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**ENTRY-LEVEL COGNITIVE MATHEMATICS SKILL AND
FIRST-SEMESTER MATHEMATICS PERFORMANCE AS CORRELATES OF
FALL-TO-FALL RETENTION OF COMMUNITY COLLEGE STUDENTS**

by

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B.S. May 1972, North Carolina State University
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A Dissertation Submitted to the Faculty of
Old Dominion University in Partial Fulfillment of the
Requirement for the Degree of

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OLD DOMINION UNIVERSITY
May, 2014

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ABSTRACT

ENTRY-LEVEL COGNITIVE MATHEMATICS SKILL AND FIRST-SEMESTER MATHEMATICS PERFORMANCE AS CORRELATES OF FALL-TO-FALL RETENTION OF COMMUNITY COLLEGE STUDENTS

Stephen Tyler Corbin
Old Dominion University, 2014
Director: Dr. Dana D. Burnett

The purpose of this study was to investigate the relationship between first-semester mathematics performance and fall-to-fall retention for first-time-in-college, degree-seeking community college students. The study further refined the investigation by seeking to determine if the significance of this relationship was affected by student readiness for college-level mathematics as of the first semester of enrollment at the institution under study.

The sample chosen for this study consisted of 1518 first-time-in-college, degree-seeking students enrolled in fall semester 2011 at a large, multi-campus community college in Virginia. The dependent variable was fall-to-fall retention, a commonly applied student success metric in the Virginia Community College System. The primary independent variable, first-semester mathematics performance, was tripartite, with each student having either enrolled in and successfully completed a first-semester mathematics course, enrolled in but failed to complete a first-semester mathematics course successfully, or deferred enrollment in mathematics until after the first semester. Quantitative statistical analysis was applied to determine the significance of the relationship between these variables within each of the subgroups and demographic constituencies.

The study found that, regardless of readiness level, students who enrolled in and successfully completed a first-semester mathematics course experienced a fall-to-fall retention rate nearly 20% higher than that experienced by the sample taken as a whole. Meanwhile students who were unsuccessful in a first-semester mathematics class, as well as those who deferred enrollment in mathematics, experienced retention rates approximately 10% lower than that experienced by the sample overall.

The study concluded that successful, first-semester enrollment in mathematics portends significantly higher fall-to-fall retention rates for degree-seeking students. However, disturbingly low success rates in both college-level and developmental-level mathematics courses suggest that first-semester enrollment in mathematics is a high-risk strategy for improving retention.

This dissertation is dedicated to
my beautiful wife and lifetime partner, Rhonda,
whose persistent encouragement has sustained me throughout this effort,

and to

my two accomplished sons, Trent and Trevor,
whose enthusiasm for life inspires me,

and to

the cherished memories of my father, Archie S. Corbin, Sr., and mother, Eunice P.
Corbin, whose unconditional love and support never wavered over the course of my life
and career.

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I was also blessed with an outstanding committee. My methodologist, Dr. Mitchell Williams, was indispensable in steering me to the most appropriate analyses of my data. Dr. Susan Wood, a long-time friend and colleague, brought to bear her extensive experience as a community college mathematics instructor, as an academic leader of renown in the Virginia Community College System, and as a prolific contributor in mathematics education, curricular design, and instructional reform across the country.

The faculty who provided instruction in the Community College Leadership program were truly outstanding. Many were accomplished community college practitioners whose knowledge and experience provided meaningful applications for an expansive range of leadership theories. Others were enthusiastic researchers and educators with seemingly boundless expertise that they joyously shared in the classroom. All were devoted to preparing the outstanding community college leaders of the future.

I am indebted, as well, to the students of my Community College Leadership cohort. The comradeship and mutual support engendered by the cohort model, in general,

and by our cohort, in particular, not only sustained me but introduced me to a network of new friends that I will value always.

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CHAPTER 1

INTRODUCTION

In the fall of 2011, enrollment in America's community colleges was estimated to be approximately 13 million students, of whom about 8 million were taking credit coursework (American Association of Community Colleges [AACC], 2013).

Unfortunately, a majority of these students will not persist in their educational pursuits long enough to obtain an academic degree or certificate that signifies completion of their chosen academic program. In fact, ACT, Inc. (2012) reported that the mean first-to-second-year retention rate of America's two-year public institutions was only 55.5% and that only 25.4% of students in two-year public colleges complete Associate degree programs within three years.

In the fall semester of 2011, Virginia's twenty-three community colleges enrolled a total of 197,226 students. Of this number, 135,279 returned to enroll for the subsequent spring semester, an attrition rate of approximately 31.4 percent. By fall semester 2012, only 81,951 of the original cohort remained. More than 58% of Virginia Community College System (VCCS) students did not persist from one fall semester to the next, representing over 115,000 departures (Virginia Community College System [VCCS], 2013).

The 2011-12 academic year was not an anomaly for the VCCS. For the five-year period from fall 2007 to fall 2011, the VCCS experienced an average, system-wide fall-to-fall retention rate of 42.2% (VCCS, 2013). While acknowledging that some student departures result from completion of and graduation from an academic program, and others are due to successful transfer to a senior institution prior to receipt of a graduation

award, it is widely known that most student attrition occurs for other reasons. For example, from fall 2007 to fall 2008, the VCCS retention rate of 41.2% represented a total of 98,260 departures (VCCS, 2011). For the 2007-08 academic year, the VCCS reported that 17,280 graduation awards were presented (Virginia Community College System [VCCS], 2008) and the State Council of Higher Education for Virginia reported that another 3,743 students transferred from VCCS colleges to Virginia's four-year public institutions without having received a graduation award (State Council of Higher Education for Virginia [SCHEV], 2011). The remaining 77,237 students who failed to persist from one fall to the next departed for other reasons.

Community colleges across the country rely upon enrollment to generate funding support. On average, student tuition accounts for approximately 20% of community college operating budgets. In addition, while funding formulas vary from state to state, enrollment is central to determining community college funding allocations in every state (Cohen & Brawer, 2003). Virginia community colleges depend upon both tuition revenues and state funding support commensurate, in large part, with enrollments. Consequently, it becomes necessary for the individual colleges and the system as a whole to recruit new students every year to replace those who depart and, in fact, to strive to increase enrollments from one year to the next.

There is little disagreement that retaining a student who has already matriculated is a more cost-effective means of sustaining enrollment than recruiting new students to replace those who leave (Schuh & Gansemer-Topf, 2012). However, efforts to improve retention among community college students present a set of challenges different from those encountered at four-year, residential colleges and universities. Community college

students are usually commuter students and most enroll only on a part-time basis (AACC, 2013). Community college students are more likely to be employed and to have family obligations that may impose priorities that are in conflict with their educational endeavors. A high percentage of community college students are not of traditional college age (AACC, 2013) and many have a propensity not to become engaged in campus social culture, such as fraternities and sororities, athletics, student government, and other such activities that might otherwise influence their desire to persist (Cohen & Brawer, 2003; Crisp & Mina, 2012).

Background

While the earliest published research on attrition behaviors among college students dates to the 1930s, the first theoretical models designed to predict such behaviors were not developed until approximately forty years later. William Spady, Alexander Astin, and Vincent Tinto are perhaps the most highly regarded of the early retention theorists (Berger & Lyon, 2005). Each of these pioneers, in his particular way, associated premature departure with a combination of social and academic factors.

The studies conducted by investigators like Spady, Astin, and Tinto have since fostered an enormous body of research related to the subject of college student retention (Berger & Lyon, 2005). However, the findings and the theoretical models thus produced have consistently acknowledged that academic readiness and academic performance after admission to college are primary indicators of student persistence. In fact, academic factors have often been found to supersede the influence of other factors, such as demographic characteristics or social integration to the institutional culture, as

contributors to retention and premature departure (Feldman, 1993; Snell & Mekies, 1993; Adelman, 1999; Hawley & Harris, 2005-2006; Craig & Ward, 2007-2008).

Not surprisingly, the research findings and models produced by Spady, Astin, Tinto, and their contemporaries were focused upon traditional four-year colleges and universities. Two-year, public community colleges, with their open-door admissions policies, commuter campuses, low-cost tuition, and occupational-technical program alternatives to the traditional baccalaureate degree, emerged upon the scene in the latter half of the Twentieth Century and began attracting a new type of student to the higher education environment. The expectation that retention among community college students might be influenced by factors different than those affecting students at senior institutions engendered an expansive, supplemental body of research to examine persistence behaviors within this new population (Crisp & Mina, 2012).

Data published recently by the American Association of Community Colleges reveals that only about 30% of community college students are 21 years of age or younger compared to about 40% of the undergraduate population at all degree-granting institutions. About 60% of community college students attend on a part-time basis, while only about 38% of all undergraduates at degree-granting institutions are not enrolled full-time. Community college students are also more likely to be employed while enrolled in college than are their counterparts at four-year institutions (AACC, 2013; NCES, 2012b). Moreover, community college students tend to be less academically prepared for college-level work than are students who attend four-year colleges, thus more often requiring remedial coursework upon entry (NCES, 2011).

Studies have shown that non-cognitive factors such as educational goals, employment status, family circumstances, and social integration into the campus culture contribute to persistence and attrition behaviors among community college students (Nora, Attinasi, & Matonak, 1990; Bers & Smith, 1991; Napoli & Wortman, 1998; Freeze, 2000; Gilmartin, Sax, & Hagedorn, 2003). Nonetheless, cognitive factors, such as college readiness and first-year academic performance have also been shown to have significance as predictors of retention for this population (Feldman, 1993; Snell & Mekies, 1993; Craig & Ward, 2007-2008).

Based upon placement test scores, approximately half of all entering community college students are determined to be in need of remediation (McCabe & Day, 1998). As a result, America's community colleges provide developmental-level courses, primarily in reading, writing, and mathematics. Numerous studies have investigated the effectiveness of developmental studies programs by comparing persistence rates of students who enroll in these courses to those of students who are deemed to be college-ready upon entry. Consistently, drop-out rates have been found to be higher among remedial students than among college-ready students (Hoyt, 1999; Grimes & David, 1999; Bettinger & Long, 2005; Martorell & McFarlin, 2007).

It must be noted that some studies have shown that remedial programs do not have a negative impact on persistence and that successful remediation can result in previously underprepared students being retained at approximately the same rate as students who do not require remediation (Boylan & Bonham, 1992; Seybert & Soltz, 1992; Van Etten, 1997; Curtis, 2002; Kreysa, 2006-2007). However, most students who

enroll in remedial courses, especially in mathematics, fail to successfully complete the prescribed developmental program (Bahr, 2008).

It is estimated that 90% of all community college students will enroll in at least one mathematics course (Blair, 2006). In fall 2010, just over 2 million students in two-year public colleges were enrolled in mathematics and statistics courses, including about 1,150,000 (56.8%) in precollege-level mathematics courses (Blair, Kirkman, & Maxwell, 2013).

Success rates in college-level mathematics courses, however, are alarmingly low, ranging between 40% and 60% (Small, 2002). Meanwhile, given that most community college students require remediation in mathematics prior to enrolling in college-level coursework and that success rates in remedial mathematics have often been found to be even lower than those reported for college-level mathematics courses, it is clear that mathematics, in particular, can be a barrier to academic success in college and, ultimately, to retention and persistence to degree attainment.

Statement of the Problem

Prior research has consistently shown there to be a significant correlation between academic factors and college student retention. Typically, academic variables such as overall grade point average (Feldman, 1993; Snell & Mekies, 1993; Hawley & Harris, 2005-2006; Craig & Ward, 2007-2008) or course credit hours successfully completed (Adelman, 1999; McCormick, 1999; Voorhees & Zhou, 2000; Szafran, 2001) have been used in these investigations. In addition, studies investigating the effect of developmental studies on student persistence and success are abundant (Cohen & Brawer, 2003).

However, the number of studies that have sought to determine the effect of academic readiness and performance related to a specific discipline or course is quite limited.

Nearly all community college students face mathematics course requirements (Small, 2002; Blair, 2006). Moreover, most community college curricula include mathematics as a first-year requirement. It is therefore reasonable to investigate the potential effect of mathematics readiness and first-year mathematics performance upon the fall-to-fall retention of first-year, degree-seeking, community college students.

The present study is conducted in an effort to identify more clearly how academic integration within a specific academic discipline is related to first-year to second-year retention. In particular, this study seeks to determine the extent to which mathematics readiness and first-semester performance in mathematics coursework may correlate to student persistence behaviors.

Purposes of the Study

The present study has two primary goals. First, for first-year, degree-seeking community college students who are recommended for developmental mathematics based upon placement test scores, it seeks to determine the significance of the relationship between first-semester mathematics performance and fall-to-fall retention. Second, for students in the population under study who are not recommended for developmental mathematics, it seeks to determine the significance of the relationship between first-semester mathematics performance and fall-to-fall retention.

In addition to its primary goals, the present study has a secondary purpose. The investigation will determine the effect of certain demographic characteristics upon the significance of the relationship between first-semester mathematics performance and

retention. In particular, the study will seek to determine if the relationships among the academic variables under study are significantly influenced by the gender, age, race, enrollment status, financial aid status, or first-generation status of the students in the population.

Research Questions

To achieve its purposes, this study will examine a sample population of first-time-in-college, degree seeking students enrolled for fall semester 2011 at a large, multi-campus, public community college located in the southeastern United States. The study will seek to answer two primary research questions.

First, in order to determine the effect of inadequate entry-level cognitive skill in mathematics on the relationship between first-semester mathematics performance and retention from the first year of college enrollment to the second, this study will investigate the following question:

1. For students in the sample under study who are recommended for developmental mathematics based upon placement test scores, are there significant differences in fall-to-fall retention rates among those who, in their first semester of enrollment, successfully complete a developmental mathematics course, those who enroll in a developmental mathematics course but fail to successfully complete it, and those who postpone developmental mathematics coursework until after the first semester?

Second, in order to determine the effect of first-semester performance in college-level mathematics on student retention from the first year of college enrollment to the second, this study will investigate the following research question:

2. For students in the sample under study who are recommended for college-level mathematics based upon placement test scores, are there significant differences in fall-to-fall retention rates among those who, in their first semester of enrollment, successfully complete a college-level mathematics course, those who enroll in a college-level mathematics course but fail to complete it successfully, and those who postpone college-level mathematics coursework until after the first semester?

To inform its findings further, the present study will investigate several demographic characteristics to determine whether these variables significantly affect the relationship between first-semester mathematics performance and fall-to-fall retention of first-year, degree-seeking, community college students. To this end, this study will consider the following additional research questions:

3. For students in the sample under study, to what extent does gender influence the significance of the relationship between first-semester mathematics performance and fall-to-fall retention?
4. For students in the sample under study, to what extent does student age influence the significance of the relationship between first-semester mathematics performance and fall-to-fall retention?
5. For students in the sample under study, to what extent does race or ethnicity influence the significance of the relationship between first-semester mathematics performance and fall-to-fall retention?
6. For students in the sample under study, to what extent does enrollment status influence the significance of the relationship between first-semester mathematics performance and fall-to-fall retention?

7. For students in the sample under study, to what extent does financial aid status influence the significance of the relationship between first-semester mathematics performance and fall-to-fall retention?
8. For students in the sample under study, to what extent does first-generation status influence the significance of the relationship between first-semester mathematics performance and fall-to-fall retention?

Overview of Methodology

The present study will employ a non-experimental design, conducting a quantitative analysis of *ex post facto* data to examine the significance of the relationship between first-semester mathematics performance and the fall-to-fall retention rates of first-year, degree-seeking community college students. In particular, the study will seek to determine if there are significant differences in this relationship for students who are recommended for developmental mathematics as compared to those who are not.

The sample chosen to represent the population under investigation for this preliminary study will include first-time-in-college students who were enrolled in associate degree programs in the fall semester of 2011 at a large, multi-campus community college in Virginia. The Office of Institutional Effectiveness at the college will provide data for completion of the study, which will include demographic information specifically relevant to the research questions. To assure anonymity of the subjects, no personal identifier information will be included in the data provided.

