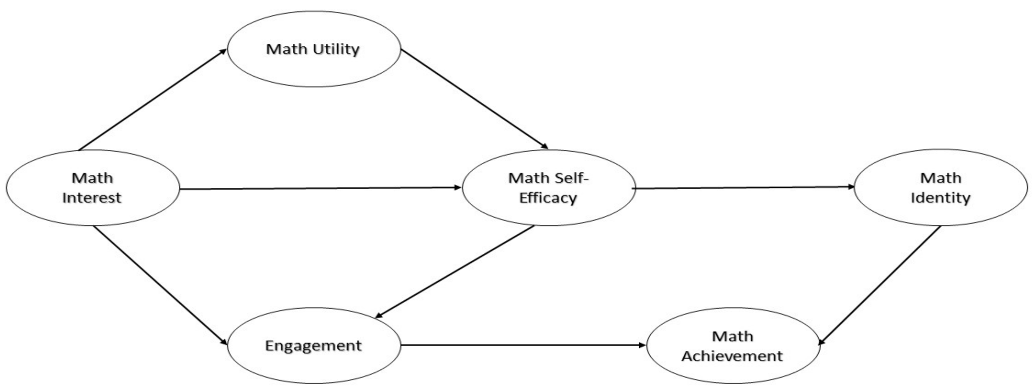

Figure 5. Ford (2017) Empirical Model of Mathematics Achievement

Chapter 4

Results

Descriptive Statistics and Initial Analyses

Data-related assumptions (Kline, 2011) were verified prior to the structural equation modeling process. These assumptions included the following: 1) observations or scores are independent, 2) there are no missing values, and 3) endogenous variables have multivariate normality. Observations were assumed to be independent, as students, at each community college, had demonstrated math ability prior to the start of their current mathematics course and had only been working with their current mathematics teacher for a short amount of time (possibly 1 – 2 weeks). Missing values were addressed at the outset of data preparation by removing students with incomplete surveys, as the integrity of the study needed full completion to assess all of the constructs and their various relationships to achievement and each other. Normality was verified if skewness and kurtosis values fell anywhere within a range from +/-2 and +/-7 respectively (Malone & Lubansky, 2012) (see Table 7). Skewness values ranged from -1.282 to 0.578, and kurtosis values ranged from -0.904 to 3.323, all of which fall between the suggested cutoffs.

Five of the scales, Math Identity, Math Self-Efficacy, Math Interest, Math Utility, and Math Achievement showed acceptable to good reliability ranging from $\alpha = 0.74$ to 0.89. The subscale Engagement (Skills) had a reliability ranging from $\alpha = 0.61$ to 0.70 (Table 7). As the other engagement scales had poor internal consistency, only the Skills subscale was used going forward.

Table 7. Descriptive Statistics Summary

College	Scale	Number of Items	α	Mean	SD	Min.	Max	Quartiles Q1	Q2	Q3	Skewness	Kurtosis
A	Identity	2	0.833	5.05	1.693	2	8	4	5	6	0.064	-0.740
	Self-Efficacy	4	0.829	8.64	2.344	4	16	8	9	10	0.346	0.900
	Interest	3	0.797	9.00	1.961	3	12	8	9	10	-0.649	0.523
	Utility	3	0.753	6.20	1.945	3	12	5	6	7	0.433	0.364
	Engagement											
	Skills	9	0.611	38.03	4.090	27	47	35	38	41	-0.105	-0.221
	Emotional	5	0.458	20.25	3.785	5	30	18	20	22	-0.349	1.124
	Participation	6	0.548	23.63	4.646	6	34	21	24	27	-1.282	2.956
	Performance	3	0.554	12.43	1.947	6	16	11	12	14	-0.290	-0.360
	Achievement	15	0.767	6.30	3.452	0	14	4	6	9	0.505	-0.689
B	Identity	2	0.889	5.50	1.698	2	8	4	6	7	-0.043	-0.904
	Self-Efficacy	4	0.869	8.64	2.506	4	16	8	8	10	0.460	0.407
	Interest	3	0.754	8.90	1.906	3	12	8	9	10	-0.652	0.713
	Utility	3	0.750	6.67	2.043	3	12	5	6	8	0.491	0.324
	Engagement											
	Skills	9	0.700	37.56	4.740	9	46	35	38	41	-0.845	3.323
	Emotional	5	0.516	20.28	3.737	5	30	18	20	23	-0.382	1.059
	Participation	6	0.468	23.71	4.464	6	33	22	24	27	-0.705	1.198
	Performance	3	0.675	12.17	2.234	3	18	10	12	14	-0.416	0.834
	Achievement	15	0.740	5.55	3.240	0	14	3	5	8	0.578	-0.586
C	Identity	2	0.869	5.05	1.709	2	8	4	5	6	0.128	-0.789
	Self-Efficacy	4	0.846	8.86	2.381	4	16	8	9	10	0.416	0.457
	Interest	3	0.783	8.67	1.980	3	12	7	9	10	-0.438	-0.080
	Utility	3	0.759	6.92	1.975	3	12	6	7	8	0.348	0.050
	Engagement											
	Skills	9	0.618	37.45	4.332	17	48	35	37	40	-0.537	0.999
	Emotional	5	0.519	20.31	4.035	5	30	18	20	23	-0.450	1.313
	Participation	6	0.458	24.09	4.289	6	36	21	24	27	-0.368	0.897
	Performance	3	0.565	11.99	2.146	3	18	10	12	14	-0.163	0.662
	Achievement	15	0.770	7.00	3.507	0	15	4	7	10	0.154	-0.912

Table 7. Descriptive Statistics Summary (cont.)

College	*Scale*	*Number of Items*	*α*	*Mean*	*SD*	*Min.*	*Max*	*Quartiles Q1*	*Q2*	*Q3*	*Skewness*	*Kurtosis*
Comb.	Identity	2	0.871	5.16	1.714	2	8	4	5	6	0.078	-0.824
	Self-Efficacy	4	0.850	8.78	2.408	4	16	8	8	10	0.415	0.480
	Interest	3	0.778	8.77	1.962	3	12	8	9	10	-0.513	0.138
	Utility	3	0.759	6.77	2.002	3	12	6	7	8	0.385	0.128
	Engagement											
	Skills	9	0.640	37.55	4.408	9	48	35	38	41	-0.591	1.678
	Emotional	5	0.510	20.30	3.930	5	30	18	20	23	-0.424	1.245
	Participation	6	0.478	23.94	4.380	6	36	21	24	27	-0.595	1.342
	Performance	3	0.595	12.09	2.148	3	18	11	12	14	-0.251	0.610
	Achievement	15	0.770	6.56	3.488	0	15	4	6	9	0.300	-0.874

Note: Comb. = All schools combined.

Bivariate correlations, between the constructs and math achievement, were evaluated to assess linearity of the relationships among constructs. Significant correlations ranged from -0.64 to 0.58 for College A, -0.49 to 0.55 for College B, -0.50 to 0.57 College C, and -0.52 to 0.56 for combined DATA (see Table 8).

Table 8. Correlation Matrix

School		Identity	Self-Efficacy	Interest	Utility	Eng. (Skills)
College A	Identity	1				
	Self-Efficacy	0.579**	1			
	Interest	-0.217**	-0.407**	1		
	Utility	0.298**	0.334**	-0.635**	1	
	Eng. (Skills)	0.038	-0.129	0.148	-0.152	1
	Achievement	-0.142	-0.185*	0.146	-0.062	0.129
College B	Identity	1				
	Self-Efficacy	0.549**	1			
	Interest	-0.257**	-0.368**	1		
	Utility	0.279**	0.431**	-0.488**	1	
	Eng. (Skills)	-0.003	-0.034	0.232**	-0.020	1
	Achievement	-0.219**	-0.115*	0.076	-0.086	0.132*
College C	Identity	1				
	Self-Efficacy	0.570**	1			
	Interest	-0.340**	-0.397**	1		
	Utility	0.387**	0.446**	-0.501**	1	
	Engagement (Skills)	-0.061	-0.123**	0.234**	-0.119**	1
	Achievement	-0.250**	-0.231**	0.212**	-0.218**	0.121**
Combined	Identity	1				
	Self-Efficacy	0.557**	1			
	Interest	-0.298**	-0.392**	1		
	Utility	0.341**	0.429**	-0.516**	1	
	Eng. (Skills)	-0.034	-0.102**	0.225**	-0.100**	1
	Achievement	-0.243**	-0.186**	0.160**	-0.151**	0.119**

Notes: ** Correlation is significant at $p < 0.01$; * Correlation is significant at $p < 0.05$. Eng. (Skills) = Skills subscale of engagement measure.

Structural Equation Modeling Results

Combined Data

A suitable fit to the data was achieved for the Measurement Model for the larger dataset containing all three schools, $\chi 2$ (179, N = 1234) = 684.958, $p < .001$; RMSEA = 0.048, TLI 0.974, and CFI = 0.978. There was also a suitable fit achieved for the Structural Model, $\chi 2$ (202, N = 1234) = 746.186, $p < .001$; RMSEA = 0.047, TLI 0.973, and CFI = 0.976.

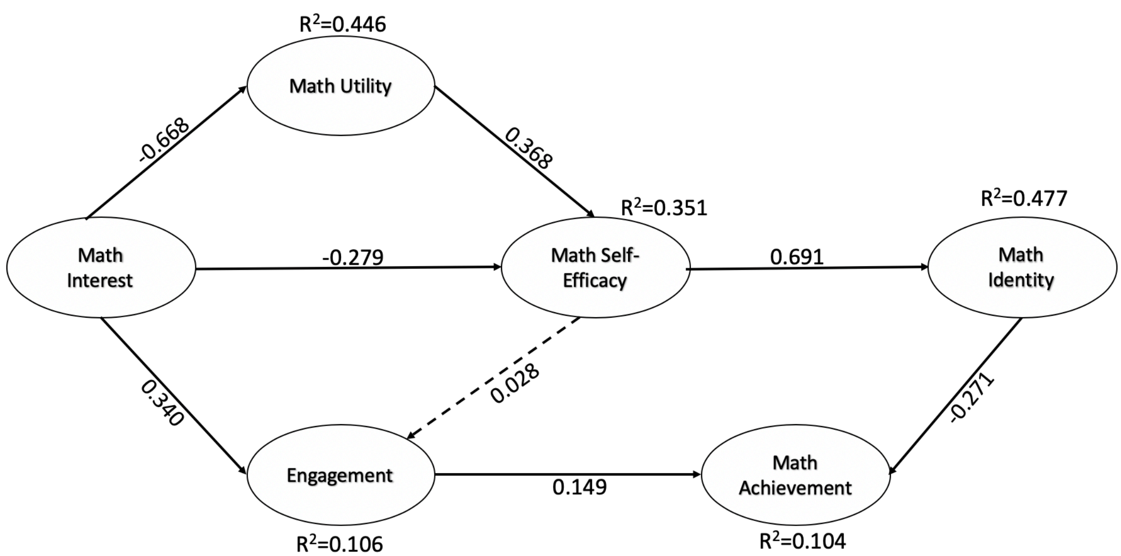

Figure 6. Structural model with standardized estimates of combined data for all schools
Note: Solid line indicated significance at 0.05 and dash lines indicate non-significance.

All paths in the model except Math Self-Efficacy to Engagement were significant. As seen in Figure 6, the majority of the direct effects were positive. Math Interest had positive effects on Engagement. This suggests a greater interest in math produced a greater level of engagement in school. Math Interest had an inverse relation with Math Utility and Math Self-Efficacy, as higher math interest scores indicated less interest based on the negative wording of the items. The negative estimates indicate that a greater understanding of math's usefulness, and greater perception in math ability or mathematical self-efficacy leads to greater mathematical interest. Math Utility had a positive direct effect on Math Self-Efficacy, which indicates greater perception of math's usefulness translated to greater beliefs in or perceptions of self-efficacy in math. Additionally, Math Self-Efficacy had a positive direct effect on Math Identity, indicating greater perceptions in math ability or mathematical self-efficacy meant a greater identification with and through mathematics. Math Self-Efficacy also had an insignificant effect on Engagement. Approximately 10.4% of the variance in math achievement was explained by math identity, self-efficacy, interest, utility and engagement.

College A Data

A suitable fit to the data was achieved for the Measurement Model, $\chi 2$ (179, N = 155) = 278.815, p < .001; RMSEA = 0.060, TLI 0.945, and CFI = 0.953. There was also a suitable fit achieved for the Structural Model, $\chi 2$ (202, N = 155) = 301.345, p < .001; RMSEA = 0.056, TLI 0.947, and CFI = 0.953.

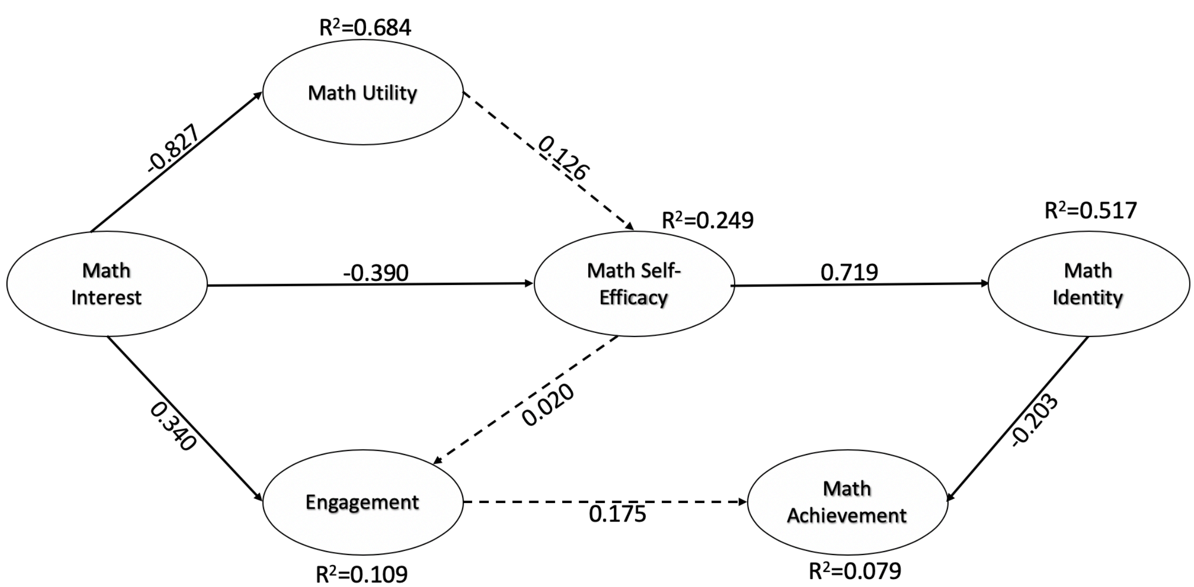

Figure 7. Structural model with standardized estimates for College A participants
Note: Solid line indicated significance at 0.05 and dash lines indicate non-significance.