Descriptive statistics will describe the sample selected for study in terms of its demographic characteristics and in terms of the primary independent variables, mathematics readiness and first-semester mathematics performance, and the dependent

variable, fall-to-fall retention. Chi-square analysis will be used to test hypotheses regarding differences in fall-to-fall retention outcomes among subgroups, to determine if first-semester mathematics performance was related to fall-to-fall retention for both developmental-level math students and college-level math students. Chi-square tests of independence will also be employed to investigate whether each of the demographic factors of gender, age, race or ethnicity, enrollment status, financial aid status, and first-generation status impacts the significance of the relationship between first-semester mathematics performance and fall-to-fall retention for students in the sample population.

The research methodology developed for this study can readily be replicated for similar populations at either a single institution or from multiple institutions of comparable type. Such replication would serve to elucidate further and perhaps validate these findings.

Delimitations

The scope of the present study is delimited by several self-imposed boundaries. Identification of these parameters is intended to acknowledge any resulting threats to the external validity and generalizability of the findings. In particular, the study is susceptible to selection bias. The population sample chosen for the study was a cohort of students from the subject community college who were enrolled for the fall semester of a single academic year. Further study would be necessary to determine if similar findings would emerge from a cohort of students enrolled at the subject community college in other terms or in other years.

In addition, this study was not designed to consider the effect of all variables that may influence college student retention. Most notably, no measures of social integration

were considered. Moreover, many widely recognized measures of academic integration, such as grade point average or credit hours successfully completed, were intentionally disregarded in order to focus on variables associated with a single academic discipline, mathematics. Finally, the array of personal traits, such as self-efficacy, as well as certain demographic characteristics, such as employment status, that have been shown in other studies to correlate with persistence, were not addressed by this investigation.

The dependent variable identified for this study was fall-to-fall retention of first-year, degree-seeking students. Fall-to-fall retention was chosen because it is valued as a measure of student success at the college under study and throughout its parent community college system. However, fall-to-fall retention of a first-year, degree-seeking community college student does not assure that the student will persist to degree completion or successful transfer. The present study did not investigate retention beyond the second fall semester for the students in the selected sample.

Lastly, the present study did not attempt to distinguish retention rates based upon the levels of difficulty of the curricular math requirements facing the students in the sample, nor did it consider the effect of spring semester mathematics performance upon retention to the following fall semester. It is reasonable to expect that persistence and attrition might be further influenced by such factors.

Limitations

The research design developed for this study presents certain inherent limitations that may be considered mitigating factors when assessing the internal validity of the findings. Specifically, it must be recognized that causality is not to be inferred from statistical analysis of *ex post facto* data. That is, significant relationships between

independent and dependent variables do not imply a cause-and-effect relationship (Gay, 1987).

Significance of the Study

This study is intended to offer a valuable contribution to the body of research on retention of college students from their first semester of enrollment into their second year of study, particularly among community college students. It is expected to add a measure of specificity to the various academic factors that are related to student persistence behaviors. Awareness of the potential impact of entry-level mathematics readiness and first-semester mathematics performance upon the ultimate achievement of student educational goals can influence admissions and advisement practices in ways that will position students for success in the earliest stages of their college experience.

Community college leaders and policymakers may be able to utilize findings from this and similar studies to inform college programs and policies and to collaborate with secondary school partners regarding entry-level math readiness, how the needs of students with insufficient entry-level skill are most effectively addressed, and acknowledgement of the importance of first-semester mathematics performance.

Factors that can improve retention rates and encourage persistence to a degree or to successful transfer are becoming increasingly important to community colleges and their leaders. More than ever before, policymakers are seeking to hold public institutions of higher education accountable for their stewardship of taxpayer funding support by employing measures of productivity. For community colleges, those measures are likely to include the number of students who either graduate with a community college credential or transfer to a four-year college or university. Retention of students is an

essential ingredient in the formula for such productivity. Empirical evidence provided by this study and other research of its type can help to identify specific strategies that increase the likelihood that students will remain enrolled.

Definitions of Key Terms

Certain terms that appear in the research literature surrounding the present study have been found to occur with various meanings and in a variety of contexts. The following list of definitions is offered for the purpose of specifying the intent of this researcher in use of these terms:

Attrition – Discontinuance of enrollment resulting in failure to attain a college credential or achieve successful transfer to another institution of higher education.

Degree-seeking student – An individual enrolled in a two-year associate degree program at a community, technical, or junior college.

Developmental course – A non-college level course offered at a college for the purpose of remediating entry-level academic weakness in a specific discipline; for the purposes of the present study, this term is considered to be synonymous with the term “remedial course.”

Developmental student – An individual enrolled in one or more developmental courses; for the purposes of the present study, this term is considered to be synonymous with the term “remedial student.”

Enrollment status – A dichotomous variable indicating whether a student is attending college on either a full-time or part-time basis.

Financial aid status – A dichotomous variable indicating whether a student is or is not eligible for a Pell grant.

Non-curricular student – An individual enrolled in courses at a community, technical, or junior college but who is not program-placed.

Persistence – Continuation of enrollment, either from one academic term to the next or from one academic year to the next; for the purposes of the present study, this term is considered to be synonymous with the term “retention.”

Program-placed student – An individual enrolled in a certificate, diploma, or degree program at a community, technical, or junior college.

Remedial course – A non-college level course offered at a college for the purpose of remediating entry-level academic weakness in a specific discipline; for the purposes of the present study, this term is considered to be synonymous with the term “developmental course.”

Remedial student – An individual enrolled in one or more developmental courses; for the purposes of the present study, this term is considered to be synonymous with the term “developmental student.”

Retention – Continuation of enrollment, either from one academic term to the next or from one academic year to the next; for the purposes of the present study, this term is considered to be synonymous with the term “persistence.”

Summary

It is well-established that the factors contributing to college student persistence and attrition behaviors are many and varied. Among those factors, academic preparedness prior to admission and academic performance after matriculation are generally regarded as being among the most influential. However, evidence of the impact of preparedness and performance in specific disciplines or courses is quite limited.

This study will attempt to determine the extent to which entry-level cognitive skill in mathematics and first-semester mathematics performance are related to fall-to-fall retention of first-year, degree-seeking, community college students. It will also attempt to determine any significant variation in these relationships among selected demographic constituencies.

The findings of this study may contribute to efforts to improve the persistence behaviors of community college students by recognizing a relationship between those behaviors, pre-admission mathematics readiness, and success in initial college mathematics coursework. Community colleges that can improve retention rates can, in turn, help more students achieve their presumptive goal of degree-attainment or successful transfer.

CHAPTER 2

REVIEW OF THE LITERATURE

Scholarly research related to the subject of student retention in higher education can be traced as far back as the 1930s (Berger & Lyon, 2005). These early studies examined a variety of factors for their potential to influence persistence. Correlations to retention were often found among such variables as the socio-economic status and educational level attained by a student's parents, the academic ability of a student prior to entry, a student's personal characteristics such as personality, self-reliance, and commitment to one's educational goals, the size and type of the institution, and the student's academic and social acclimation to the college environment (Tinto, 1975). However, much of this research failed to utilize longitudinal data and often focused on either a single college or university or only a select few institutions (Astin, 1975). It was not until the 1960s and 1970s that researchers began to synthesize the existing research to formulate structural models that, in theory, could be used to forecast and, perhaps, to influence persistence behaviors. Among the first meaningful attempts to examine systematically certain patterns associated with premature departure of college students, was the work of John Summerskill. His contribution to the edited volume, *The American College*, published in 1962, concentrated on personality traits such as personal maturity and motivation as the primary indicators of persistence and attrition behaviors (Berger & Lyon, 2005). However, retention research that limited itself to investigation of psychological influences failed to offer a complete explanation of the phenomenon. An era of research intended to produce more comprehensive models of student retention and attrition was about to begin. Among the most highly regarded pioneers in the field of

retention modeling were William Spady, Alexander Astin, and Vincent Tinto (Berger & Lyon, 2005).

Modeling Student Retention and Attrition Behaviors

In 1970, William Spady authored a review of previously published research on college dropouts. While he acknowledged that his was not the first attempt to synthesize the literature on this topic, his stated objective was to provide “theoretical and empirical coherence” to a field of study that had failed to establish a conceptual basis for productive future investigation (Spady, 1970). Spady’s work appears to be the seminal effort to construct a modular framework that might explain student departure (Berger & Lyon, 2005).

Spady’s model was based upon the foundational principle that persistence and attrition behaviors were a result of interaction between the student’s attributes and the academic and social systems of the college. He asserted that if rewards drawn from either of these two systems were deemed insufficient, there was an increased likelihood that the student could be influenced to leave prematurely (Spady, 1970).

Academic performance as an independent variable correlating to student attrition was of keen interest to Spady. His work seems to reveal that he was intrigued by the prospect that, while poor academic performance could lead directly to involuntary student departure due to institutional academic suspension and dismissal policies, some students with poor grades persisted and some high academic achievers dropped out. Spady believed that certain factors affecting academic performance also affected persistence behaviors, even when data describing these behaviors were statistically controlled for customary academic performance measures, such as grades (Spady, 1970).

Spady conceded that grades were the most obvious form of extrinsic reward emanating from the academic system of any college. However, he opined that a less conspicuous, intrinsic academic reward he referred to as “intellectual development” could perhaps be a more important factor influencing student persistence or departure decisions (Spady, 1970).

Combining academic integration with social integration, the latter defined as the compatibility of a student’s personal attributes with the college environment, Spady identified a comprehensive, influential factor he called “normative congruence.” He also identified a second major social influence, “friendship,” defined as the formation of personal relationships with fellow students, faculty, and others at the institution. Spady was then able to describe a parallel between his model of dropout behavior and Durkheim’s model of suicidal behavior (Spady, 1970). It was this parallel that later guided the research of Vincent Tinto (Hagedorn, 2004).

In 1971, Spady published findings from a longitudinal study of 683 first-year students who had enrolled at the University of Chicago in 1965. While conceding that students at the University of Chicago were not typical of students across the full spectrum of higher education, Spady felt that this was an adequate first test of the model he had proposed the previous year. His findings were unexpected to an extent sufficient to suggest significant modifications to the structure of his original model. In particular, he found that, for these students, long-term persistence correlated more strongly with academic performance than with any other factor or combination of factors (Spady, 1971).

Alexander Astin also sought to establish a retention and attrition model that would allow college counselors, faculty advisors, academic administrators, and even students to measure the likelihood that a student would prematurely drop out of college. Astin's first major study of college student persistence behavior was considered to be groundbreaking in its use of multi-institutional data. Astin used a national database to establish an initial population of more than 240,000 college freshmen from 358 two-year and four-year colleges and universities. The students were first surveyed during their freshman year in 1968. In 1972, follow-up surveys were sent to 101,000 of these students, representing approximately 300 students randomly selected from the 1968 freshman class at each of the institutions in the study. Usable survey responses were submitted by 41,356 of the students solicited (Astin, 1975).

Astin studied the predictive value of a wide range of independent variables, including academic ability, family background, student aspirations, institutional type, financial aid status, employment status, residential arrangements, and other campus environmental factors. He also investigated differences in the correlations of these variables with persistence behaviors among students within various demographic groups (Astin, 1975). Astin found that the extent of student "involvement" in both the academic and social environment of the college was the primary factor influencing persistence. His analysis determined that the more heavily invested the student, both psychologically and physically, in both aspects of the college experience, the more likely the student was to remain enrolled (Berger & Lyon, 2005). His data showed that students who were engaged in extracurricular activities, who worked on campus, or who lived on campus were more likely to persist than their counterparts (Astin, 1975).

Like Spady, however, Astin concluded that the strongest correlations existed between academic factors and retention. Astin found the most significant predictive value to exist in the student's academic performance prior to college entry and in academic ability as measured upon admission. Nevertheless, he also concluded that, after controlling for the student's entering characteristics, the most important predictor of persistence to degree was "getting good grades in college" (Astin, 1975, p.174).

In 1975, Vincent Tinto offered his Student Integration Model of Attrition as a comprehensive analysis of the factors that influence a student's decision to leave college prematurely. Tinto expanded upon Spady's model and strengthened the parallels to Durkheim's theory of the relationship between social integration and suicidal behavior. Tinto's theories have emerged as the foundation upon which further studies of premature departure are based (Berger & Lyon, 2005).

Tinto acknowledged that students enter college with an array of attributes and predispositions, including such factors as race, gender, socio-economic status, and academic ability that are not irrelevant to academic persistence. In addition to these readily identifiable entry characteristics, though, Tinto identified two variables he believed to be of significant value in predicting student dropout: commitment to one's educational goal and commitment to one's chosen institution (Tinto, 1975).

Tinto's model asserts that a student's interaction with and integration into the academic and social systems of the college, both formal and informal, continuously impact the student's commitment to his educational goal, to the institution, or to both. As these commitments change, either positively or negatively, the student becomes more or less likely to persist. For example, Tinto theorized that a low level of commitment to

either one's goal or to the institution upon entry was a significant predictor of premature departure. However, as such a student successfully integrates into the academic and social systems of the college, the level of commitment can be expected to increase and the likelihood of persistence can be expected to improve (Tinto, 1975).

Tinto conceded that factors external to the college environment could affect student commitment. Thus, in addition to Durkheim's theories of suicide, he drew upon economic cost-benefit concepts to refine his model further. Recognizing that commitment to an original educational goal might be influenced by economic factors such as fluctuations in the job market, Tinto realized that certain dropout decisions were not related to the level of integration into the college systems. Nevertheless, this realization did not diminish his confidence in the predictive value of student commitment as an indicator of persistence behavior (Tinto, 1975).

During the more than thirty-five years since Vincent Tinto offered his Student Integration Model of Attrition, an impressive body of research and literature has continued to emerge to help educators understand this phenomenon. Tinto, in fact, has offered valuable suggestions for further study and has continued to be prolific in continuing his own research. A wide assortment of variables, including student demographics, non-cognitive characteristics such as social integration and self-efficacy, and cognitive abilities such as those measured by grade point averages or college aptitude test scores, have been investigated for their potential to affect retention. Researchers are motivated by the belief that if the factors that contribute most significantly to student attrition can be accurately identified, it may be possible to provide interventions to

increase the likelihood that students will persist to achieve the educational goals that prompted them to enter college in the first place.

Alternative retention models have been developed that expand upon and sometimes challenge Tinto. Pascarella and Terenzini (1980) provided a model that improved the predictive accuracy of Tinto's model by assessing five specific measures of institutional integration, such as student-faculty interaction and peer group interaction. Bean (1980) designed and tested a model that adapted worker satisfaction and turnover resulting from organizational characteristics of the workplace to analyze student departure attributable to organizational characteristics of the college. Somewhat later, Bean and Metzner (1985) proposed a model suggesting that for non-traditional students, factors external to the college environment, such as employment status and personal financial situation, affect student beliefs, attitudes, and intentions in ways that contribute more significantly to the willingness to persist than does integration into the campus social system. More recently, Braxton, Hirschy, and McLendon theorized that two different models were necessary to explain student attrition adequately, one to model such behavior at residential colleges and universities, the other to model departure from commuter colleges (Braxton & Hirschy, 2005).

As Tinto has continued his research and revised his original model, he has remained consistent in his underlying belief that the most reliable predictors of persistence are the student's commitment to educational goals and to the institution, influenced as those commitments are by integration into the academic and social environment and by other external factors. While his studies have focused primarily on four-year colleges and universities, many of his findings and conclusions are relevant to

community colleges. In particular, Tinto's work has confirmed the notion that most premature departures from college occur in the first year. Also, students who voluntarily leave prematurely do so more often for reasons associated with their experiences after they have enrolled than for reasons attributable to pre-entry characteristics (Tinto, 1993).

The conceptual models conceived by Tinto and his fellow researchers have engendered a vast body of research seeking to test the validity of the models against the influence of a multitude of independent variables. Such is the motivation of the present study, which seeks to contribute a modest addition to the collective knowledge surrounding the phenomenon of college student attrition.

The Demography of College Student Retention

The pioneers of research in persistence behaviors and retention modeling recognized from the beginning that premature departure rates vary among college students by gender, by race and ethnicity, by age, by enrollment status, by socioeconomic status, and by other demographic characteristics. The body of research investigating correlations between various demographic constituencies and retention data is enormous, stemming from both intellectual curiosity and taxpayer-funded studies. Recognition of these differences in attrition patterns and how they may relate to academic preparedness and performance is instructive.