Similar to the model of the combined data, the path from Math Self-Efficacy to Engagement was not significant. Also, the path from Math Utility to Math Self-Efficacy and the path from Engagement to Math Achievement were not significant. All other paths were significant. As seen in Figure 7, the majority of the direct effects were positive. Math Interest had positive effects on Engagement. This suggests a greater interest in math produced a greater level of engagement in school. Math Interest had an inverse relation with Math Utility and Math Self-Efficacy as higher math interest scores indicated less interest based on the negative wording of the items. The negative estimates indicate that a greater understanding of math's usefulness, and greater perception in math ability or mathematical self-efficacy leads to greater mathematical interest. Additionally, Math Self-Efficacy had a positive direct effect on Math Identity, indicating greater perceptions in math ability or mathematical self-efficacy meant a greater identification with and through mathematics. Math Self-Efficacy also had an insignificant effect on Engagement. Approximately 7.9% of the variance in math achievement was explained by math identity, self-efficacy, interest, utility and engagement.

College B Data

A suitable fit to the data was achieved for the Measurement Model, $\chi 2$ (179, N = 304) = 306.583, $p < .001$; RMSEA = 0.048, TLI 0.975, and CFI = 0.979. There was also a suitable fit achieved for the Structural Model, $\chi 2$ (202, N = 304) = 329.420, $p < .001$; RMSEA = 0.046, TLI 0.976, and CFI = 0.979.

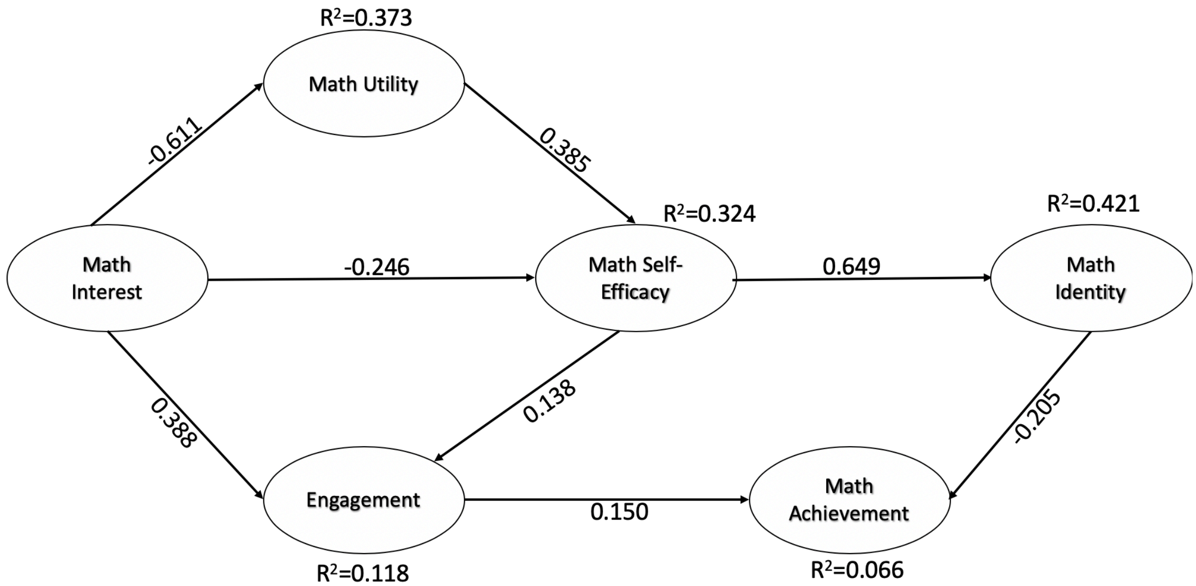

Figure 8. Structural model with standardized estimates for College B participants
Note: Solid line indicated significance at 0.05 and dash lines indicate non-significance.

All paths in the model were significant. As seen in Figure 8, the majority of the direct effects were positive. Math Interest had positive effects on Engagement. This suggests a greater interest in math produced a greater level of engagement in school. Math Interest had an inverse relation with Math Utility and Math Self-Efficacy as higher math interest scores indicated less interest based on the negative wording of the items. The negative estimates indicate that a greater understanding of math's usefulness, and greater perception in math ability or mathematical self-efficacy leads to greater mathematical interest. Math Utility had a positive direct effect on Math Self-Efficacy, which indicates greater perception of math's usefulness translated to greater beliefs in or perceptions of self-efficacy in math. Additionally, Math Self-Efficacy had a positive direct effect on Math Identity, indicating greater perceptions in math ability or mathematical self-efficacy meant a greater identification with and through mathematics. Approximately 6.6% of the variance in math achievement was explained by math identity, self-efficacy, interest, utility and engagement.

College C Data

A suitable fit to the data was achieved for the Measurement Model, $\chi 2$ (179, N = 775) = 571.146, p < .001; RMSEA = 0.053, TLI 0.967, and CFI = 0.972. There was also a suitable fit achieved for the Structural Model, $\chi 2$ (202, N = 775) = 640.069, p < .001; RMSEA = 0.053, TLI 0.963, and CFI = 0.969.

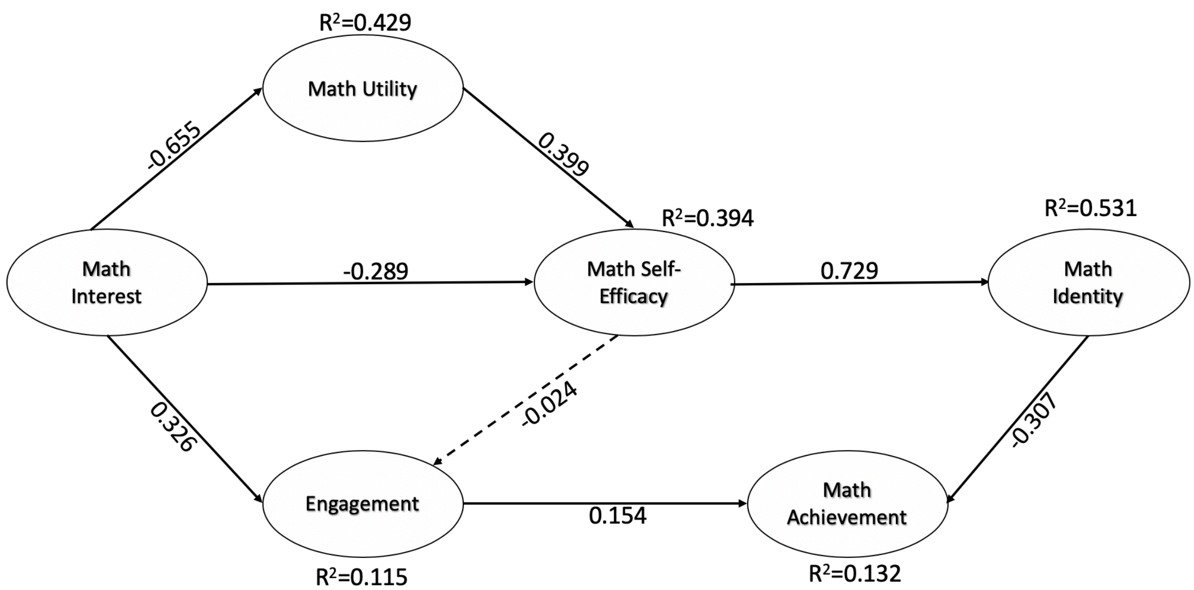

Figure 9. Structural model with standardized estimates for SUSSC participants
Note: Solid line indicated significance at 0.05 and dash lines indicate non-significance.

Similar to the model of the combined data and the College A data, the path from Math Self-Efficacy to Engagement was not significant. All other paths were significant. As seen in Figure 9, the majority of the direct effects were positive. Math Interest had positive effects on Engagement. This suggests a greater interest in math produced a greater level of engagement in school. Math Interest had an inverse relation with Math Utility and Math Self-Efficacy as higher math interest scores indicated less interest based on the negative wording of the items. The negative estimates indicate that a greater understanding of math's usefulness, and greater perception in math ability or mathematical self-efficacy leads to greater mathematical interest. Math Utility had a positive direct effect on Math Self-Efficacy, which indicates greater perception of math's usefulness translated to greater beliefs in or perceptions of self-efficacy in math. Additionally, Math Self-Efficacy had a positive direct effect on Math Identity, indicating greater perceptions in math ability or mathematical self-efficacy meant a greater identification with and through mathematics. Math Self-Efficacy also had a negative insignificant effect on Engagement. Approximately 13.2% of the variance in math achievement was explained by math identity, self-efficacy, interest, utility and engagement.

Summary of All Model Results

Table 9 below summarizes the path results for all four models. All paths for the College B data were significant. Both the Utility to Self-Efficacy and the Engagement to Achievement paths were not significant with College A. Additionally, the Self-Efficacy to Engagement path was not significant for the Combined college data, College A, and College C.

Table 9. Model Results Summary

	Model			
Paths	Combined	College A	College B	College C
Interest -> Utility	-0.668 *	-0.827 *	-0.611 *	-0.655 *
Interest -> Self-Efficacy	-0.279 *	-0.390 *	-0.246 *	-0.289 *
Interest -> Engagement	0.340 *	0.340 *	0.388 *	0.326 *
Utility -> Self-Efficacy	0.368 *	0.126	0.385 *	0.399 *
Self-Efficacy -> Identity	0.691 *	0.719 *	0.649 *	0.729 *
Self-Efficacy -> Engagement	0.028	0.020	0.138 *	-0.024
Engagement -> Achievement	0.149 *	0.175	0.150 *	0.154 *
Identity -> Achievement	-0.271 *	-0.203 *	-0.205 *	-0.307 *

Note: * indicates significant pathways.

Table 10. Measurement and Structural Model RMSEA for this study and past studies using this model

Model	Past Studies: Ford (2017)	Past Studies: Allen (2019, 2020)	This Study: Combined Data	This Study: College A	This Study: College B	This Study: College C
Measurement Model	0.049	0.087	0.048	0.060	0.048	0.053
Structural Model	0.056	0.083	0.047	0.056	0.046	0.053

Chapter 5

Discussion

This study assessed the usefulness and appropriateness of the empirical mathematics achievement model developed by Ford (2017) for a population of two-year community college students enrolled in Developmental/Foundational or College/Transfer level mathematics courses at three different community colleges in the southern United States. This study also builds on the work done in Allen (2019, 2020) where the model was used with community college students enrolled in developmental/foundational mathematics courses. Similarities and differences among the different community colleges and with findings from two previous studies using this model are discussed in the following sections.

Summary of Findings

There were similarities in terms of the direction and strength of most of the relationships observed in this study between the three community colleges and their combined data. In all the models in this studies, Math Interest had positive direct effects on Engagement, and a negative direct effect on Math Utility and Math Self-Efficacy. Math Utility had a positive direct effect on Math Self-Efficacy for all data sets except College A. For the College A data the relationship between Math Utility and Self-Efficacy was not significant. Math Self-Efficacy had positive direct effects on Math Identity for all the models in this study. Math Self-Efficacy had positive direct effects on Math Engagement for the College B data only. This path was not significant for College A, College C, or the combined data. Math Engagement had a positive direct effect on Math Achievement for all data sets except College A. For the College A data, the relationship between Math Engagement and Achievement was not significant. Lastly, Math Identity had a negative direct effect on Math Achievement for all models.

There were some findings consistent between Ford (2017), Allen (2019, 2020), and this study. The relationship between Math Interest and Engagement and between Math Self-Efficacy and Math Identity all had a positive direct effect and were significant. There were also inconsistent findings between Ford (2017), Allen (2019, 2020), and this study. In this study, the relationship between Math Interest and Utility and between Math Interest and Math Self-Efficacy were inversely related based on the negative wording of the items. In Ford (2017) and Allen (2019, 2020), those relations had a positive direct effect. In this study the mean scale score for Math Interest was greater than the mean scale score for Math Utility and Math Self-Efficacy, indicating that a greater understanding of math's usefulness, and greater perception in math ability or mathematical self-efficacy leads to greater mathematical interest. In Ford (2017) and Allen (2019, 2020) the mean scale score for Math Interest was less than the mean scale score for Math Utility and Math Self-Efficacy, suggesting that a greater interest in math produced a greater understanding of math usefulness and a greater belief in or perceptions of self-efficacy in math. In Allen (2019, 2020), the relation between Math Identity and Math Achievement was not significant. However, in Ford (2017) and this study that relationship was inversely related. In Ford (2017) and this study the mean scale score for Math Identity was less than the mean scale score for Math Achievement suggesting that a higher sense of math identity translated to better performance on the math assessment.

The model fit was better in Ford (2017) than Allen (2019, 2020) or this current study. Table 10 which shows the reported RMSEA for the measurement and structural models for Ford (2017), Allen (2019, 2020) and in this study. Ford's (2017) model, which was originally proposed with high school students, was used in Allen (2019, 2020) with developmental or foundational mathematics community college students. No attempt was made to try to improve the model fit or to fit Middleton's model, as the purpose was to see if Ford's model worked similarly for three different community colleges. There were some demographic differences in terms of enrollment among the three schools. College A was the smaller of the three institutions. And while College B and College C saw comparable enrollments overall, summer enrollment for College B was nearly 50% lower than College C. In terms of gender difference, Colleges A and B had similar percentages, with roughly 60% female students and 40% male, whereas College C saw a more even balance. In addition, there were some racial/ethnic differences, as College A had a higher percentage of African American students (55%) and Colleges B and C had larger percentages of White students (61% and 72% respectively) (See Table 1). Only 10.4% (combined data), 7.9% (College A), 6.6% (College B), and 13.2% (College C) of the variance in math achievement was dictated by the other scales: Identity, Self-Efficacy, Interest, Utility, and Engagement, whereas for Ford (2017) reported R^2 = 19% and Allen (2019, 2020) reported R^2 = 2.7%.

The Cronbach's alpha estimate for the behavioral engagement scale was higher for the high school students in Ford's study ($\alpha = 0.67$) than the community college students in the Allen (2019, 2020) study ($\alpha = 0.48$). This issue was addressed in this study by attempting to use a more comprehensive measure of engagement that has been previously validated with college students. Surprisingly, three of the engagement subscales had poor internal consistency; Emotional (α ranged from 0.46 to 0.52), Participation/Interaction (α ranged from 0.46 to 0.55), and Performance (α ranged from 0.55 to 0.68) (See Table 5). In Handelman (2005), the Cronbach's alpha estimate for the Skills subscale was higher ($\alpha = 0.82$) than in this study (α ranged from 0.61 to 0.70) (See Table 5). However, this was an improvement the reliability of the HSLS behavioral engagement scale use in Allen (2019, 2020).