Retention and Gender

Recently available data from the National Center for Educational Statistics (2012a) indicates significant differences in persistence behaviors of males and females at two-year colleges. Among the 2008 cohort of first-time, full-time, credential-seeking students, 34.1% of females obtained the credential within 150% of prescribed time-to-

completion,¹ while only 27.3% of their male counterparts achieved the same level of success. These statistics apparently represent a reversal of circumstances described by earlier researchers. Tinto (1975) cited several prior studies finding that, proportionally, more men than women completed their degree programs. He also noted, however, that research related to the reasons for premature departure indicated that females were more likely to leave college voluntarily, while males were more likely to remain until forced to leave for academic reasons.

Interest in the differences between the persistence behaviors of men and women has generated considerable investigation seeking to determine reasons for the disparity. Most studies show that certain other variables, considered together with gender, may have more predictive value than gender alone. Leppel (2002) used data from the 1990 Beginning Postsecondary Students survey conducted by the NCES to investigate the relationship between gender, a variety of other variables, and persistence among college freshmen from the 1989-90 academic year to the 1990-91 academic year, including those students who enrolled at a different institution for the second year. The population included 2,647 men and 2,737 women for whom all necessary information was available. Some variables, such as age, marital status, and employment status were found to have a similar impact upon retention for men and women. However, women who have children, for example, were more likely to persist than men with children.

Studies conducted using smaller populations seem to confirm that other factors contribute more significantly than gender alone to the differences in retention rates

¹ "Prescribed time-to-completion" refers to "normal time" as defined by the National Center for Education Statistics: The amount of time necessary for a student to complete all requirements for a degree or certificate according to the catalog of the reporting institution. This is typically 2 years (4 semesters, 4 trimesters, or 6 quarters, excluding summer terms) for an associate's degree, but varies in duration for certificate programs.

between men and women. In her study of 140 community college students, Grimes (1997) found that females demonstrated stronger self-management skills, including study habits and time management, than did the males in the sample. However, the women in her study also exhibited attributes and behaviors such as low self-esteem and non-continuous enrollment that made them more susceptible to drop-out than their male counterparts.

DeBernard, Spielman, and Julka (2004) studied 204 undergraduates at a private university and found that women had a higher first-year grade point average than did the men in the study, but that this did not result in a correlation between gender and retention. McGrath and Braunstein (1997) also found that gender was not a valid predictor of retention among the 604 freshman in their study.

Seeking to determine the generalizability of Tinto's constructs to community college students, Napoli and Wortman (1998) found some variability between males and females in certain measures of academic and social integration. Academic integration among the females in their study was greater than for males and females were found to have a higher level of initial institutional commitment.

The body of evidence seems to suggest that the explanation for gender differences in retention patterns lies in the fact that one gender may be more likely than the other to possess certain characteristics or attributes that influence persistence behavior. Some researchers have found evidence of gender-specific characteristics that contribute to significant differences in entry-level cognitive skill in mathematics and first-year mathematics performance between males and females.

Hagedorn, Siadat, Forgel, Nora, & Pascarella (1999) compared the college mathematics achievement of remedial and non-remedial students from 23 colleges and universities throughout the United States. The sample was selected to approximate the gender and ethnic composition of the national population of college undergraduates in fall semester 1992. Of the 1,780 students in the sample, approximately 48% enrolled in remedial mathematics, while 52% enrolled in college-level mathematics courses. However, among the community college students in the study, nearly 85% enrolled in remedial courses. For the purposes of the study, mathematics achievement was measured using student scores on the math module of the American College Testing (ACT) Program's Collegiate Assessment of Academic Proficiency (CAAP) test taken at the end of the first year.

The researchers found that females were over-represented in the remedial group and that women in this group were more likely to enroll in the lowest level remedial courses. Regardless of their enrollment level, however, women indicated that they had spent more time studying in high school, had received stronger encouragement to attend college, and had more positive perceptions of the quality of instruction received in college than did their male counterparts. While the direct correlation between gender and math achievement was not tested in this study, the indirect effects of high school study habits, encouragement to attend college, and perceptions of the quality of teaching did not significantly influence mathematics achievement for remedial students (Hagedorn, et al., 1999) .

In a study of the academic records of 3,476 first-time-in-college students who enrolled at a private, urban university in Texas during the fall semesters from 2005 to

2009, Fike and Fike (2012) found that 28% of males in the sample qualified, upon admission, as college-ready in mathematics, compared to 24% of the females in the sample. However, 45% of the females who were not college-ready enrolled in developmental mathematics in their first semester, while only 41% of the non-college-ready males did so. In all three measures of first-year student success outcomes under investigation, including fall semester GPA, fall-to-spring retention, and fall-to-fall retention, females significantly out-performed their male counterparts.

Mathematics self-efficacy, the perception of one's own abilities to apply the skills and concepts of mathematics effectively to accomplish mathematical tasks, is believed to contribute significantly to student achievement in mathematics coursework. Some researchers have found evidence to suggest that women tend to demonstrate deficits in mathematics self-efficacy, resulting in diminished interest in science, engineering, and other mathematics-related programs of study. Based upon the results of surveys conducted among 11th–graders, O'Brien, Martinez-Pons, and Kopala (1999) found significantly lower interest in science and engineering among females and found mathematics self-efficacy to be the primary determinant of career interest in those fields.

Not all studies investigating gender differences in levels of mathematics self-efficacy have produced similar results, however. Hall and Ponton (2005) compared scores on the Mathematics Self-Efficacy Scale (MSES) for students enrolled in both developmental Intermediate Algebra and college-level Calculus I and reported no significant difference in the MSES scores between males and females in either course.

The present study seeks to determine if there are significant differences in the relationships between first-semester mathematics performance and retention based upon student gender.

Retention and Age

The number of 18- to 24-year-olds enrolled in college increased approximately 34% over the ten-year period from 2000 to 2010 to about 12.5 million students. However, enrollment of students age 25 and older increased at an even faster rate over the same period, growing by 42%. The National Center for Educational Statistics projects that between 2010 and 2020, the percentage growth rate of the 25-and-older demographic will be 20%, nearly twice that of traditional-age students (National Center for Education Statistics [NCES], 2012b). Persistence and attrition behaviors of older undergraduates have been and will continue to be of keen interest to researchers.

Findings pertaining to the correlation between student age and retention have varied. Brooks-Leonard (1991) and Feldman (1993) both found that age was a significant predictor of retention, but the results of these two studies seem contradictory. Brooks-Leonard concluded that older students, especially those age 40 or older, were more likely to drop out than traditional-age students. In Feldman's study, attrition rates were higher for students age 24 and younger. McGrath and Braunstein (1997) found no relationship between age and retention of freshmen to the sophomore year. However, this result must be viewed within the context of the population under study, 632 freshmen enrolled fulltime at a four-year private university. It is likely that students older than age 24 were underrepresented in this sample.

Burley, Butner, and Cejda (2001) studied retention behaviors of 63,770 first-time-in-college students enrolled in Texas community colleges in 1992. The data revealed that age was a significant predictor of persistence, with younger students more likely than older students to be retained. The researchers, however, qualified this finding because older students were shown to be more likely to have entered with academic deficiencies, a stronger predictor of premature departure than age.

As noted above, the percentage of the community college student population that is of traditional college age, between 18 and 24 years old, is growing. In 1991, 32% of credit-seeking community college students were under the age of 22. By 2001, this percentage had grown to 42%. Community college enrollment data for 2001 also reveals that nearly 75% of all first-time community college students were under the age of 24 (Adelman, 2005).

Using data from the postsecondary transcripts of 8,900 students included in the National Education Longitudinal Study, which followed 25,000 students who were eighth-graders in 1988, Adelman (2005) investigated several markers of academic performance among degree-seeking community college students of traditional age. One such marker was credits earned at the community college. Among traditional-age students, 55% earned at least 30 credits, the traditionally recognized equivalent of one complete academic year. A second marker was the extent to which these students achieved a successful educational outcome in the form of either transfer to a four-year institution or completion of an associate degree. Among traditional-age students who earned at least 30 credits at the community college, approximately 40% earned an

associate degree and approximately 47% transferred to a senior institution. Of those who transferred, about 47% did so without having earned an associate degree.

Of particular interest to the present study is the mathematics readiness of community college students, their performance in college-level mathematics coursework, and the relationship between these variables and persistence. Adelman (2005) reported that 44% of the traditional-age students who entered community colleges during the 1990s did not complete Algebra II in high school. He found further that success in college mathematics impacted achievement of the success markers analyzed in his study. Among the students who completed at least 30 credits in community college, nearly 100% were retained from their first year of enrollment to the second and approximately 30% earned some credits in college mathematics. Of the students who completed fewer than 30 credits, about 71% were retained to the second year, but only 7% earned credits in college mathematics. Adelman also found a strong positive correlation between the number of credits earned in college mathematics and both successful transfer and associate degree attainment. He also found a similarly strong positive correlation between the number of college mathematics credits earned and the eventual attainment of a bachelor's degree by students who began their post-secondary education in a community college.

The messages summarizing the Adelman study include the finding that student age upon entry to the community college is a demographic characteristic that influences essentially every measure of postsecondary achievement. He also concludes that completion of Algebra II in high school and credits earned in college-level mathematics serve to establish an academic momentum that enhances the likelihood that community

college students of traditional college age will achieve their educational goals (Adelman, 2005).

To understand the relationship between persistence behaviors and age more fully, researchers have attempted to identify how the influence of other variables differs between traditional and non-traditional age students. Grosset (1991) found differences between older and younger students in the significance of some factors that influence retention. Self-perception of academic readiness was found to be the most important factor affecting persistence behaviors among the older community college students in her study. Institutional commitment had a positive correlation with retention among older students, but had no impact on the persistence for students of traditional age.

Applying the constructs of the pioneers of retention research, Napoli and Wortman (1998) found a strong positive correlation between age and institutional commitment, while reporting a strong negative correlation between age and social integration. This study also found that older students demonstrated greater academic integration than their younger classmates. Sorey and Duggan (2008) discovered that social integration was the strongest predictor of retention among older community college students, but had minimal effect for students of traditional age. Meanwhile, academic integration was the strongest predictor of persistence for traditional-age students, but the least influential for older students.

Voorhees and Zhou (2000) reported that younger students were more likely to report that they had attained their educational goal than were older students, hypothesizing that older students perhaps perceived their goals to be more long-term.

Howell (2001) summarizes such studies by concluding that community college students who are 25 or older come with other characteristics that are different from those of traditional-age students. These differing attitudes, expectations, goals, personal circumstances, and levels of academic readiness will impact how they learn and whether they succeed. Of interest to the present study is to determine if age mitigates the impact of entry-level mathematics ability and first-year mathematics success upon retention.

Retention and Race

Studies have shown that persistence and attrition behaviors vary along racial and ethnic lines, prompting researchers to investigate the possible explanations for this variation. As is the case with other demographic constituencies, these variations are often found to be attributable to certain elucidating characteristics within groups rather than mere race or ethnicity alone.

Feldman (1993) found that white students were less likely to drop out than were minority students. However, distinguishing among the minorities represented in her sample, she reported that Asian students experienced approximately the same retention rates as white students. Napoli and Wortman (1998) discovered differences in the extent to which Tinto's constructs applied to minority and non-minority students. White students were found to have a significantly higher initial goal commitment than non-white students.

Some studies, however, suggest that differences in retention rates among racial and ethnic groups may be related to the demographic composition of the student body. Survey results from first-time students at a large metropolitan community college in the mid-Atlantic region of the United States, having a student population that is more than

70% African-American, indicate that African-American and non-Mexican-American Latino students were more likely to persist to the second year than students from other racial groups, including Caucasians (Hawley & Harris, 2005-2006).

Weissman, Bulakowski, and Jumisko (1998) found that Black community college students had lower grade point averages than Whites or Hispanics, and a lower percentage of credits earned to credit hours attempted. Hispanic and Black students were identified as needing remediation at a higher rate than Whites. The Weissman study also found that Black students had more modest educational goals than did the Hispanic and White students.

Most researchers seem to agree that, though there may be differences in retention rates and other success metrics among various racial and ethnic groups, the differences are attributable to factors other than race and ethnicity. Controlling for these factors statistically usually reveals insignificant variability in retention rates of community college students along racial and ethnic lines (Bers & Smith, 1991, Brooks-Leonard, 1991, Grosset, 1993, Voorhees & Zhou, 2000, Hagedorn, Maxwell, & Hampton, 2001-02, Craig & Ward, 2007-08). Some studies suggest that entry-level mathematics ability and performance in college-level mathematics may be among the factors associated with variations in the retention behaviors of minority and non-minority groups.

Hagedorn, et al. (1999) found that minority students were overrepresented in remedial mathematics and that non-minorities attained higher levels of first-year achievement in mathematics. Their study also examined the racial composition of the high schools from which students in the sample had graduated, finding that more students placing into remedial mathematics attended high schools with proportionately higher

minority student populations. This latter correlation suggested to the researchers that the quality of instruction or counseling, or both, provided in such high schools might be lower than that offered in schools whose population is predominantly white.

Bettinger and Long (2005) investigated the effects of remediation at Ohio community colleges and found some significant differences between minority and non-minority groups. In that study, more than 75% of black and Hispanic students placed into remedial mathematics compared to only 55% of whites. Race was also found to be a significant predictor of successful completion of remedial coursework, with black and Hispanic students significantly less likely to succeed than their white and Asian counterparts. Moreover, among degree-seeking students, those placed into remedial mathematics were found to be significantly less likely to obtain a two-year degree within five years of matriculation or transfer to a senior institution than were students not requiring remediation in mathematics.

Fike and Fike (2012) also found that white students had a greater likelihood of being assessed as college-ready in mathematics than did minorities and that black and Hispanic students were more likely to defer enrollment in prescribed remedial coursework. Such deferment was found to correlate with a significantly lower first-semester grade point average.

Ethnic identity is a construct designed to measure an individual's sense and appreciation of their own ethnicity. O'Brien, Martinez-Pons, and Kopala (1999) found a significant predictive relationship between ethnic identity and self-efficacy in mathematics, which, in turn, predicts diminished career interest in science and engineering among minorities.

The present study will seek to determine if the strength of relationships between the independent variables, mathematics readiness and first-semester mathematics performance, and the dependent variable, retention, vary significantly among racial subgroups.

Retention and Enrollment Status

Across all types of higher education institutions, 71.1% of first-time, full-time, degree-seeking students were retained from 2010 to 2011. For two-year colleges, where 37.5% of these students were enrolled in 2010, the percentage retained to 2011 was 59.9%. There is a dramatic decrease, however, in year-to-year retention rates for part-time students. From 2010 to 2011, all of higher education, in general, and two-year institutions, in particular, retained only 41.9% of first-time, part-time, degree-seeking students (NCES, 2012c).

Brooks-Leonard (1991) found a significant correlation between enrollment status and retention, with full-time students more likely to be retained than part-time students. In her study of 1140 first-time community college students, Feldman (1993) found nearly 86% were attending fulltime and there was a significantly greater likelihood of premature departure among part-time students. O'Toole, Stratton, and Wetzel (2003) found that the timing of part-time enrollment affects the likelihood of persistence. That is, the attrition rate of students who originally enrolled on a part-time basis was 70%, compared to 48% of students who originally enrolled on a full-time basis, but eventually enrolled part-time in a subsequent semester.

Cofer and Somers (2000) studied with-in year persistence of community college students to determine factors associated with departure between the fall and spring

semester of the same academic year. In this study, 78.4% of the students who were retained were enrolled full-time.

Using data from 1,424 respondents to the Community College Student Experience Questionnaire, Horn and Ethington (2002) found that full-time students reported significantly higher perception of gains in all four areas of educational objectives tested in that study. One of those four areas was Mathematics, Science, and Technology. The relationship between enrollment status, mathematics readiness and achievement, and retention of first-year students has been explored by other researchers.

Bettinger and Long (2005) reported that among full-time, degree-seeking students placed into remedial mathematics, approximately 77.5% had stopped attending within five years without obtaining a two-year degree. For part-time, degree-seeking students with remedial mathematics placements, the percentage of dropouts within five years increased to over 89%.