Limitations

There were several limitations in the study. The greatest is that the study may suffer from self-selection bias due to the voluntary, out-of-class nature of the survey. Only 20% (1,458 out of 7,284) of the enrolled students solicited in the mathematics courses attempted the survey. However, 85% (1,234 out of 1,458) of those students who attempted the survey actually completed the survey. Since extra credit was awarded to participants, only those feeling they needed help with their grade may have participated. Also, as previously noted, incomplete surveys were removed to protect the integrity of the study. The incompletions may have been the result of survey fatigue – the phenomenon where respondents fail to fully complete or engage the survey because of boredom, disinterest or exhaustion. While the final sample size for this study was reasonable for the model being estimated, Ford (2017) had nearly five times the number of participants using a nationally representative sample that employed random sampling. It is possible that using a randomized sampling design could have led to different results. Secondly, the students attended only three urban community colleges in the South, possibly limiting the generalizability to other similar types of institutions. The study could have been enhanced by employing more community colleges in both urban and rural locations to broaden the diversity of the students.

Implications and Future Research for Community College Instruction

The aim of this study was to broadly survey the relationship between various constructs (e.g. interest, utility, engagement) and achievement. More unique to the study, however, it centered around community college students in an effort to assess the relationships with a particular group of students. Ultimately, the study echoed previous scholarship in affirming the strong parallels between math identity, interest, utility, engagement, self-efficacy and achievement (Bandura, 1993; Wigfield & Eccles, 2000; May, 2009). However, as noted by research, community college students are still achieving success at a significantly lower rate than students at traditional four-year colleges and universities (Chen, 2016). As a result, this study begs the question: What are the pedagogical initiatives needed to close the achievement gap and broaden participation in STEM fields, particularly in the area mathematics?

This study points towards many implications for community college teaching and instruction. Given the strong connection between mathematical interest and achievement, it first suggests a need for instructors to foster interest within their students. In the case of those students who arrive already scarred by previous experiences, instructors are tasked with creating new ways to renew student interest. Despite the need for instructors to incorporate new and innovative methods to stimulate interest, community colleges must understand other factors affecting achievement, specifically, students' mathematical identity. By understanding a student's personal relationship to mathematics, or by recognizing the role of self-concept, instructors can better assess the student's achievement. In addition, race, gender, and class identities are often telling of how students relate to certain subject areas. This study encourages new pedagogies where social location and difference become strong considerations in the development of curriculum and teaching activities.

In an effort to either generate interest or shape identity, instructors can incorporate more inclusive pedagogical techniques and styles. Beyond this, it is important for community college educators to teach their students the value of mathematics and mathematical study. By revealing how important and necessary math is, they can strengthen the incentive to learn and achieve. This might take the form of deviating from the textbook to reveal how mathematic ideas are readily used in day-to-day life. By showing students the usefulness of math in everyday life, the instructors will heighten their desire to succeed. In this case, instructors can rely on active learning techniques or strategies, as they blend the traditional material with contemporary learning exercises.

Future research based on this study might turn to an examination of the relationship between achievement and social identities like race, class, and gender within community colleges. The study could perform similar analysis but control for those categories as a way to evaluate larger achievement trends and gaps. As highlighted by this study, a student's academic history plays a role in their success at the community college level. In future studies, questionnaires and surveys might include questions specific to the courses a student took in high school in an effort to gauge their levels of preparation for college. In addition, studies can be done that focus on instructional or teaching demographics to see if there are any correlations between instructor types (educational or degree attainment, social factors, identity differences, et al) and student success at community colleges. Specifically, a study of major interest could assess the relationship between motivational constructs and student achievement by evaluating the instructors instead of the students.

Ultimately, this study demonstrates the strong ties between the various psychological constructs related to student beliefs about mathematics and mathematics achievement. A positive change in one construct has the potential to enhance the others. By increasing student interest by teaching of mathematics utility, instructors could positively affect a student's self-efficacy. At the community college level, these improvements can help to alter the data surrounding success and failure as completion of mathematics courses has implications for participation in STEM and degree completion. If the student enters college hating math, it is the instructor's responsibility to get them to like it. And if they simply like it, then we must get them to love it. Either way, student achievement depends on it, so let us implement activities and pedagogies that will lead up to making the relationship true: If a student likes it or loves it, they're likely to have a higher achievement in the field of mathematics.

References

Ackerman, P. L., Bowen, K. R., Beier, M. E., & Kanfer, R. (2001). Determinants of individual differences and gender differences in knowledge. *Journal of Educational Psychology, 93*(4), 797–825.

Adelman, C. (1985). The New College Course Map and Transcript Files. Washington, DC: US Department of Education.

Adelman, C. (2005). *Moving into town – and moving on: The community college in the lives of traditional – age students*. Washington, DC: US Department of Education.

Ainley, M. (2006). Connecting with learning: Motivation, affect and cognition in interest processes. *Educational Psychological Review*, *18*(1), 391-405.

Allen, E. (2019, March). *Like it or love it: Exploring elements affecting student's mathematical achievement.* Poster presentation at the 22nd Annual Conference on Research in Undergraduate Mathematics Education (RUME), Oklahoma City, OK. http://sigmaa.maa.org/rume/RUME22_Proceedings.pdf

Allen, E. (2020). Like it or love it: Exploring elements affecting student's mathematical achievement. *MathAMATYC Educator*, *11*(2), Winter 2020.

Amelink, C.T. (2012) Female Interest in Mathematics. In B. Bogue & E. Cady (Eds.). *Apply Research to Practice(ARP) Resources*. Retrieved February 10, 2016 from http://www.engr.psu.edu/AWE/ARPResources.aspx

Anthony, John . (1991). Involvement in learning: Its impact on student outcomes. *Community/Junior College Quarterly of Research and Practice*, *15*(4), 391-394.

Appleton, J. J., Christenson, S. L., Kim, D., & Reschly, A. L. (2006). Measuring cognitive and psychological engagement: Validation of the student engagement instrument. *The Journal of School Psychology, 44*, 427-445.

Association of American Colleges. (1990). Study of the arts and sciences major, challenges for college mathematics: An agenda for the next decade. Washington, DC: Mathematical Association of America.

Astin, H., & Sax, L. (1996). Developing Scientific Talent in Undergraduate Women. *The Equity Equation: Fostering the Advancement of Women in the Sciences, Mathematics, and Engineering.* San Francisco: Jossey-Bass.

Atkinson, J. W. (1957). Motivational determinants of risk-taking behavior. *Psychological Review, 64*(6), 359-372.

Atkinson, J. W. (1950). Studies in projective measurement of achievement motivation. *Microfilm Abstracts, 10*(4), 290–291.

Ayotola, A. & Adedeji, T. (2009). The relationship between mathematics self-efficacy and achievement in mathematics. *Procedia Social and Behavioral Sciences.* Vol 1, 953-957.

Bahr, P. R. (2008). Does Mathematics Remediation Work?: A Comparative Analysis of Academic Attainment among Community College Students. *Research in Higher Education. 49*, 420-450.

Bahr, P. (2010). Preparing the Underprepared: An Analysis of Racial Disparities in Postsecondary Mathematics Remediation. *The Journal of Higher Education, 81*(2), 209-237.

Bailey, Thomas (2009). Challenge and opportunity: Rethinking the role and function of developmental education in community college. New Directions for Community Colleges, *2009*(145),11-30.

Bailey, T., Jenkins, D., & Leinbach, T. (2005). Community college low-income and minority student completion study: Descriptive statistics from the 1992 high school cohort. New York: Columbia University, Teachers College, Community College Research Center.

Bandura, A. (1986). *Social foundations of thought and action: a social cognitive theory.* New Jersey: Prentice Hall.

Bandura, A. (1993). Perceived self-efficacy in cognitive development and functioning. *Educational Psychologist, 28*(2).

Bandura, A. (1994). Self-efficacy. *Encyclopedia of human behavior, 4*, 71-81.