Fike and Fike (2012) investigated the strength of correlations between first-year semester hours completed, mathematics readiness, first-year performance in developmental mathematics, and fall-to-fall retention. Not surprisingly, they found a significant positive correlation between semester hours completed and retention from first year to second. In addition, the logistic regression model revealed no significant difference in retention rates between math-ready students and students who successfully completed developmental mathematics coursework. However, students who were placed into remedial mathematics but postponed enrollment in developmental coursework were 28.5% less likely to be retained, while students who enrolled in but failed remedial mathematics were 80.6% less likely to persist.

The relationships between cognitive ability in mathematics, as measured by mathematics readiness and first-semester mathematics performance, and fall-to-fall retention for full-time community college students may differ significantly from such relationships for part-time students. The present study will investigate these possible differences.

Retention and Financial Aid

In 2007-08, 56.6% of all full-time, undergraduate students in public institutions of higher education were receiving some form of federal financial aid and 30.2% of all part-time students were receiving some form of federal assistance. For two-year college students, most of whom attend community colleges where tuition costs are reduced, these percentages are somewhat lower. At two-year colleges, 49.2% of full-time students and 25.2% of part-time students were receiving federal financial aid in 2007-08 (NCES, 2013).

Financial aid can come in different forms, including grants, scholarships, and loans. Dowd & Coury (2006) found that there was no significant relationship between receipt of grants and persistence of community college students, but that a negative correlation existed between taking loans and retention. This latter finding is contrary to results obtained by Cofer & Somers (2000).

In a study of community college financial aid recipients in California, MacCallum (2008) found a significant relationship between processing time for financial aid applications and retention. The longer a student had to wait to receive benefits, the more likely the student was to drop out.

Some researchers have found a positive correlation between financial aid and retention. Mendoza, Mendez, & Malcolm (2009) found that the majority of Oklahoma community college students who attained second-year status after one academic year were financial aid recipients. The predictive value of the financial aid variable was significant whether considered alone or in combination with other demographic characteristics.

Numerous studies have revealed that financial aid can impact persistence within demographic groups. St. John, Paulsen, and Carter (2005) found that African-American students were more influenced regarding choice of college by financial aid offers than were Caucasian students. Gross, Hossler, and Ziskin (2007) found that institutional financial aid influenced retention rates among men more significantly than among women. In analyzing the effect of financial aid among low-income, middle-income, and high-income students, Alon (2011) reported that persistence gains were seen only for the low-income and middle-income groups.

Nonetheless, academic factors are sometimes found to mitigate the influence of financial aid upon retention. In a study of the impact of financial aid on student persistence, Herzog (2008) found that academic success improved retention among low-income students more significantly than did additional financial aid. In his sample of 5000 university students, for those students in the lowest of three income levels, there existed a 15% greater likelihood of persistence to the second year for each letter-grade increase in Grade Point Average (GPA). Herzog also found that among all students receiving financial aid, there was a 12% greater likelihood of persistence for each letter-

grade increase in GPA and an additional 5% increase among those students who were successful in an advanced mathematics course.

Many of the studies investigating the correlation between financial aid and retention, how those correlations vary among demographic groups, and how those correlations are affected by other cognitive and non-cognitive factors have been applied to students at four-year colleges and universities. The present study seeks to contribute to a better understanding of the impact that financial aid has on the strength of relationship between cognitive ability in mathematics and retention among community college students.

Retention and First-Generation Status

A demographic constituency that is of increasing interest to researchers investigating college student retention is the first-generation student population. While there are several ways in which “first-generation” is defined in the literature, the most widely-used definition considers a student to be first-generation if neither of the student’s parents attended college (McConnell, 2000).

First-generation students represented approximately 45% of all undergraduate college students in the United States in 1995-96. However, the majority of first-generation students, estimated to be about 55%, choose to enroll in two-year, public colleges (McConnell, 2000).

Students whose parents did not attend college enter higher education with certain personal, psychosocial, and academic characteristics that differ from those of other first-year students. Researchers have found that differences in performance after enrolling are to be expected, as well.

Inman and Mayes (1999) studied data from 4620 first-year community college students in Kentucky. Approximately 41.9% of the students in the sample were found to be first-generation, as the term is most commonly defined. Their study confirmed that first-generation students were more likely to come from low-income families, were more likely to be female, and were more likely to be older than the median age of the sample than were their non-first-generation counterparts.

Several studies have shown that first-generation students exhibit different psychosocial characteristics than do non-first-generation students. They are more likely to identify career preparation as their reason for attending college, more likely to select a college based upon its location and cost, and less likely to be knowledgeable about college procedures, practices, and culture than students whose parents attended college (McConnell, 2000). First-generation students also demonstrate lower levels of social integration than do non-first-generation students (McConnell, 2000).

Researchers have also found that first-generation students are often not as well-prepared, academically, to enter college. Based upon such measures as the rigor of high school coursework and scores on standardized achievement tests, Lohfink and Paulsen (2005) found lower levels of college readiness among the 1167 first-generation students in their study than were found among the 3017 non-first-generation students in their sample.

There is also evidence that first-generation students differ from other students in various measures of academic performance after entering college. Pascarella, Wolniak, Pierson, and Terenzini (2003) reported that, during the first two years of college, first-generation students had completed fewer credit hours and had lower grades than non-

first-generation students. First-generation students in their study had also taken fewer classes in natural science, mathematics, and arts and humanities than their non-first-generation peers. Inman and Mayes (1999) found that first-generation community college students experienced slightly lower first-year-to-second-year retention rates than non-first-generation students. This finding is consistent with findings pertaining to first-generation students at four-year colleges (Lohfink & Paulsen, 2005).

The present study will seek to determine if the significance of the relationships between first-semester mathematics performance and fall-to-fall retention differs based upon first-generation status.

Impact of Academic Achievement and Cognitive Ability on Retention

The pioneers of retention modeling recognized the significance of academic preparedness, academic integration, and academic performance in influencing persistence behaviors. Spady (1970) theorized that insufficient rewards drawn from either the academic or social systems of the college could give rise to a student's decision to leave. He noted that grades were the most tangible form of reward available from the academic system and that the importance of grades in predicting attrition of career-oriented students, in particular, and in precipitating premature departure directly as a result of involuntary dismissal. However, for students whose dispositions, interests, and expectations were more education-oriented, Spady believed that a more intrinsic reward emanating from the academic system, a concept he referred to as "intellectual development," was perhaps a more relevant indicator of successful integration into the institutional environment. Intellectual development, as conceived by Spady, was the result of the confluence of academic potential, the congruence of the student's attitudes,

skills, and interests with those of the college, and the establishment of personal relationships with others.

In analyzing the large national database used in his study, Astin (1975) concluded that the factors of greatest value in assessing one's chance of persisting were the student's past academic record and the achievement of good grades after entry. The impact of academic aspects on integration into the college environment has remained a consistent theme throughout Tinto's work, as well. He concluded from his synthesis of prior research leading to his Model of Student Retention that, in many studies, grade performance was shown to be the single most important factor in predicting persistence. However, he hastened to add that those same studies often failed to distinguish between involuntary academic dismissal pursuant to college policies and voluntary withdrawal. Still, he observed that a student may decide to withdraw voluntarily as a result of his academic experiences despite his level of social integration (Tinto, 1975).

Later, Tinto reaffirmed these conclusions, finding that, while 15% to 25% of all institutional departures occur due to academic failures, the inability to satisfy formal academic requirements does not explain most departures. Obviously, when the academic demands of the institution exceed the skills and abilities of the student, academic difficulty ensues. However, Tinto asserted that some students depart voluntarily after deciding not to invest time and commitment to meet the demands of the college's academic system even though those demands may not exceed the student's ability (Tinto, 1993).

Support for Tinto's theory that academic integration significantly influences persistence varies in the research that has followed. Peer-reviewed studies conducted

across multiple institutions of various types offer stronger empirical evidence of this influence than do studies that examine single institutions (Braxton & Lien, 2000).

Traditionally, for the purposes of projecting the likelihood of a student's academic success, admissions policies of four-year colleges and universities focus on aptitude test scores, high school grade point average (GPA), and high school class rank rather than on the secondary school curriculum experienced by the applicant. Adelman (1999) studied a national sample of students who were 10th graders in 1980 and followed their academic progress through 1993 to analyze the relationship between the academic wherewithal with which students enter college and their persistence and degree completion rates. He found that the academic intensity of the high school curriculum was a more reliable predictor of bachelor degree completion than 12th grade aptitude test scores, GPA, or class rank. Adelman constructed a metric he referred to as "Academic Resources" (ACRES) to compare the rigor of high school curricula. He found the ACRES measure to be a reliable predictor of bachelor degree completion rates, independent of demography. For example, students in the bottom two quintiles of socio-economic status but in the top quintile of ACRES completed bachelor degrees at a higher rate than most students in the top socio-economic quintile. Students in the bottom two quintiles (lower 40%) of ACRES complete degrees at a low rate regardless of socioeconomic status (Adelman, 1999).

The findings of other researchers seem to support Adelman's assertion that academic preparedness correlates strongly with academic success in college, which, in turn, portends persistence behavior. A prolific collection of research by Karl Alexander and his various research associates demonstrated that the predictive value of academic background exceeds that of demographic factors such as gender, race, and socio-

economic status relative to aptitude test performance, college attendance, and persistence to degree attainment (Adelman, 1999). In describing “Academics” as one of his *Nine Themes of College Student Retention*, Bean (2005) suggested that, “The combination of the student’s background, interaction with the institution related to academic matters, and a belief in one’s abilities to perform academic work have a cumulative mutual influence resulting in academic integration” (p. 226). He asserted that academic integration directly affected academic performance, which, in turn, correlated positively with retention. Nevertheless, acknowledging that numerous factors influence persistence, Bean cautioned against overestimating the effect of academic performance upon departure decisions. Alexander, Riordan, Fennessey, and Pallas (1982) observed that academic variables are stronger predictors of degree completion than factors related to social background.

A key component of Adelman’s measure of the academic intensity of high school curricula was the highest level of mathematics completed. When compared to other component measures of academic intensity, the level of mathematics completed in high school was shown to be the strongest predictor of degree completion. For each math course completed at the level of Algebra II or higher, the odds of completing a baccalaureate degree increased, on average, by a factor of 2.59-to-1, with the greatest increase occurring with the first course beyond Algebra II. Unfortunately, 37.2% of high school students who complete a college preparatory curriculum attain a highest level of mathematics lower than Algebra II (Adelman, 1999).

Adelman also investigated the value of certain academic performance variables after matriculation as predictors of persistence to degree attainment. He found that

persistence from Year 1 to Year 2 may not be a dependable indicator of a student's eventual success. Rather, likelihood of degree completion may be a factor of the number of course credits completed successfully in Year 1 (Adelman, 1999). A study conducted by Gore (2006) confirmed that a student's level of confidence in academic self-efficacy can predict persistence behavior. However, Gore's findings also suggested that assessment of a student's sense of self-efficacy is more useful as a predictor if measured at the end of the first semester of college rather than prior to enrollment.

Szafran (2001) found that students who enroll in heavier first-semester and first-year course loads had a higher probability of achieving an optimal grade point average and demonstrated a greater likelihood of persistence. Importantly, though, Szafran's study of 2,047 new college students revealed that enrollment in high risk courses such as college algebra could serve as a deterrent to retention. Similarly, McCormick (1999) concluded that accrual of course credits was a more reliable measure of progress toward a degree than years of attendance.

Studies of the impact of academic performance upon retention seem to confirm that there are corresponding influences for community college students. In a study of first-time-in-college, program-placed students, the Virginia Community College System (2008, August) found that, among a fall 2006 cohort of 25,652 students, only 33% of the 4,878 students who successfully completed no more than 25% of course credits attempted persisted to the subsequent spring semester. Meanwhile, 84% of the 18,259 students who successfully completed at least 51% of course credits attempted returned the following spring.

Voorhees and Zhou (2000) surveyed 87,000 community college students in Colorado and found a positive correlation between the number of credits completed and a student's change in educational intentions. In the Adelman (1999) study, 64% of the students for whom the Associate Degree was the highest degree attained either dropped, withdrew from, or otherwise failed to complete less than 10% of the courses they attempted. By contrast, 10.6% of the students in the study dropped, withdrew from, or failed to complete over 40% of their courses. Of this final group, 95% earned no degree.

Adelman (1999) concluded that we do students a disservice to attribute their failure to persist to social factors whose actual effect is only marginal. Academic preparation, continuous enrollment, and successful first-year performance are the truly significant predictors of college completion. The predominant source of information in most studies of retention and completion is student self-reports (Adelman, 1999), but to the extent that academic factors can serve as reliable predictors of persistence, the more important data can be found on high school and college transcripts.

Characteristics of the Community College Student Population

The community college system evolved in the United States in the middle of the Twentieth Century, growing out of a vast and diverse collection of two-year technical and junior colleges, with a mission to provide affordable access to higher education to a greater number of Americans. The open-door admissions policies, low-cost tuition, and state funding support featured by these institutions were intended to provide the opportunity to attend college for anyone who wished to attend. By the 1960s, community colleges had been established in every state in the union, and by the mid-1970s, community college enrollments represented 34% of all students enrolled in higher

education in the country (Cohen & Brawer, 2003). As of fall 2012, the community college population constituted 45% of the undergraduate enrollment in the United States (American Association of Community Colleges [AACC], 2013).

Students choose to enroll in community colleges for a variety of reasons. Generally, their educational objectives can be categorized in three ways: intent to transfer, pursuit of new or improved occupational or technical skills, or personal satisfaction (Cohen & Brawer, 2003). Since all of these goals can be attained from providers other than community colleges, the goals themselves are not the sole determining factors in a student's choice to attend community college. Other considerations that are likely to influence student decisions are convenience of location, affordability of tuition, and open-door access.

In a survey of 3,219 currently enrolled community college students in Colorado, Voorhees and Zhou (2000) found that 66% reported their educational objective upon entering college to be either to obtain a degree or certificate or to transfer, while 21% had originally enrolled for the purpose of improving job skills and 12% had enrolled for reasons of personal satisfaction. Of interest to the present study are students enrolled in degree programs. The two-year degree programs offered by community colleges, commonly referred to as associate degrees, are typically of two types. Degree programs designed for transfer usually parallel the first two years of a baccalaureate degree program in the same or a related field of study. Occupational-technical associate degree programs are intended to be terminal degrees, though some transfer opportunities may exist.

If demographic characteristics influence persistence patterns, as suggested by numerous researchers and chronicled elsewhere herein, then it must be acknowledged that the demographic characteristics of first-year community college students are significantly different from those of freshmen at four-year colleges and universities. Many community college students are not of traditional college age, but frequently are older students returning to the educational arena, sometimes after an extensive hiatus. In fall 2011, the average age among community college students was 28, half were over the age of 23, and 15% were over the age of 40 (AACC, 2013). Many studies exploring the relationship between age and college persistence suggest that age may be a far more significant contributing factor to attrition in community college than in four-year institutions. In fact, a major criticism of Tinto's Student Integration Model is that it cannot be generalized to the non-traditional college student (McCubbin, 2003). Feiger (1996) found that, among women, those who reported having the most barriers in their personal lives preventing them from taking more classes were between the ages of 27 and 35.

Today's community college student populations seem to be disproportionately female and nearly half are of non-Caucasian ethnicity. In fall semester 2011, 57% of all community college students were female and 48% represented racial minorities. Community colleges enrolled 49% of all Hispanic and 42% of all African-American college undergraduates in the United States in fall 2011 (AACC, 2013).

Most community college students enroll only on a part-time basis. In fall 2011, 59% of all community college students were enrolled part-time (AACC, 2013). Also, the majority of community college students are employed while attending college. Among

fulltime students, 80% are employed either fulltime or part-time, while 87% of part-time students are employed (AACC, 2013).

Students often choose to enroll in community college for financial reasons. Typically, community colleges are more affordable than four-year colleges or proprietary institutions. The percentage of community college students from lower socioeconomic strata is greater than the percentage of students of similar economic status who attend four-year institutions (Cohen & Brawer, 2003). Many community college students rely upon financial aid. In fall 2011, 46% of the students attending community colleges in the United States received some form of financial assistance (AACC, 2013).

Finally, due to the open-access mission of community colleges, it is often suggested that some students who enroll in community colleges are underprepared academically and possess a lower level of commitment to succeed than that possessed by their counterparts who attend four-year colleges and universities (Cohen & Brawer, 2003). In 2007-08, 36.2% of all first-year undergraduates in the United States reported having taken at least one remedial course. By contrast, nearly 41.9% of all first-year undergraduates at two-year public colleges had taken remedial coursework (NCES, 2011).

One metric that can be used to assess commitment to educational goal is persistence to degree attainment. The National Education Longitudinal Survey administered by the National Center for Educational Statistics found that among community college students whose high school graduation year was 1992 and who were enrolled in associate degree programs, only 44% had attained any degree or certificate within eight years of enrolling (Bailey, 2004).

If lack of readiness and commitment contributes to high attrition rates, it is logical for community college leaders to search for interventions in the first year that might enhance students' sense of commitment. However, there is concern regarding the extent to which retention models such as those developed by Spady and Tinto can be applied to community college students. Braxton and Lee (2005) conducted an expansive review of research studies that tested Tinto's thirteen principles as applied to commuter-college student populations. Applying an objective standard to the body of research corresponding to each principle taken individually, they were unable to find sufficient support for any of them.

Tinto (2005) acknowledged that retention models were likely to require adjustment in order to be valid for commuter colleges. He suggested that the influence of the classroom experience, not often included in analysis of student attrition, but perhaps the only experience that students at such institutions have in common, should not be disregarded as a factor in the study of retention for commuter-college students.

Retention, Persistence, and Attrition in the Community College

Tinto's original studies and the majority of research on retention that was first precipitated by his work were directed at the traditional college student; that is, a fulltime student of traditional college age attending a residential four-year institution (Crawford, 1999). More recent investigations have begun to focus attention on the first-year community college student. From 1983 to 2001, freshman-year to sophomore-year retention rates at four-year public colleges and universities ranged from 70% to 72%. In two-year public colleges, though, the first-year to second-year persistence rates ranged between 50% and 55% during the same period (Mortenson, 2005).

The reasons that community college students do not persist are many and varied. Cohen & Brawer (2003) suggest that most are beyond the ability of the college to control. For example, surveys of students who have dropped out indicate that some departures that appear to be premature are actually attributable to achievement of personal educational objectives that are more modest than degree attainment. Some students who leave early are stop-outs who intend to return when personal circumstances allow. Among the other reasons for attrition commonly identified from surveys are personal or family issues, inadequate academic or social integration, and insufficient academic preparedness (Cohen & Brawer, 2003).

Numerous studies have investigated the correlation between certain non-cognitive factors and persistence of community college students. Bers and Smith (1991) found that educational goals and intentions, as well as employment status, more accurately differentiated community college persisters and non-persisters than did Tinto's constructs of academic and social integration. These conclusions were supported by Napoli and Wortman (1998). Nora, Attinasi, and Matonak (1990) found that family and personal influences affected the persistence of a commuting student population. Freeze (2000) found that several non-cognitive factors discriminated to a significant degree between community college students who departed college prematurely and those who were retained.

Other researchers have investigated the validity of applying Tinto's model to the persistence and attrition behaviors of community college students, with mixed results. Borglum (1998) found that Tinto's model was not valid for the community college students she studied, concluding that there was no significant correlation between

academic or social integration and retention. By contrast, the United States Department of Education funded a comprehensive research project on the Transfer and Retention of Urban Community College Students (TRUCCS). One study conducted as part of the TRUCCS project found that “friendship,” a measure of social integration, had a significant influence on retention of some community college students (Gilmartin, Sax, & Hagedorn, 2003).

Academic factors, including college readiness and first-year performance, have been shown to be reliable predictors of retention in the community college. Feldman (1993) considered an array of demographic and other non-cognitive factors, but found that the most significant predictor of persistence for first-time-in-college community college students was high school grade point average. High school grade point average also proved to be a significant predictor of community college student transfer and persistence to a baccalaureate degree (Snell & Mekies, 1993). More recently, Hawley and Harris (2005-2006) determined that the number of developmental courses required was a strong predictor of attrition, while cumulative college grade point average served as a strong predictor of retention. In their study of 1,729 full-time community college students, Craig and Ward (2007-2008) found significant predictive value in cumulative college grade point average, second semester grade point average, and number of credits attempted. Their study identified only one demographic variable with significant predictive value, the length of the time interval between graduation from high school and enrollment in college, a factor that could easily be interpreted as an indicator of academic readiness.

Some observers suggest that, since the community college philosophy of open-door access results in the admission of large numbers of under-prepared students, high attrition rates are to be expected. According to Cohen & Brawer (2003, p.66), “Studies of student dropout may be only marginally relevant to an institution that regards accessibility as its greatest virtue.” However, if academic factors can be shown to be a significant influence in premature departure among community college students, such studies may indeed be quite relevant, perhaps suggesting interventions that could improve retention rates.

The Impact of Developmental Studies on Community College Retention

Given their open-access mission, it is inevitable that community colleges will be faced with serving the educational needs of many students who are academically unprepared for college-level work. Placement test results indicate that roughly half of all students who enroll in community colleges are in need of remediation in at least one subject (McCabe & Day, 1998). In the 2007-08 academic year, approximately 24% of first-year community college students took at least one remedial course, based upon self-reported data (NCES).

However, despite the efforts of community colleges to provide the necessary developmental instruction, large numbers of these students drop out or are dismissed for academic reasons before achieving their goals. In a scathing report entitled *Remediation: Higher Education’s Bridge to Nowhere*, Complete College America (2012) called remedial programming in America’s colleges a “broken system.” The report argued that too many students are placed into developmental coursework unnecessarily, that nearly 40% of those who enroll in developmental coursework never complete it, that fewer than

25% of students who complete developmental coursework ultimately complete the college-level courses for which they were being prepared, and, finally, that fewer than 10% of community college students who begin in developmental courses graduate within three years.

The impact of remediation on college student retention has been the subject of countless studies. Hoyt (1999) tracked the persistence of three cohorts of community college freshman who entered college in 1993, 1994, and 1995. By fall 1998, 60% of the non-remedial students in the 1995 cohort had dropped out. The drop-out rate, though, for students in the 1995 cohort who required remediation in one subject area was 63%. For students identified as needing remediation in two subject areas, the drop-out rate rose to 70%, while 72% of students requiring remediation in three areas had dropped out. Grimes and David (1999) found that 47% of the college-ready community college students in their study achieved at least one persistence metric, while only 27% of underprepared students in that cohort did so. Analyzing data from students entering two-year and four-year colleges in Texas over a nine-year period beginning in 1991, Martorell and McFarlin (2007) reported that only 23% of remedial students enrolled at two-year colleges attained an Associate or Bachelor's degree within 6 years of initial matriculation compared to 38% of non-remediated students.

Bettinger and Long (2005) conducted a longitudinal investigation of Ohio community college students who first enrolled in fall 1998. Students who placed into remedial mathematics were 15% more likely to have discontinued their education within five years without having received a two-year degree than students not requiring remediation in mathematics. There were similar but less dramatic findings for students

who placed into remedial English. However, after controlling for certain demographic, academic background, and educational intent characteristics, Bettinger and Long found no significant difference in retention outcomes between remedial students and non-remedial students.

Some researchers have found remedial coursework actually to have a positive impact on retention, while other studies have reached conclusions similar to Bettinger and Long. Boylan and Bonham (1992) reported that 24% of developmental students in community colleges obtained an associate's degree, while only 22% of the general community college student population achieved the same milestone. Seybert and Soltz (1992) found that the graduation rate among developmental mathematics students was almost twice as high as the graduation rate college-wide. Van Etten (1997) demonstrated that community college students enrolled in developmental courses were more likely to be retained than students who were not. Curtis (2002) found that enrollment in developmental coursework had no effect on the likelihood of persistence to program completion for community college students. Kreysa (2006-2007) found no significant difference in retention rates or graduation rates between remedial and non-remedial students, concluding that developmental coursework achieved its purpose by allowing underprepared students to catch up with their more college-ready classmates.

Bahr (2008) analyzed the effectiveness of mathematics remediation for nearly 86,000 first-year students enrolled in 107 community colleges. He concluded that students who are successfully remediated are essentially "indistinguishable" from students not requiring remediation in terms of degree attainment and transfer. However,

Bahr also found that 75% of students needing remediation in mathematics are not successfully remediated.

In summary, it must be acknowledged that research into the relationship between developmental studies and retention among college students has produced mixed findings. However, given the ubiquity of college-level mathematics course requirements in community college degree programs and the number of entering students who are identified as being inadequately prepared for college math, it remains reasonable to expect that effective and efficient remediation can improve success rates in college-level courses. Such success, logically, should impact other variables, such as grade point average and credit hour accrual that have been shown to correlate positively with persistence.

Mathematics in the Undergraduate Curriculum

In 1953, the Mathematical Association of America established the Committee on the Undergraduate Program in Mathematics (CUPM) with the intent of “modernizing” the curriculum of studies included in the typical baccalaureate degree program faced by mathematics majors. While the CUPM was charged with developing recommendations regarding the core curriculum in the major, there were 800,000 students enrolled in college mathematics courses at the time, but only 4000 bachelor’s degrees were being awarded in mathematics (Steen, 1998). In 1978, the CUPM formed a panel to study general education in mathematics. The panel’s report, entitled *Minimal Mathematical Competencies for College Graduates*, included among its recommendations that all college graduates should possess reasonable and demonstrable proficiency in mathematics. The panel acknowledged that these proficiencies might differ for college

students in occupational programs at two-year colleges, but stipulated that the knowledge, skills, and abilities required of four-year graduates should also apply to two-year college students enrolled in transfer curricula (Wardrop & Wardrop, 1982).

The National Research Council (NRC) continued to strengthen the case for requiring quantitative literacy at all levels of the American educational system with its publication of *Everybody Counts: A Report to the Nation on the Future of Mathematics Education* in 1989. This report summarized studies conducted by three separate units of the NRC, noting that the intellectual attributes fostered by the mathematical disciplines were increasingly relevant and essential as the world and the workplace became more technological. Yet, the report conceded that “mathematics is the worst curricular villain in driving students to failure in school” (National Research Council [NRC], 1989, p. 7). The NRC found that, while there are many compelling reasons to require students to study mathematics and approximately 10% of the educational resources of the United States (about \$25 billion in 1989) is devoted to mathematics education, nearly half of all students enrolled in mathematics courses at all levels exit the “mathematics pipeline” each year (NRC, 1989).

The NRC also identified some disturbing demographic trends. The underrepresentation of Blacks, Hispanics, and Native Americans in professional, engineering, and other scientific fields was found to be in direct proportion to the amount of mathematics required in the respective career. The study also reported that men significantly outnumbered women in mathematics-based positions, despite the fact that mathematics preparedness upon entry to college was virtually the same for both genders (NRC, 1989).

Not surprisingly, the NRC found that most postsecondary programs included some form of mathematics study, either as a general education requirement or as a prerequisite for subsequent courses in the curricular program. Therefore, *Everybody Counts* suggested that mathematics offerings in college should be sufficiently broad-based to meet the demand for general elective courses, service courses for programs with specific mathematics requirements, teacher education courses, and rigorous courses for mathematics majors (NRC, 1989).

In 1990, the Mathematical Association of America and the American Mathematical Association of Two-Year Colleges (AMATYC) collaborated on the production of a report entitled, *A Curriculum in Flux: Mathematics at Two-Year Colleges*. By 1990, nearly five million students were enrolled in two-year colleges in the United States and these institutions were delivering approximately one-third of all mathematics instruction in the country. The report continued to stress the need for mathematics as an essential component of postsecondary programs and offered specific recommendations for enhancing the mathematics curriculum at two-year colleges. In particular, the report called for the expansion of the Statistics offerings, incorporation of the hand-held calculator and the computer into mathematics instruction, and the generalization of mathematics courses designed for specific career areas (Davis, 1990).

The vast majority of students studying mathematics in two-year colleges are enrolled in courses referred to by AMATYC as “introductory college mathematics.” These courses include developmental mathematics, technical mathematics for occupational programs, mathematics for the liberal arts, mathematics for elementary school teachers, finite mathematics, college algebra, trigonometry, precalculus, and

introductory statistics. In 1995, AMATYC published *Crossroads in Mathematics: Standards for Introductory College Mathematics Before Calculus*. The intent of this publication was to establish guidelines for both content and pedagogy that would modernize and revitalize the introductory college mathematics curriculum at two-year colleges to address the unique needs of its various audiences. *Crossroads* also specified a new framework for the skills and concepts to be imparted to students, identifying those that should receive “increased attention” and certain traditional content and pedagogy that should receive “decreased attention.” AMATYC considered *Crossroads* to be a call to action for two-year college mathematics educators (Cohen, 1995).

Ten years after their publication of *Crossroads*, AMATYC issued a follow-up report entitled, *Beyond Crossroads: Implementing Mathematics Standards in the First Two Years of College*, in response to findings from surveys of member institutions regarding progress toward implementation of the *Crossroads* standards. The National Advisory Committee for the *Beyond Crossroads* project sought “to renew and to extend the goals, principles, and standards set forth in *Crossroads*.” In addition, though, *Beyond Crossroads* introduced a new, additional set of “Implementation Standards” designed to guide two-year colleges in their efforts to incorporate the prescribed recommendations for content and pedagogy (Blair, 2006).

In fall 2005, approximately 1.3 million students were enrolled in mathematics courses at two-year colleges in the United States. Roughly fifty-seven percent of these students were enrolled in developmental mathematics and less than ten percent were enrolled in calculus or higher-level college mathematics (Blair, 2006). AMATYC acknowledged the responsibility of two-year institutions to provide the ninety percent of

its students who enroll in introductory college mathematics with relevant content, meaningful learning outcomes assessment, and improved opportunity for success.

Mathematics Achievement Among College Students

As recently as the middle of the Twentieth Century, the United States led the rest of the world in mathematics and science education, fostering a culture of research and technological innovation and development during and in the aftermath of World War II. More recently, however, the United States has experienced a precipitous decline in the percentage of college degrees awarded in science, technology, engineering and mathematics (STEM) disciplines. Colleges are experiencing low success rates in required college-level mathematics courses and an increasing demand for remedial education in mathematics. Enrollment in public two-year colleges in the United States increased by 11% from fall 2005 to fall 2010. However, enrollment in precollege-level mathematics at these institutions grew by 19% over the same period (Blair, Kirkman, & Maxwell, 2013). On assessments of mathematics and science achievement, American elementary and secondary school students do not perform as well as their counterparts in many other countries (Thiel, Peterman, & Brown, 2008).

There are many factors that contribute to low success rates in mathematics, including inadequate preparation, student predispositions toward mathematics, lack of alignment between the subject matter and the student's program of study, and student behaviors such as poor attendance, poor study habits, and failure to utilize academic support services offered by the institution (Gaston, 2009). Higbee and Thomas (1999) found that non-cognitive factors such as self-confidence, math anxiety, and perceptions of the usefulness of mathematics course content were significant predictors of success

among high-risk students placed in developmental mathematics courses. Mathematics self-efficacy among students in college-level mathematics courses, enhanced by a teacher-centered classroom environment, has been shown to have a strong positive correlation with achievement as measured by final exam grades in college algebra (Peters, 2013). In his study, after first controlling for previous academic achievement, House (1993) found that students with a higher level of academic self-concept made better grades in college algebra.

Regardless of the reasons for student success or failure, though, mathematics often seems to be a determining factor in students' choice of degree program and an inhibitor to degree completion, regardless of program choice (Hall & Ponton, 2005). Fike and Fike (2012) examined the effect of mandatory first-semester enrollment in remedial mathematics for students identified as needing remediation. Results of that study indicated that students who enrolled in and successfully completed a developmental mathematics course in the first semester attained the same success outcomes, defined by first-semester grade point average, fall-to-spring retention, and fall-to-fall retention, as students who were ready for college mathematics upon admission. As might be expected, students who enrolled but were unsuccessful in developmental mathematics had lower first-semester GPAs and retention rates. Similarly, students who deferred enrollment in developmental coursework until after the first semester of college were not as successful as those who completed a remedial course in the first semester.