Bandura, A. (1997). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*, 191-215.

Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Reviews Psychology, 52*, 1-20.

Baranchik, A., & Cherkas, B. (2002). Identifying Gaps in Mathematics Preparation That Contribute to Ethnic, Gender, and American/Foreign Differences in Precalculus Performance. *The Journal of Negro Education, 71*(4), 253-268.

Berger, J. B., & Milem, J. F. (1999). The role of student involvement and perceptions of integration in a causal model of student persistence. *Research in Higher Education, 40*, 641-664.

Bettinger, E., & Long, B. T. (2005). Remediation at the community college: Student participation and outcomes. *New Directions for Community Colleges, 129*, 17-26.

Boswell, S. L. (1980). *Women and Mathematics: The Development of Stereotypic Attitudes*. Boulder: Institute for Research on Social Problems.

Boykin A. W. (2014). Human Diversity, Assessment in Education and the Achievement of

Excellence and Equity. *The Journal of Negro Education, 83*(4), 499-521.

Branden, N. (1994). *Six pillars of self-esteem.* New York: Bantam.

Bressoud, D. (2014). *Attracting and Retaining Students to Complete Two- and Four-Year Undergraduate Degrees in STEM: The Role of Undergraduate Mathematics Education.* Commissioned paper prepared for the Committee on Barriers and Opportunities in Completing 2-Year and 4-Year STEM Degrees, National Academy of Sciences, Washington, DC.

Brookover, W., Thomas, S., & Paterson, A. (1964). Self-Concept of Ability and School Achievement. *Sociology of Education, 37*(3), 271-278.

Brown, S. D., Tramayne, S., Hoxha, D., Telander, K., Fan, X., & Lent, R. W. (2008). Social cognitive predictors of college students' academic performance and persistence: A meta-analytic path analysis. *Journal of Vocational Behavior, 72*(3), 298-308.

Calisi, G., & Huebner, T. (2007). *Rethinking High School: Preparing Students for Success in College, Career and Life*. San Francisco: WestEd.

Cass, C.A.P., Hazari, Z., Cribbs, J., Sadler, P.M., Sonnert, G. (2011). Examining the impact of mathematics identity on the choice of engineering careers for male and female students. Paper presented at 41stASEE/IEEE Frontiers in Education Conference. October 12–15, 2011, Rapid City, SD.

Chen, X. (2016). *Remedial Coursetaking at U.S. Public 2- and 4-Year Institutions: Scope, Experiences, and Outcomes* (NCES 2016-405). U.S. Department of Education. Washington, DC: National Center for Education Statistics. Retrieved [March 30, 2017] from http://nces.ed.gov/pubsearch.

Chen, X., & Soldner, M. (2013). STEM attrition: College students' paths into and out of STEM fields (2014- 001). Washington, DC: National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education.

Chen, X., & Thomas, W. (2009). *Students who study science, technology, engineering and mathematics (STEM) in post-secondary education*. NCES 2009-161. Washington, D.C.: U.S. Department of Education, National Center for Education Statistics.

Colomeischi, A., & Colomeischi, T. (2015). The students' emotional life and their attitude toward mathematics learning. *Procedia-Social and Behavioral Sciences, 180,* 744-750.

Community College Survey of Student Engagement (CCSSE). (2008) *High expectations and high thoughts.* Austin: University of Texas at Austin, Community College Leadership Program.

Costello, C. B. (2012). Increasing opportunities for low-income women and student parents in science, technology, engineering, and math at community colleges (IWPR Report C388). Retrieved from Institute for Women's Policy Research website http://www.iwpr.org/publications/pubs/increasing-opportunities-for- low-income-women-and-student-parents-in-science-technology-engineering-and-math-at-community-colleges

Covington, M. V. (1984). The self-worth theory of achievement motivation: Findings and implications. *The Elementary School Journal*, *85*, 5-20.

Crisp, G., Nora, A., & Taggart, A. (2009). Student Characteristics, Pre-College, College, and Environmental Factors as Predictors of Majoring in and Earning a STEM Degree: An Analysis of Students Attending a Hispanic Serving Institution. *American Educational Research Journal*, *46*(4), 924–942.

Daempfle, P. (2002).An analysis of the high attrition rates among firstyear college science, math and engineering majors. U.S. Dept. of Edu-cation, Office of Educational Research and Improvement, Educational Resources Information Center (ERIC).

Dewey, J. (1913). Interest and effort in education. Boston, MA: Houghton Mifflin.

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

Eccles, J. S. (1986). Gender-roles and women's achievement. *Educational Researcher, Vol 15*(6), 15-19.

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

Eccles, J. S. (2005). Subjective task values and the Eccles et al. model of achievement related choices. In A. J. Elliot & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 105-121). New York, NY: The Guilford Press.

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

Farooq, M. S., & Ullah Shah, S. (2008). Students' attitude towards mathematics. *Pakistan Economic and Social Review, 46*(1), 75-83.

Finn, J., & Voelkl, K. (1993). School characteristics related to student engagement. *Journal of Negro Education, 62(3), 249-268.*

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention, and behavior : an introduction to theory and research*. Reading, Mass.: Addison-Wesley Pub.

Ford, J. M. (2017). Revising Middleton's model of mathematics achievement and exploring ethnic differences across white, black, and hispanic adolescents. (Doctoral dissertation).

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School Engagement: Potential of the Concept, State of the Evidence. *Review of Educational Research*, *74*(1) p59-109.

Fredericks, J. A., & Eccles, J. S. (2002). Children's competence and value beliefs from childhood to adolescence: Growth trajectories in two "male-typed" domains. *Journal of Developmental Psychology, 38,* 519-533.

Frenzel, A. C., Goetz, T., Pekrun, R., & Watt, H. M. G. (2010). Development of mathematics interest in adolescence: Influences of gender, family, and school context. *Journal of Research on Adolescence, 20*(2), 507–537.

Garibay, G. (2017). Self-efficacy beliefs of underrepresented minorities in science, technology, engineering, and math. (Doctoral dissertation)

Green, J., Liem, G., Martin, A. J., Colmar, S., Marsh, H. W., & McInerney, D. (2012). Academic motivation, self-concept, engagement, and performance in high school: Key processes from a longitudinal perspective. *Journal of Adolescence*, *35*(5), 1111-1122.

Greene, T., Marti, C., & McClenney, K. (2008). The Effort-Outcome Gap: Differences for African American and Hispanic Community College Students in Student Engagement and Academic Achievement. *The Journal of Higher Education, 79*(5), 513-539.

Griffith, A. (2010). Persistence of women and minorities in STEM field majors? Is it the school that matters? *Economics of Education Review, 29*(6), 911-922.

Grigg, S., Perera, H. N., McIlveen, P., & Svetleff, Z. (2018). Relations among math self-efficacy, interest, intentions, and achievement: A social cognitive perspective. *Contemporary Educational Psychology, 53*, 73-86.

Grubb, N.W. & Cox, R.D. (2005). Pedagogical alignment and curricular consistency: The challenges for developmental education. *New Directions for Community Colleges*, *2005*(129), 93-103.

Hackett, G. (1985). The role of mathematics self-efficacy in the choice of mathematics related majors of college women and men. A path analysis. *Journal of Counselling Psychology*, *32*, 47-56.

Hagedorn, L. S., & Purnamasari, A. V. (2012). A Realistic Look at STEM and the Role of Community Colleges. *Community College Review*, *40*(2), 145-164.

Hall, J. M., & Ponton, M. K. (2005). Mathematics self-efficacy of college freshman. *Journal of Developmental Education, 28*(3), 26-32.

Handelsman, M.M., Briggs, W. L., Sullivan, N., Towler, A. (2005). A measure of college student course engagement. *The Journal of Educational Research, 94*(3)*,* 184-191.

Harackiewicz, J.M., Barron, K.E., Tauer, J.M. & Elliot, A.J. (2002). Predicting success in college: A longitudinal study of achievement goals and ability measures as predictors of interest and performance from freshman year through graduation. *Journal of Educational Psychology, 94,* 562-575.

Harackiewicz, J.M. & Hulleman, C.S. (2010). The importance of interest: The role of achievement goals and task values in promoting the development of interest. *Social & Personality Psychology Compass, 4,* 42-52.

Harackiewicz, J. M., Smith, J. L., & Priniski, S. J. (2016). Interest Matters: The Importance of Promoting Interest in Education. *Policy Insights from the Behavioral and Brain Sciences*, *3*(2), 220–227.

Hargens, D. K. (2013). Examining student achievement and interventions for underprepared vocational math students. (Doctoral dissertation) https://lib.dr.iastate.edu/etd/13367

Horn, L. J. (1998). *Stopouts or Stayouts? Undergraduates who leave college in their first year* (NCES 1998-087). U.S. Department of Education. Washington, DC: National Center for Education Statistics.

Ingels, S. J., Pratt, D. J., Herget, D. R., Burns, L. J., Dever, J. A., Ottem, R., Rogers, J. E., Jin, Y., & Leinwand, S. (2011). *High school longitudinal study of 2009 (HSLS: 09). Base-Year data file documentation (NCES 2011-38).* U. S. Department of Education. Washington, DC: National Center for Educational Statistics.

Jenkins, D., Jaggars, S. S., & Roksa, J. (2009). *Promoting Gatekeeper Course Success Among Community College Students Needing Remediation Findings and Recommendations from a Virginia Study (Summary Report).* Community College Research Center, Columbia University, New York, NY.

Jones, M.H., Irvin, M.J., & Kibe, G.W. (2012). Does geographic setting alter the roles of academically supportive factors? African American adolescents' friendship, math self-concept, and math performance. *The Journal of Negro Education, Vol 81, No. 4,* 319-337.

Kim, S., Jiang, Y., & Song, J. (2015). The effects of interest and utility value on mathematics engagement and achievement. *Interest in Mathematics and Science Learning.* Chapter 4, 63-78.

Kinch, J. W. (1963). The formalized theory of self-concept. *American Journal of Sociology*, LXVIII, 481-486.

Kitsantas, A., Cheema, J., & Ware, H.W. (2011). Mathematics achievement: The role of homework and self-efficacy beliefs. *Journal of Advanced Academics, 22*(2), 310-339.

Kline, R. B. (2011). *Principles and practice of structural equation modeling* (3rd ed.). New York: Guilford Press.

Kuh, G. D. (2003). What we're learning about student engagement from NSSE. Change, *35*(2), 24-32.

Kuh, G., Cruce, T., Shoup, R., Kinzie, J., & Gonyea, R. (2008). Unmasking the Effects of Student Engagement on First-Year College Grades and Persistence. *The Journal of Higher Education, 79*(5), 540-563.

Lawson, M. A., & Lawson, H. A. (2013). New conceptual frameworks for student engagement research, policy, and practice. *Review of Educational Research, 83,* 432-479.

Lee, J. (2012). College for all: Gaps between desirable and actual P-12 math achievement trajectories for college readiness. *Educational Researcher, 41*(2)*,* 43-55.

Lipnevich, A., Preckel, F., & Krumm, S. (2016). Mathematics attitudes and their unique contribution to achievement: Going over and above cognitive ability and personality. *Learning and Individual Differences, 47,* 70-79.

Linn, M. C., & Peterson, A. C. (1986). A meta-analysis of gender differences in spatial ability: Implications for mathematics and science achievement. In J.S. Hyde & M.C. Linn (eds.), *Psychology of Gender Differences: Advances through Meta-analysis* (pp. 67-101). Baltimore: Johns Hopkins Press.

Liu, X., & Koirala, H. (2009). The effect of mathematics self-efficacy on mathematics achievement on high school students. *Northeastern Educational Research Association (NERA) Annual Conference*.

Malone, P. S., & Lubansky, J. B. (2012). Preparing data for structural equation modeling: Doing your homework. In R. H. Hoyle (Ed.), *Handbook of structural equation modeling* (pp. 263-276). New York, NY, US: Guilford Press.

Marsh, H., & Craven, R. (2006). Reciprocal Effects of Self-Concept and Performance from a Multidimensional Perspective: Beyond Seductive Pleasure and Unidimensional Perspectives. *Perspectives on Psychological Science, 1*(2), 133-163.

May, D. K. (2009). Mathematics self-efficacy and anxiety questionnaire. (Doctoral dissertation)

Matsunaga, M. (2010). How to factor-analyze your data right: Do's, don't, and how-to's. *International Journal of Psychological Research, 3*(1), 97-110.

McClellan, E. (2011). Relationships among Parental Influences, Selected Demographic Factors, Adolescent Self-Concept as a Future Music Educator, and the Decision to Major in Music Education.

Middleton, J. A. (2013). More than motivation: The combined effects of critical motivational variables on middle school mathematics achievement. *Middle Grades Research Journal, 8*(1), 77-95.

Moller, S., Stearns, E., Mickelson, R., Bottia, M., & Banerjee, N. (2014). Is Academic Engagement the Panacea for Achievement in Mathematics across Racial/Ethnic Groups? Assessing the Role of Teacher Culture. *Social Forces, 92*(4), 1513-1544.

Montt, G. (2011). Cross-national Differences in Educational Achievement Inequality. *Sociology of Education, 84*(1), 49-68.

Morris, E. W., & Perry B. L. (2016). The punishment gap: School suspension and racial disparities in achievement. *Social Problems, 63*(1), 68-86.

Muthén, L. K., & Muthén, B. O. (1998-2011). Mplus User's Guide. Sixth Edition. Los Angeles, CA: Muthén & Muthén.

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

Napoli, A. R., & Wortman, P. M. (1998). Psychosocial factors related to retention and early departure of two-year community colleges students. *Research in Higher Education, 39*(4), 419-456.

Newmann, F., Wehlage, G. G., & Lamborn, S. D. (1992). The significance and sources of student engagement. In F. Newmann (Ed.), *Student engagement and achievement in American secondary schools* (pp. 11-39). New York: Teachers College Press.

Olson, S. & Riordan, D. G. (2012). *Engage to Excel: Producing One Million Additional College Graduates with Degrees in Science, Technology, Engineering, and Mathematics*. Washington, DC: Executive Office of the President.

Parajes, F. & Kranzler, J. (1995). Self-efficacy beliefs and general mental ability in mathematical problem-solving. *Contemporary Educational Psychology*, *26*, 426-443.

Park, S. (2005). Student engagement and classroom variables in improving mathematics achievement. *Asia Pacific Education Review, 6*(1), 87-97.

Porchea, S., Allen, J., Robbins, S. & Phelps, R. (2010). Predictors of Long-Term Enrollment and Degree Outcomes for Community College Students: Integrating Academic, Psychosocial, Socio-demographic, and Situational Factors. *The Journal of Higher Education*, *81*(6), 680-708.

Prescott, E. (2017). Examining the relationship between math achievement and self-efficacy in developmental math students. (Doctoral dissertation)

Prichard, G. R. (1995). The NCTM Standards and Community Colleges: Opportunities and Challenges. *Community College Review*, *23*(1), 23–32.