Wofle (2012) found no significant difference in retention rates between successful developmental mathematics students and students who were identified as college-ready. However, 72.2% of the students in that study who were identified as

needing remediation did not even enroll in a prescribed developmental mathematics course.

Some researchers have found that retention rates among successful developmental students are actually significantly higher than for students identified as college-ready upon admission. Waycaster (2001) examined fall-to-spring retention rates at five Virginia community colleges over three consecutive academic years. She found that retention rates for developmental students ranged from 61.9% to 80.6%, while non-developmental students were retained at rates ranging between 42.1% and 61.9%. Similarly, Lesik (2007) found that participation in a developmental mathematics program had a positive causal effect on the persistence of students at a four-year college.

While the relationship between developmental mathematics and persistence has been the subject of numerous studies, the correlation between achievement in college mathematics and retention has been investigated by fewer researchers. Parker (2005) found that 46% of the 1,215 first-time-in-college students studied at a mid-size public university in Pennsylvania did not persist to degree attainment. These non-persisting students successfully completed only 52.3% of the mathematics coursework they attempted prior to departure. By comparison, students who received a degree within four years successfully completed 91.7% of the mathematics courses taken. In this study, 35.4% of the students were still enrolled at the university under study after four years but had not obtained a degree. Among this latter group, students had been successful in 69.8% of the mathematics courses taken.

Todd (2004-05) investigated the performance of students at a four-year, liberal arts college who had successfully completed at least 15 credits of general education

coursework prior to enrolling in their first general education mathematics course. For the three-year period under study, nearly 28% of these students earned a grade of D or lower in their first general education math course, while fewer than 9% received a grade of D or lower in their first general education English course.

College mathematics educators are keenly aware that for many degree-seeking students, college algebra is the general education mathematics course that stands in the way of a steady progression to their educational goal. In fall 2000, nearly 400,000 students were enrolled in this course at colleges across the country, more than were enrolled in any other college-level, credit-bearing mathematics course. College algebra courses enhanced with trigonometry enrolled an additional 100,000 students and precalculus courses enrolled approximately 200,000 more (Small, 2002). Unfortunately, success rates in these courses are low. Studies have found that the number of students who receive a grade of D or F or choose to withdraw from these courses ranges between 40% and 60%. Thus, college algebra and courses with similar content serve as a barrier to about 200,000 students each year (Small, 2002).

A statewide community college system in the southeastern United States commissioned a study by the Community College Research Center to investigate the performance of remedial students in subsequent, college-level “gatekeeper” courses. The population under study consisted of 24,140 first-time-in-college students who first enrolled in summer or fall 2004. Their progress was tracked for four years, through summer 2008. Only 26% of the students in the cohort completed a gatekeeper mathematics course during the four-year period. Sixty-four percent of the students did not enroll in a gatekeeper math course (VCCS, 2009).

The evidence seems to suggest that student readiness for, avoidance of, and performance in college-level mathematics hinders pursuit of their educational goals. The present study seeks to determine if these variables exhibit a strong correlation with fall-to-fall retention of first-year students.

Summary and Research Questions

The abundant research into the phenomenon of college student retention clearly suggests that there are numerous factors that contribute to premature departure. It is also apparent that these factors have differing influences within various demographic groups and that persistence and attrition behaviors among community college students may be attributable to circumstances that are unlike those encountered by students at four-year, residential colleges and universities. Many of the theories, models, and predictive variables that have been applied to these studies have been based upon subjective and self-reported data and characteristics much of which is often provided by the students themselves.

Out of this milieu of scholarly inquiry, there appears to emerge a substantial body of reliable evidence that academic readiness and first-year academic performance variables correlate meaningfully with retention and persistence measures. Taken together with the numbers of community college students who are identified as lacking entry-level skills in mathematics, thus being directed to developmental mathematics coursework, and the first-year, college-level mathematics course requirements inherent to most associate degree curricula, this evidence calls for targeted research to investigate the relationship between mathematics readiness and first-year mathematics performance and the fall-to-

fall attrition of degree-seeking, community college students. Such is the purpose of the present study.

Given the challenges faced by community colleges in their attempts to retain students, it would seem valuable to identify variables that are both objective and easily measured and that exhibit significant correlations to retention. Mathematics readiness and first-year mathematics performance can be assessed by metrics that are readily quantifiable with objective data that can be obtained from student academic records. Consequently, though the present study is limited to a specific student cohort at a single community college, its methodology is easily replicated to determine if the findings can be reliably scaled and applied across the statewide community college system of which this institution is a member or, perhaps, to broader populations of college students.

Against the backdrop of the theoretical framework established by decades of research and with the ultimate goal of investigating the relationship between entry-level readiness in mathematics, first-semester mathematics performance, and first-year to second-year retention, this study will seek to answer the following research questions:

1. For students in the sample under study who are recommended for developmental mathematics based upon placement test scores, are there significant differences in fall-to-fall retention rates among those who, in their first semester of enrollment, successfully complete a developmental mathematics course, those who enroll in a developmental mathematics course but fail to complete it successfully, and those who postpone developmental mathematics coursework until after the first semester?

2. For students in the sample under study who are recommended for college-level mathematics based upon placement test scores, are there significant differences in fall-to-fall retention rates among those who, in their first semester of enrollment, successfully complete a college-level mathematics course, those who enroll in a college-level mathematics course but fail to complete it successfully, and those who postpone college-level mathematics coursework until after the first semester?
3. For students in the sample under study, to what extent does gender influence the correlation between first-semester mathematics performance and fall-to-fall retention?
4. For students in the sample under study, to what extent does student age influence the correlation between first-semester mathematics performance and fall-to-fall retention?
5. For students in the sample under study, to what extent does race or ethnicity influence the correlation between first-semester mathematics performance and fall-to-fall retention?
6. For students in the sample under study, to what extent does enrollment status influence the correlation between first-semester mathematics performance and fall-to-fall retention?
7. For students in the sample under study, to what extent does financial aid status influence the correlation between first-semester mathematics performance and fall-to-fall retention?

CHAPTER 3

METHODOLOGY

Introduction and Goals of the Study

The review of the literature presented in the previous chapter suggests that among many factors that may be related to college student retention, cognitive ability has often been shown to have a significant positive correlation to persistence behaviors. The relevant research further indicates that cognitive ability may be defined in terms of both college readiness at the point of admission and academic performance in college-level coursework. College readiness, in turn, has typically been measured by the extent to which an entering student is identified as being in need of remediation. Academic performance in college-level coursework has been measured in terms of course credits completed, grade point average, or both.

Prior research also indicates that the relationship between demographic characteristics and other variables that influence retention behaviors should not be overlooked. Some studies have found no significant differences in the correlation of variables under investigation after controlling for selected demographic factors. Other researchers, however, have occasionally detected that certain demographic factors do, indeed, have a significant impact upon such correlations for both cognitive and non-cognitive variables.

McGrath & Braunstein (1997) and DeBernard, Spielman, & Julka (2004) found no significant correlation between gender and retention. Grimes (1997) and Leppel (2002), among others who found differences in retention rates based upon gender, ascribe these differences to other personal characteristics, such as self-efficacy, self-esteem, or

family circumstances determined to be more influential than gender alone. Hagedorn, et al. (1999) and Fike & Fike (2012) found females to be over-represented in remedial mathematics. However, Fike & Fike (2012) reported that females in remedial mathematics exhibited higher retention rates than their male counterparts.

The McGrath & Braunstein (1997) study also found no significant correlation between age and retention among freshmen at a four-year, private university. On the other hand, Brooks-Leonard (1991), Feldman (1993), Burley, Butner, & Cejda (2001), and Adelman (2005) are among numerous researchers who have offered evidence that age is a significant predictor of persistence.

It is not uncommon for there to exist significant differences in retention rates among various racial or ethnic constituencies. Such findings have often been shown to be a result of differing entry-level cognitive ability or post-admission academic performance. Weissman, Bulakowski, & Jumisko (1998) found that Black and Hispanic students were in greater need of remediation than White students. Similarly, Hagedorn, et al. (1999) found that minority students were over-represented in remedial mathematics. Notwithstanding these results, differences in retention rates among racial and ethnic groups are often found to be insignificant when statistical treatments control for other factors (Bers & Smith, 1991; Brooks-Leonard, 1991; Grosset, 1993; Voorhees & Zhou, 2000; Hagedorn, Maxwell, & Hampton, 2001-2002; Craig & Ward, 2007-2008).

Most studies have shown that full-time students are more likely to be retained than are part-time students (Brooks-Leonard, 1991; Feldman, 1993; Cofer & Somers, 2000). Bettinger and Long (2005) and Fike and Fike (2012) also reported higher levels of

persistence among full-time students enrolled in remedial mathematics than among part-time students in such programs.

Students who are receiving financial aid assistance have commonly been found to demonstrate higher retention rates (Cofer & Somers, 2000; Mendoza, Mendez, & Malcolm, 2009). Relationships between financial aid status and persistence within demographic subgroups have also been studied. Gross, Hossler, and Ziskin (2007) reported that financial aid correlated with retention more strongly for males than for females. Herzog (2008) and Alon (2011) reported that financial aid improved persistence among low-income and middle-income socioeconomic groups than among high-income students. Only occasionally has a researcher found that financial aid was not found to influence retention (Dowd & Coury, 2006).

The present study seeks to determine the extent to which cognitive ability in mathematics influences the fall-to-fall retention of first-year, degree-seeking community college students. Transferrable degree programs in the Virginia Community College System include at least two college-level mathematics course requirements and non-transferrable degree programs require a least one college-level mathematics course. Moreover, the curriculum designs for both types of these two-year programs consistently represent the mathematics coursework as a first-year requirement.

In keeping with the revelations stemming from the related literature, cognitive ability in mathematics will be assessed in terms of a student's readiness for college mathematics and in terms of a student's performance in college-level mathematics courses.

Previous studies have investigated results for students whose cognitive ability in mathematics at the point of admission has necessitated remediation. The eventual retention of such students has been shown to depend upon their successful completion of remedial coursework. Waycaster (2001) and Lesik (2007) found a positive correlation between participation in a developmental mathematics program and retention rates. Bahr (2008) and Wolfle (2012) found that students who are successfully remediated in mathematics exhibit retention rates that are not significantly different from those exhibited by students deemed to possess college-ready mathematics ability upon admission. Though studies that attempt to assess the effects of timeliness of mathematics remediation are few, Fike and Fike (2012) found that first-semester enrollment and success in developmental math courses resulted in higher retention rates than those experienced by students who postponed or otherwise failed to complete the prescribed remedial math courses successfully in the first semester.

Prior research related to the effect of timely and successful completion of required college-level mathematics coursework upon retention is even more limited. In such studies that are available, however, the relationship is difficult to ignore. For example, Parker (2005) that, among students who failed to persist to degree attainment, the successful completion rate in college-level mathematics coursework attempted was only 52.3%. Students who received a degree, by contrast, completed 91.7% of their college-level math courses.

The present study also seeks to determine if the correlations between cognitive ability in mathematics and retention are influenced by demographic characteristics, including student gender, age, race or ethnicity, enrollment status, financial aid status, or

first-generation status. Thus, the goals of this study are to ascertain answers to the following research questions:

1. For students in the sample under study who are recommended for developmental mathematics based upon placement test scores, are there significant differences in fall-to-fall retention rates among those who, in their first semester of enrollment, successfully complete a developmental mathematics course, those who enroll in a developmental mathematics course but fail to complete it successfully, and those who postpone developmental mathematics coursework until after the first semester?
2. For students in the sample under study who are recommended for college-level mathematics based upon placement test scores, are there significant differences in fall-to-fall retention rates among those who, in their first semester of enrollment, successfully complete a college-level mathematics course, those who enroll in a college-level mathematics course but fail to complete it successfully, and those who postpone college-level mathematics coursework until after the first semester?
3. For students in the sample under study, to what extent does gender influence the significance of the relationship between first-semester mathematics performance and fall-to-fall retention?
4. For students in the sample under study, to what extent does student age influence the significance of the relationship between first-semester mathematics performance and fall-to-fall retention?

5. For students in the sample under study, to what extent does race or ethnicity influence the significance of the relationship between first-semester mathematics performance and fall-to-fall retention?
6. For students in the sample under study, to what extent does enrollment status influence the significance of the relationship between first-semester mathematics performance and fall-to-fall retention?
7. For students in the sample under study, to what extent does financial aid status influence the significance of the relationship between first-semester mathematics performance and fall-to-fall retention?
8. For students in the sample under study, to what extent does first-generation status influence the significance of the relationship between first-semester mathematics performance and fall-to-fall retention?

Research Design

The present study will be quantitative analysis of *ex post facto* data, assigning numerical values to all variables and applying methods of inferential statistics to arrive at conclusions. The dependent variable will be fall semester-to-fall semester retention. The primary independent variables will be entry-level mathematics readiness and first-semester mathematics performance. The relationship between first-semester mathematics performance and fall-to-fall retention are to be investigated for students in each of two subgroups, those who are deemed ready for college-level mathematics upon entry to the institution and those who are deemed not to be ready for college-level mathematics at the time of entry. In addition, the influence of demographic control variables upon the relationship between first-semester mathematics performance and fall-to-fall retention

will be evaluated for all students in the sample population. Specifically, the demographic control variables included in this study will be gender, age, race or ethnicity, enrollment status, financial aid status, and first-generation status.

The analysis conducted in this study will employ a non-experimental design. That is, the independent variables will not be manipulated to serve as a treatment applied to one or more experimental groups (Gay, 1987).

The dependent variable, fall-to-fall retention, will be defined to be dichotomous (retained, not retained). The primary independent variables will also be discrete-valued. College math readiness shall be defined to be dichotomous (college ready, not college ready), while first-semester mathematics performance shall be defined to be multi-valued (enrolled with successful completion, enrolled without successful completion, not enrolled).

Covariate demographic control variables will also be defined to be discrete-valued. . Specifically, the gender (male, female), enrollment status (full-time, part-time), financial aid status (Pell eligible, not Pell eligible), and first-generation status covariates are to be dichotomous. The race or ethnicity (Black, White, other) and student age group (under 18, 18-21, 22-24, 25-and-over) covariates are to be multi-valued.

Chi-square analysis will be utilized to examine the significance of the relationships between first-semester mathematics performance and fall-to-fall retention for students in each subgroup, those who are deemed ready for college-level mathematics upon entry to the institution and those who are deemed not to be ready for college-level mathematics at the time of entry. In addition, chi-square analysis will be applied to assess the influence of demographic characteristics on these relationships.

Population and Sample

The population of interest to the present study is first-time-in-college, degree-seeking community college students. The sample chosen to represent this population for this preliminary study will include first-time-in-college students who were enrolled in an associate degree program at a large Virginia community college in the fall semester of the 2011-2012 academic year. The college from which the sample was drawn is among the largest of the 23 colleges in the Virginia Community College System. It has three comprehensive campuses, one located in an urban setting, one in a large suburban county, and one in a rural community. In fall 2011, the college's total credit enrollment was 13,367 students. Of this number, those who were first-time-in-college, degree-program-placed students totaled 1,518.

Data for the sample were provided by the Office of Institutional Effectiveness at the college under study. Personal identifiers are not to be included among the data provided for this study to assure anonymity of the subjects. Approval to conduct the study using the data provided is to be obtained from the Human Subjects Review Committee at Old Dominion University and from the Associate Vice-President of Policy and Institutional Effectiveness at the community college selected for this study.

Data Analysis

Descriptive statistics will be used to describe the sample selected for study in terms of its demographic characteristics and in terms of mathematics readiness, first-semester mathematics performance, and fall-to-fall retention.

Since the covariates are to be discrete-valued, chi-square analysis will be used to test hypotheses regarding differences in fall-to-fall retention outcomes among subgroups.

The chi-square test is used to determine whether two or more categorical variables are related. The chi-square test for independence tests the null hypothesis that two variables are independent of each other (Boslaugh, 2013), using observed values of the variables to calculate the probability that the null hypothesis is true (Orcher, 2005).