Provasnik, S., & Planty, M. (2008). *Community colleges: Special supplement to the condition of education 2008*. Washington, DC: National Center for Education Statistics.

Reid, K. W. (2013). Understanding the Relationships among Racial Identity, Self-Efficacy, Institutional Integration and Academic Achievement of Black Males Attending Research Universities. *The Journal of Negro Education, 82*(1), 75-93.

Riegle-Crumb, C., & Grodsky, E. (2010). Racial-ethnic differences at the intersection of math course-taking and achievement. *Sociology of Education*, *83*(3)*,* 248-270.

Riehl, R. (1994). The academic preparation, aspirations, and first-year performance of first-generation students. *College and University*, *70*(1)*,* 14-19.

Robinson, J. & Biran, M. (2006). Discovering self: Relationship between African identity and academic achievement. *Journal of Black Studies*, *37*(1)*,* 46-68.

Ronfeldt, M., Loeb, S., & Wyckoff, J. (2013). How teacher turnover harms student achievement. *American Educational Research Journal, 50*(1), 4 – 36.

Rosin, M. (2012). With Long-term consequences, community colleges students struggle to pass college-level math courses. *EdSource: Highlighting Strategies for Student Success*.

Royer, D. J., Gilles, R. (1998). Directed self-placement: An attitude of orientation. *College Composition and Communication*, *50*(1), 54–70.

Ryan, R.M. & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *American Psychological Association, Inc*, *55*(1)*,* 68-78.

Safavian, N., & Conley, A. (2016). Expectancy-Value Beliefs of Early-Adolescent Hispanic and Non-Hispanic Youth: Predictors of Mathematics Achievement and Enrollment. *AERA Open*.

Sansone, C., & Harackiewicz, J. M. (Eds.). (2000). Intrinsic and extrinsic motivation: The search for optimal motivation and performance. San Diego, CA, US: Academic Press.

Schunk, D. H. (2012). Social cognitive theory. In K. R. Harris, S. Graham, & T. Urdan (Eds.), *APA educational psychology handbook, Vol. 1: Theories, constructs, and critical issues* (pp. 101–123). Washington, DC: American Psychological Association.

Sciarra, D. T., & Seirup, J. (2008). The multidimensionality of school engagement and math achievement among racial groups. *Professional School Counseling, 11*(4), 218-228.

Seymour, E., & Hewitt, N. (1997). *Talking About Leaving: Why Undergraduates Leave the Sciences.* Boulder, Colo.: Westview Press.

Shavelson, R. J., Hubner, J., & Stanton, G. (1976). Self-concept: Validation of construct interpretations. *Review of Education Research*, *46*, 407-441.

Shechter, O.G., Durik, A.M., Miyamoto, Y. & Harackiewicz, J.M. (2011). The role of utility value in achievement behavior: The importance of culture. *Personality and Social Psychology Bulletin, 37,* 303-317.

Singh, K., Granville, M., & Dika, S. (2002). Mathematics and science achievement: Effects of motivation, interest, and academic engagement. *The Journal of Educational Research, 95*(6), 323-332.

Skinner, E. A., Kindermann, T. A., Connell, J. P., & Wellborn, J. G. (2009). Engagement as an organizational construct in the dynamics of motivational development. In K. Wentzel, & A. Wigfield (Eds.), *Handbook for motivation in school* (pp. 223-245). Malwah, NJ: Erlbaum.

Stage, F., & Kloosterman, P. (1995). Gender, Beliefs, and Achievement in Remedial College-Level Mathematics. *The Journal of Higher Education, 66*(3), 294-311.

Stigler, J. W., Givvin, K. B. & Thompson, B. J. (2013). *What community college developmental mathematics students understand about mathematics*. The Carnegie Foundation for the Advancement of Teaching.

Swinton, A.D., Kurtz-Costes, B, Rowley, S.J., & Okeke-Adeyanju, N. (2012). A longitudinal examination of African American adolescents' attributions about achievement outcomes. *Child Development, 82*(5), 1486-1500.

The College Board (2016). *Accuplacer College Level Mathematics Test*. Retrieved from https://accuplacer.collegeboard.org/?navId=accu-lu

Todor, I. (2014). Investigating "The Old Stereotype" about boys/girls and mathematics: Gender differences in implicit theory of intelligence and mathematics self-efficacy beliefs. *Procedia - Social and Behavioral Sciences, 159*, 319-323.

Treisman, U. (1992). Studying students studying calculus: A look at the lives of minority mathematics students in college. *The College Mathematics Journal, 23*(5), 362-372.

Umoh, U., Eddy, J., & Spaulding, D. (1994). Factors Related to Student Retention in Community College Developmental Education Mathematics. *Community College Review, 22*(2), 37-47.

Wang, M., Willett, J. B., & Eccles, J. S. (2011). The assessment of school engagement: Examining dimensionality and measurement invariance by gender and race/ethnicity. *Journal of School Psychology, 49,* 465-480.

Werblow, J. & Duesbery, L. (2009). The impact of high school size on math achievement and dropout rate. *The High School Journal, 92*(3), 14-23.

Wheeler, D. L., & Montgomery, D. (2009). Community college students' views on learning mathematics in terms of their epistemological beliefs: A Q method study. *Educational Studies in Mathematics, 72*(3), 289-306.

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

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

Appendix A

List of Community College Courses

College A

Developmental / Foundational Mathematics Courses

DMTH 1304 Foundations of Mathematics

DMTH 1424 Foundations of Algebra

College / Transfer Level Mathematics Courses

MATH 1103 Applied Technical Mathematics

MATH 1113 College Algebra

MATH 1213 Quantitative Reasoning

MATH 2103 Survey of Calculus

MATH 2113 Math for Teachers I

MATH 2115 Calculus I

MATH 2123 Math for Teachers II

MATH 2124 Calculus II

MATH 2133 Introduction to Statistics

College B

Developmental / Foundational Mathematics Courses

MAT 0123 Beginning Algebra

MAT 1233 Intermediate Algebra

College / Transfer Level Mathematics Courses

MAT 1313 College Algebra

MAT 1323 Trigonometry

MAT 1343 Pre-Calculus

MAT 1613 Calculus I

MAT 1623 Calculus II

MAT 2613 Calculus III

MAT 2623 Calculus IV

MAT 2113 Introduction to Linear Algebra

MAT 2913 Differential Equations

MAT 1513 Business Calculus I

MAT 1523 Business Calculus II

MAT 1723 Real Number System

MAT 1733 Geometry, Measurement, and Probability

MAT 2323 Statistics

MAT 2513 Elementary Mathematical Analysis

College C

Developmental / Foundational Mathematics Courses

MTH 098 Elementary Algebra

MTH 099 Support for Intermediate College Algebra

MTH 100 Intermediate College Algebra

College / Transfer Level Mathematics Courses

MTH 109 Support for Finite Mathematics

MTH 110 Finite Mathematics

MTH 111 Support for Precalculus Algebra

MTH 112 Precalculus Algebra

MTH 113 Precalculus Trigonometry

MTH 115 Precalculus Algebra & Trigonometry

MTH 116 Mathematical Applications

MTH 120 Calculus and Its Applications

MTH 125 Calculus I

MTH 126 Calculus II

MTH 227 Calculus III

MTH 231 Math for The Elementary Teacher I

MTH 232 Math for The Elementary Teacher II

MTH 237 Linear Algebra

MTH 238 Applied Differential Equations I

MTH 265 Elementary Statistics

Appendix B
IRB Approval

The data collected in this study was covered under University of Memphis IRB# PRO-FY2018-328.