A chi-square test of independence will be performed to determine if first-semester mathematics performance was significantly related to fall-to-fall retention for the subgroup of the sample who were recommended for developmental mathematics upon admission. Chi-square analysis will also be used to determine if first-semester mathematics performance was related to fall-to-fall retention for the subgroup of the sample who were recommended for college-level mathematics upon admission.

Chi-square tests of independence will also be conducted to investigate whether the significance of the relationship between first-semester mathematics performance and fall-to-fall retention was affected by each of the demographic factors of gender, age, race or ethnicity, enrollment status, financial aid status, and first-generation status.

For all analyses performed in the present study, the level of significance that will be applied is $\alpha = .05$.

Limitations and Delimitations

The present study will be subject to inherent limitations associated with causal-comparative studies that utilize *ex post facto* data. In particular, the statistical analysis to be employed in this study will not include manipulation or randomization characteristics that would be associated with a true experimental design. Therefore, a cause-and-effect relationship between variables is not to be inferred from strong correlations that may be found to exist (Gay, 1987).

The present study is delimited by its susceptibility to selection bias. The sample under study will be a cohort of community college students enrolled in the fall semester of one selected academic year at a single community college. Thus, the generalizability of the findings to students enrolled at this institution in other terms or in other years and to students at other institutions will remain to be established.

The correlational analysis will not control for other measures of academic achievement, such as total credit hours completed, grade point average, or second semester performance in mathematics that could reasonably be expected to influence fall-to-fall retention behaviors. Moreover, the study will not investigate non-cognitive factors that have been shown by other researchers to correlate with student persistence.

Finally, the present study will not attempt to distinguish retention rates based upon the levels of difficulty of the various developmental and college-level mathematics courses taken by students in the first semester of enrollment nor will it include consideration of second-semester mathematics performance of first-year students upon retention to the following fall semester. Such factors might reasonably be expected to mitigate the findings of this study.

Summary

The findings of the present study are expected to provide a useful contribution to the research into the relationship between academic performance and retention among community college students. The study lends itself to replication at similar institutions or application to multi-institutional populations. Further validation of the results of this investigation will serve to inform and assist students, counselors, and advisors in

planning mathematics coursework so as to optimize the likelihood of first-year to second-year retention of first-time degree-seeking students.

CHAPTER 4

ANALYSIS OF THE DATA

The primary purpose of the present study was to determine the significance of the relationship between first-semester mathematics performance and fall-to-fall retention for first-time-in-college, degree-seeking, community college students. The research design included analysis of this relationship for students who were deemed to be ready for college-level mathematics at the time of their admission to the institution as well as for those who were found to be in need of remediation in mathematics upon admission. For each of these two subgroups, the study defined the independent variable, first-semester mathematics performance, as having one of three possible values for each student in the population sample: successful completion of a math course in the first semester of enrollment at the college, enrollment in but failure to complete successfully a math course in the first semester, or deferment of enrollment in mathematics coursework until after the student's first semester in college. Ultimately, the relationship between first-semester mathematics performance and the dependent variable, fall-to-fall retention, was of paramount interest.

A secondary purpose of the study was to determine if the significance of the relationship between first-semester mathematics performance and fall-to-fall retention was affected by any of several demographic variables. In particular, the effect of gender, age, race or ethnicity, full-time or part-time enrollment status, financial aid status, and first-generation college student status were analyzed.

The sample chosen to represent the population under study consisted of all first-time-in-college, degree-seeking students who were enrolled in an associate degree

program at a large community college in Virginia during the fall semester of the 2011-2012 academic year. Data for the study were provided by the Office of Institutional Effectiveness at the college.

The dependent variable, fall-to-fall retention, was dichotomous; that is, each student in the sample either remained enrolled or was no longer enrolled at the college as of the fall semester of the 2012-2013 academic year. The sample was divided into two subgroups based upon the dichotomous characteristic of readiness for college-level mathematics. Most students in the sample were deemed either to be ready or not ready to enroll in the first-semester, college-level mathematics course required by their chosen curricular program based upon scores attained on mathematics placement tests administered by the college. In addition, college admission procedures allow for waiver of the mathematics placement test for students whose performance on certain nationally-recognized mathematics achievement tests met or exceeded prescribed standards. Students in the sample for whom such waivers were granted were deemed to be college-ready.

Covariate demographic control variables were defined to be discrete-valued. Specifically, the gender (male, female), enrollment status (full-time, part-time), financial aid status (Pell eligible, not Pell eligible), and first-generation college student status (first-generation, not first-generation) covariates were dichotomous. The age group (under 18, 18-21, 22-24, 25-and-over) and race or ethnicity (White, Black, other) covariates were multi-valued.

Statistical analysis was applied to examine the significance of the relationships between first-semester mathematics performance and fall-to-fall retention within each

subgroup. In addition, appropriate statistical methods were applied to assess the influence of demographic characteristics on these relationships.

Since the covariates were discrete-valued, chi-square analysis was used to test hypotheses regarding differences in fall-to-fall retention outcomes among subgroups. A chi-square test of independence was performed to determine if first-semester mathematics performance was related to fall-to-fall retention in each subgroup. Chi-square tests of independence were also conducted to investigate whether each of the demographic factors of gender, age, race or ethnicity, enrollment status, financial aid status, or first-generation status mitigated the significance of the relationship between first-semester mathematics performance and to fall-to-fall retention. For all statistical analyses performed in this study, the significance level applied was $\alpha = .05$.

Characteristics of the Sample

The sample selected for study included 1518 first-time-in-college, degree-seeking students enrolled at the community college under study in the fall semester of the 2011-2012 academic year. Two of the students in the sample each enrolled in two distinct college-level mathematics courses in the fall semester. Each student successfully completed at least one of the courses taken and, thus, each student was considered to be in the college-ready subgroup and each was considered to have successfully completed a first-semester mathematics course.

There were 703 female students and 814 male students in the sample. One student failed to provide gender information. The gender profile of the sample is presented on Table 1.

Table 1

Students in the Sample by Gender

Gender	Frequency	Percent
Female	703	46.3
Male	814	53.6
Not Reported	1	0.1
Total	1518	100.0

The sample included 1072 students between the ages of 18-years-old and 21-years-old, an expected age range for first-time-in-college students. Students 25 years of age or older comprised 16.5% of the sample. The oldest student in the sample was 62-years-old when beginning college coursework in fall 2011. Only 7.3% of the students were younger than 18 years of age, while only 5.5% were between the ages of 22 and 24. Table 2 provides a profile of the sample by age category.

Table 2

Students in the Sample by Age Category

Age Category	Frequency	Percent
Under 18	111	7.3
18 – 21	1072	70.6
22 – 24	84	5.5
25 and over	251	16.5
Total	1518	100.0

The race and ethnicity profile of the sample revealed that 43.9% of the students in the sample were Black and 43.8% were White. Race and ethnicity data for the sample is provided in Table 3.

Table 3

Students in the Sample by Race/Ethnicity

Race/Ethnicity	Frequency	Percent
Asian	58	3.8
Black	666	43.9
Hispanic	30	2.0
White	665	43.8
Other	99	6.5
Total	1518	100.0

Approximately 52.4% of the students in the sample were enrolled on a full-time basis, having registered for at least 12 course credits in fall semester 2011. Table 4 provides data on the enrollment status of students in the sample.

Table 4

Students in the Sample by Enrollment Status

Enrollment Status	Frequency	Percent
Full-time	795	52.4
Part-time	723	47.6
Total	1518	100.0

The financial aid status of students in the sample was determined by each student's eligibility for a federal Pell grant. The Pell grant program is a need-based program offering financial grants-in-aid to low-income, undergraduate students. Eligibility for the Pell grant program is determined by information provided by the student on the Free Application for Federal Student Aid (FAFSA). Table 5 provides Pell-eligibility data for students in the sample under study.

Table 5

Students in the Sample by Financial Aid Status

Financial Aid Status	Frequency	Percent
Pell-eligible	915	60.3
Not Pell-eligible	603	39.7
Total	1518	100.0

Among the 1518 students in the sample, 366 reported being a first-generation college student, the first member of their family to attend college. The full profile of the sample in terms of first-generation status is provided in Table 6.

Table 6

Students in the Sample by First-Generation Status

First-Generation Status	Frequency	Percent
First-Generation	366	24.1
Not First-Generation	1152	75.9
Total	1518	100.0

The present study sought to determine the significance of the relationship between first-semester mathematics performance and fall-to-fall retention for students in the sample. Overall, 825 (54.3%) of the students in the sample were no longer enrolled at the college as of fall semester 2012, while 693 (45.7%) of the students were retained. This distribution formed the basis for the number of students expected to be retained and the number expected not to be retained within each category of the independent variables under investigation. Fall-to-fall retention data for students in the sample is provided in Table 7.

Table 7

Fall-to-Fall Retention of Students in the Sample

Fall-to-Fall Retention Status	Frequency	Percent
Retained	693	45.7
Not Retained	825	54.3
Total	1518	100.0

Identification of Subgroups

The research design of this study required that the sample be divided into two subgroups. One subgroup consisted of those students who were deemed to be ready for college-level mathematics as of their first semester of enrollment at the college. The

second subgroup included students who were deemed to be in need of remediation in mathematics before being allowed to enroll in a college-level mathematics course required in their program.

The college-level mathematics courses required in degree programs at the college under study vary in the prerequisite mathematics skill necessary for entry. Assessment of student readiness for the required mathematics coursework is conducted by administration of a nationally-normed mathematics placement test, unless other factors in the student's academic background warrant waiver of the placement test requirement. The student's performance on the placement test results in a determination of a placement level. A student must achieve a minimum placement level no lower than four to be deemed ready to enter the first college-level mathematics course required in an associate of science or associate of arts degree program designed for transfer to a four-year institution. A student must achieve a minimum placement level no lower than two to be deemed ready to enter the first college-level mathematics course required in an associate of applied science or associate of applied arts program. Such programs are not intended to be transferable and graduates of these programs are awarded two-year, terminal degrees.

For the purposes of the present study, a student in the sample was deemed to be ready for college-level mathematics if the student enrolled in a college-level mathematics course in fall semester 2011, a result of the student having either achieved the requisite level on the placement test or having been granted a waiver of the placement test requirement. In addition, a student who did not enroll in any mathematics course in fall semester 2011 was deemed to be college level if the student was enrolled in a transfer-

degree program and achieved a mathematics placement test level of four or higher, or was enrolled in a non-transfer degree program and achieved a mathematics placement level of two or higher.

A student was deemed not to be ready for college-level mathematics and in need of remediation if the student enrolled in a developmental-level mathematics course in fall semester 2011. A student who did not enroll in any mathematics course in fall semester 2011 was deemed not to be ready for college-level mathematics if the student was enrolled in a transfer-degree program and achieved a mathematics placement test level lower than four, or was enrolled in a non-transfer degree program and achieved a mathematics placement level lower than two.

Based upon these criteria, fewer than 30% of the students in the sample were ready for college-level mathematics as of their first semester of enrollment. The data pertaining to the assignment of students to subgroups is presented in Table 8.

Table 8

Students in the Sample by Subgroup

Subgroup	Frequency	Percent
College Math-Ready	444	29.2
Not College Math-Ready	1074	70.8
Total	1518	100.0

Within the subgroups, the independent variable, first-semester mathematics performance, was multi-valued. Each student in each subgroup either enrolled in a mathematics course in fall semester 2011 and successfully completed it, enrolled in a mathematics course but failed to complete it successfully, or deferred enrollment in mathematics to a future semester.

In college-level mathematics courses, a traditional A, B, C, D, F grading system is employed at the college under study. For these courses, successful completion was indicated by the student receiving a final course grade of A, B, or C, while failure to achieve successful completion was indicated by the student receiving a final course grade of D or F. In addition, students who withdrew from the first-semester mathematics course and received a final course grade of W were deemed to have failed to complete the course successfully. Students who were awarded a course grade of I, indicating “Incomplete,” were also deemed to have failed to complete the course successfully. While a grade of I is considered temporary, allowing the student to complete the course successfully at a future date, it is nonetheless an indicator of failure to complete the course successfully within the first semester of enrollment.

In developmental-level mathematics courses, the college under study awards final course grades of S, R, or U. A grade of S in a developmental mathematics course indicates satisfactory completion of the course. A grade of R is used to indicate that a student was making satisfactory progress in the course at semester-end, but was required to “Re-enroll” in the course in a subsequent semester to complete course requirements. A grade of U indicates that a student did not successfully complete the course and was not making satisfactory progress toward course completion by semester-end. For such

courses, successful completion was indicated by the student receiving a final course grade of S, while failure to achieve successful completion was indicated by the student receiving a final course grade of R or U. As described above, students who withdrew from a first-semester developmental mathematics course and received a final course grade of W and students who were awarded a course grade of I were also deemed to have failed to complete the course successfully.

A cross-tabulation of the college math-readiness variable versus the first-semester mathematics performance variable was conducted to determine the number of students in each subgroup who successfully completed a first-semester mathematics course, the number who enrolled in but failed to complete a mathematics course in the first-semester, and the number who deferred enrollment in mathematics. The results of this cross-tabulation appear in Table 9.

Table 9

First-Semester Mathematics Performance by Subgroup

Subgroup	Enrolled and Successfully Completed	Enrolled, but Did Not Successfully Complete	Deferred Enrollment in Mathematics	Total
College Math-Ready	131	128	185	444
Not College Math-Ready	254	351	469	1074
Total	385	479	654	1518

Research Questions

The present study was designed to determine the significance of the relationship between cognitive ability in mathematics as measured by first-semester mathematics performance and fall-to-fall retention of first-time-in-college, degree-seeking community college students. In addition, the study was designed to further investigate whether certain demographic characteristics affected the significance of this relationship. To reach these determinations, a series of research questions were formulated.

Since the covariates were discrete-valued, chi-square analysis was used to test the implied hypothesis that first-semester mathematics performance was not significantly related to fall-to-fall retention. That is, no significant differences were to be found in retention rates, regardless of student performance in mathematics coursework in the first semester of enrollment.

Of primary interest to the present study was the relationship between first-semester mathematics performance and fall-to-fall retention for students in each of two subgroups – those students who were deemed ready to enroll in college-level mathematics as of the first semester of college enrollment and those students deemed to be in need of remediation prior to enrolling in a first college-level mathematics course.

Two research questions were developed to address this primary interest.

Mathematics Performance, Retention, and Developmental Mathematics Students

The first research question pertained to students who were found to be in need of remediation prior to enrolling in a college-level mathematics course. For students in the sample under study who are recommended for developmental mathematics based upon placement test scores, are there significant differences in fall-to-fall retention rates among

those who, in their first semester of enrollment, successfully complete a developmental mathematics course, those who enroll in a developmental mathematics course but fail to complete it successfully, and those who postpone developmental mathematics coursework until after the first semester?

A cross-tabulation of the first-semester mathematics performance variable versus the fall-to-fall retention variable was conducted for the 1074 students in the “Not College Math-Ready” subgroup. The results of this cross-tabulation appear in Table 10.

Table 10

First-Semester Mathematics Performance versus Retention for Developmental Subgroup

First-Semester Math Performance	Retained (Percent)	Not Retained (Percent)	Total
Enrolled and Successfully Completed	160 (63.0%)	94 (37.0%)	254
Enrolled, but Did Not Successfully Complete	125 (35.6%)	226 (64.4%)	351
Deferred Enrollment in Mathematics	173 (36.9%)	296 (63.1%)	469
Total	458 (42.6%)	616 (57.4%)	1074

A chi-square analysis for a two-way contingency table was applied to evaluate the significance of the relationship between first-semester mathematics performance and the retention rates reflected in Table 10. For this subgroup, first-semester mathematics performance and fall-to-fall retention were found to be significantly related, Pearson $\chi^2(2, N = 1074) = 56.45, p = .000$, Cramer's $V = .23$. Among developmental students who enroll in and successfully complete a developmental mathematics course, 63% are

retained to the subsequent fall semester, compared to a retention rate of only 45.7% for all students in the sample.

Follow-up pairwise comparisons were conducted to determine if there were significant differences in retention rates between developmental mathematics students who successfully completed a first-semester mathematics course, developmental mathematics students who enrolled in but were unsuccessful in a first semester mathematics course, and developmental mathematics students who deferred enrollment in mathematics. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all three comparisons. The results of these pairwise comparisons are shown in Table 11.

Table 11

Results of Pairwise Comparisons for the Developmental Subgroup

Comparison	Pearson chi-square	p value (Alpha)	Cramer's V
Successful enrollment vs. unsuccessful enrollment	44.34*	.000 (.017)	.27
Successful enrollment vs. deferred enrollment	45.19*	.000 (.025)	.25
Unsuccessful enrollment vs. deferred enrollment	0.14	.707 (.050)	.01

* p value \leq alpha

For students in the developmental subgroup, there was a significant difference in retention rates between students who successfully completed a first-semester mathematics course and those who enrolled in but failed to complete a first semester mathematics course. There was also a significant difference in retention rates between

successful first-semester mathematics students and those who deferred enrollment in mathematics. There was no significant difference in retention rates between students who were unsuccessful in a first-semester mathematics course and those who deferred enrollment in mathematics.

Mathematics Performance, Retention, and College-Ready Mathematics Students

The second research question pertained to students who were found to be ready for college-level mathematics at the time of their first semester of enrollment at the college. For students in the sample under study who are recommended for college-level mathematics based upon placement test scores, are there significant differences in fall-to-fall retention rates among those who, in their first semester of enrollment, successfully complete a college-level mathematics course, those who enroll in a college-level mathematics course but fail to complete it successfully, and those who postpone college-level mathematics coursework until after the first semester?

A cross-tabulation of the first-semester mathematics performance variable versus the fall-to-fall retention variable was conducted for the 444 students in the “College Math-Ready” subgroup. The results of this cross-tabulation appear in Table 12.

Table 12

First-Semester Mathematics Performance versus Retention for College-Ready Subgroup

First-Semester Math Performance	Retained (Percent)	Not Retained (Percent)	Total
Enrolled and Successfully Completed	87 (66.4%)	44 (33.6%)	131
Enrolled, but Did Not Successfully Complete	57 (44.5%)	71 (55.5%)	128
Deferred Enrollment in Mathematics	91 (49.2%)	94 (50.8%)	185
Total	235 (52.9%)	209 (47.1%)	444

A chi-square analysis for a two-way contingency table was applied to evaluate the significance of the relationship between first-semester mathematics performance and the retention rates reflected in Table 12. For this subgroup, first-semester mathematics performance and fall-to-fall retention were found to be significantly related, Pearson $\chi^2(2, N = 444) = 14.22, p = .001$, Cramer's $V = .18$. Among college-level mathematics students who enroll in and successfully complete a college-level mathematics course,

66.4% are retained to the subsequent fall semester, compared to a retention rate of only 45.7% for all students in the sample.

Follow-up pairwise comparisons were conducted to determine if there were significant differences in retention rates between college-ready mathematics students who successfully completed a first-semester mathematics course, college-ready mathematics students who enrolled in but were unsuccessful in a first semester mathematics course, and college-ready mathematics students who deferred enrollment in mathematics. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all three comparisons. The results of these pairwise comparisons are shown in Table 13.

Table 13

Results of Pairwise Comparisons for the College-Ready Subgroup

Comparison	Pearson chi-square	p value (Alpha)	Cramer's <i>V</i>
Successful enrollment vs. unsuccessful enrollment	12.56*	.000 (.017)	.22
Successful enrollment vs. deferred enrollment	9.25*	.002 (.025)	.17
Unsuccessful enrollment vs. deferred enrollment	0.66	.417 (.050)	.05

**p value \leq alpha*

For students in the college-ready subgroup, there was a significant difference in retention rates between students who successfully completed a first-semester mathematics course and those who enrolled in but failed to complete a first semester mathematics course. There was also a significant difference in retention rates between

successful first-semester mathematics students and those who deferred enrollment in mathematics. There was no significant difference in retention rates between students who were unsuccessful in a first-semester mathematics course and those who deferred enrollment in mathematics.

Also of interest to the present study was the extent to which the relationship between first-semester mathematics performance and fall-to-fall retention was affected by demographic characteristics, including student gender, age, race or ethnicity, enrollment status, financial aid status, or first-generation status. Thus, additional research questions were formulated.

Mathematics Performance, Retention, and Gender

The third research question pertained to the potential effect of student gender upon the relationship between first-semester mathematics performance and fall-to-fall retention. For students in the sample under study, to what extent does gender influence the relationship between first-semester mathematics performance and fall-to-fall retention?

A cross-tabulation of the first-semester mathematics performance variable versus the fall-to-fall retention variable was conducted for the 814 male students and for the 703 female students in the sample. The results of this cross-tabulation appear in Table 14.

Table 14

First-Semester Mathematics Performance versus Retention by Student Gender

Gender	Enrolled and Successfully Completed		Enrolled but did not Successfully Complete		Deferred Enrollment in Mathematics		Total
	Retained (Percent)	Not Retained (Percent)	Retained (Percent)	Not Retained (Percent)	Retained (Percent)	Not Retained (Percent)	
Male	116 (61.1%)	74 (38.9%)	102 (37.2%)	172 (62.8%)	126 (36.0%)	224 (64.0%)	814
Female	131 (67.2%)	64 (32.8%)	80 (39.0%)	125 (61.0%)	138 (45.5%)	165 (54.5%)	703
Total	247 (64.2%)	138 (35.8%)	182 (38.0%)	297 (62.0%)	264 (40.4%)	389 (59.6%)	1517

For each gender, a chi-square analysis for a two-way contingency table was applied to evaluate the significance of the relationship between first-semester mathematics performance and the retention rates reflected in Table 14. For males in the sample, first-semester mathematics performance and fall-to-fall retention were found to be significantly related, Pearson $\chi^2(2, N = 814) = 35.96, p = .000$, Cramer's $V = .21$. For females in the sample, as well, first-semester mathematics performance and fall-to-fall retention were found to be significantly related, Pearson $\chi^2(2, N = 703) = 35.27, p = .000$, Cramer's $V = .22$. Among students who enroll in and successfully complete a college-level mathematics course, 61.1% of males and 67.2% of females are retained to

the subsequent fall semester, compared to a retention rate of only 45.7% for all students in the sample.

Follow-up pairwise comparisons were conducted for each gender to determine if there were significant differences in retention rates between students who successfully completed a first-semester mathematics course, students who enrolled in but were unsuccessful in a first semester mathematics course, and students who deferred enrollment in mathematics. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all three comparisons. The results of these pairwise comparisons are shown in Tables 15 and 16.

Table 15

Results of Pairwise Comparisons for Males

Comparison	Pearson chi-square	p value (Alpha)	Cramer's V
Successful enrollment vs. unsuccessful enrollment	25.57*	.000 (.017)	.23
Successful enrollment vs. deferred enrollment	31.25*	.000 (.025)	.24
Unsuccessful enrollment vs. deferred enrollment	0.10	.752 (.050)	.01

* p value \leq alpha

Table 16

Results of Pairwise Comparisons for Females

Comparison	Pearson chi-square	p value (Alpha)	Cramer's V
Successful enrollment vs. unsuccessful enrollment	31.78*	.000 (.017)	.28
Successful enrollment vs. deferred enrollment	22.36*	.000 (.025)	.21
Unsuccessful enrollment vs. deferred enrollment	2.12	.145 (.050)	.06

* p value \leq alpha

For both males and females, there was a significant difference in retention rates between students who successfully completed a first-semester mathematics course and those who enrolled in but failed to complete a first semester mathematics course. There was also a significant difference in retention rates between successful first-semester mathematics students and those who deferred enrollment in mathematics. For both genders, there was no significant difference in retention rates between students who were unsuccessful in a first-semester mathematics course and those who deferred enrollment in mathematics.

Mathematics Performance, Retention, and Student Age

The fourth research question pertained to the potential effect of student age upon the relationship between first-semester mathematics performance and fall-to-fall retention. For students in the sample under study, to what extent does student age influence the relationship between first-semester mathematics performance and fall-to-fall retention?

A cross-tabulation of the first-semester mathematics performance variable versus the fall-to-fall retention variable was conducted for the students in each age group in the sample. The results of this cross-tabulation appear in Table 17.

Table 17

First-Semester Mathematics Performance versus Retention by Student Age Group

Age Group	Enrolled and Successfully Completed		Enrolled but did not Successfully Complete		Deferred Enrollment in Mathematics		Total
	Retained (Percent)	Not Retained (Percent)	Retained (Percent)	Not Retained (Percent)	Retained (Percent)	Not Retained (Percent)	
Under 18	17 (58.6%)	12 (41.4%)	20 (44.4%)	25 (55.6%)	12 (32.4%)	25 (67.6%)	111
18-21	184 (63.4%)	106 (36.6%)	142 (39.6%)	217 (60.4%)	169 (40.0%)	254 (60.0%)	1072
22-24	8 (61.5%)	5 (38.5%)	4 (21.1%)	15 (78.9%)	19 (36.5%)	33 (63.5%)	84
25 and over	38 (71.7%)	15 (28.3%)	16 (28.6%)	40 (71.4%)	64 (45.1%)	78 (54.9%)	251
Total	247 (64.2%)	138 (35.8%)	182 (38.0%)	297 (62.0%)	264 (40.4%)	390 (59.6%)	1518

For each age group, a chi-square analysis for a two-way contingency table was applied to evaluate the significance of the relationship between first-semester mathematics performance and the retention rates reflected in Table 17. For students under

the age of 18, first-semester mathematics performance and fall-to-fall retention were not significantly related, Pearson $\chi^2(2, N = 111) = 4.52, p = .100$, Cramer's $V = .20$.

Similarly, for students in the 22 to 24-year-old age group, first-semester mathematics performance and fall-to-fall retention were not significantly related, Pearson $\chi^2(2, N = 84) = 5.44, p = .070$, Cramer's $V = .25$. However, among students in the 18 to 21-year-old age group, the traditional age range for first-time-in-college students, first-semester mathematics performance and fall-to-fall retention were found to be significantly related, Pearson $\chi^2(2, N = 1072) = 47.73, p = .000$, Cramer's $V = .21$. Among students in this age group who enroll in and successfully complete a college-level mathematics course, 63.4% are retained to the subsequent fall semester, compared to a retention rate of 45.7% for all students in the sample. First-semester mathematics performance and fall-to-fall retention were also found to be significantly related for students who were 25 years of age or older, Pearson $\chi^2(2, N = 251) = 20.82, p = .000$, Cramer's $V = .29$.

Follow-up pairwise comparisons were conducted for each age group to determine if there were significant differences in retention rates between students who successfully completed a first-semester mathematics course, students who enrolled in but were unsuccessful in a first semester mathematics course, and students who deferred enrollment in mathematics. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all three comparisons.

The results of the pairwise comparisons for the under-18 age group are shown in Table 18. For students in this age group, there were no significant differences in retention rates, regardless of first-semester mathematics performance.

Table 18

Results of Pairwise Comparisons for the Under-18 Age Group

Comparison	Pearson chi-square	p value (Alpha)	Cramer's <i>V</i>
Successful enrollment vs. unsuccessful enrollment	1.42	.234 (.025)	.14
Successful enrollment vs. deferred enrollment	4.53	.033 (.017)	.26
Unsuccessful enrollment vs. deferred enrollment	1.23	.267 (.050)	.12

**p value \leq alpha*

The results of the pairwise comparisons for the 18 to 21-year old age group are shown in Table 19. For students in this age group, there was a significant difference in retention rates between students who successfully completed a first-semester mathematics course and those who enrolled in but failed to complete a first semester mathematics course. There was also a significant difference in retention rates between successful first-semester mathematics students and those who deferred enrollment in mathematics. There was no significant difference in retention rates between students who were unsuccessful in a first-semester mathematics course and those who deferred enrollment in mathematics.

Table 19

Results of Pairwise Comparisons for the 18 to 21-Year-Old Age Group

Comparison	Pearson chi-square	p value (Alpha)	Cramer's <i>V</i>
Successful enrollment vs. unsuccessful enrollment	36.63*	.000 (.017)	.24
Successful enrollment vs. deferred enrollment	37.99*	.000 (.025)	.23
Unsuccessful enrollment vs. deferred enrollment	0.01	.910 (.050)	.00

**p* value \leq *alpha*

The results of the pairwise comparisons for the 22 to 24-year old age group are shown in Table 20. For students in this age group, there were no significant differences in retention rates, regardless of first-semester mathematics performance.

Table 20

Results of Pairwise Comparisons for the 22 to 24-Year-Old Age Group

Comparison	Pearson chi-square	p value (Alpha)	Cramer's <i>V</i>
Successful enrollment vs. unsuccessful enrollment	5.40	.020 (.017)	.41
Successful enrollment vs. deferred enrollment	2.68	.102 (.025)	.20
Unsuccessful enrollment vs. deferred enrollment	1.52	.217 (.050)	.15

**p* value \leq *alpha*

The results of the pairwise comparisons for the 25-and-over age group are shown in Table 21. For students in this age group, there was a significant difference in retention

rates between students who successfully completed a first-semester mathematics course and those who enrolled in but failed to complete a first semester mathematics course. There was also a significant difference in retention rates between successful first-semester mathematics students and those who deferred enrollment in mathematics. In addition, there was a significant difference in retention rates between students who were unsuccessful in a first-semester mathematics course and those who deferred enrollment in mathematics.

Table 21

Results of Pairwise Comparisons for the 25-and-Over Age Group

Comparison	Pearson chi-square	p value (Alpha)	Cramer's V
Successful enrollment vs. unsuccessful enrollment	20.26*	.000 (.017)	.43
Successful enrollment vs. deferred enrollment	10.97*	.001 (.025)	.24
Unsuccessful enrollment vs. deferred enrollment	4.54*	.033 (.050)	.15

* p value \leq alpha

Mathematics Performance, Retention, and Race

The fifth research question pertained to the potential effect of race or ethnicity upon the relationship between first-semester mathematics performance and fall-to-fall retention. For students in the sample under study, to what extent does race or ethnicity influence the relationship between first-semester mathematics performance and fall-to-fall retention?

To investigate this question, each student in the sample was assigned to one of three race or ethnicity groups: Black, White, or Other. A cross-tabulation of the first-semester mathematics performance variable versus the fall-to-fall retention variable was conducted for the students in each race or ethnicity group. The results of this cross-tabulation appear in Table 22.

Table 22

First-Semester Mathematics Performance versus Retention by Race/Ethnicity

Race / Ethnicity	Enrolled and Successfully Completed		Enrolled but did not Successfully Complete		Deferred Enrollment in Mathematics		Total
	Retained (Percent)	Not Retained (Percent)	Retained (Percent)	Not Retained (Percent)	Retained (Percent)	Not Retained (Percent)	
Black	67 (58.8%)	47 (41.2%)	59 (26.5%)	164 (73.5%)	99 (30.1%)	230 (69.9%)	666
White	141 (65.0%)	76 (35.0%)	101 (50.0%)	101 (50.0%)	119 (48.4%)	127 (51.6%)	665
Other	39 (72.2%)	15 (27.8%)	22 (40.7%)	32 (59.3%)	46 (58.2%)	33 (41.8%)	187
Total	247 (64.2%)	138 (35.8%)	182 (38.0%)	297 (62.0%)	264 (40.4%)	390 (59.6%)	1518

For each race or ethnicity group, a chi-square analysis for a two-way contingency table was applied to evaluate the significance of the relationship between first-semester

mathematics performance and the retention rates reflected in Table 22. First-semester mathematics performance and fall-to-fall retention were found to be significantly related in each of the three race or ethnicity groups. For Black students, the significance of the relationship was indicated by Pearson $\chi^2(2, N = 666) = 39.18, p = .000$, Cramer's $V = .24$. For White students, the analysis produced Pearson $\chi^2(2, N = 665) = 14.95, p = .001$, Cramer's $V = .15$. Similarly, for students of other races or ethnicities, the significance of the relationship between first-semester mathematics performance and fall-to-fall retention was indicated by Pearson $\chi^2(2, N = 187) = 10.99, p = .004$, Cramer's $V = .24$.

Follow-up pairwise comparisons were conducted for each race or ethnicity group to determine if there were significant differences in retention rates between students who successfully completed a first-semester mathematics course, students who enrolled in but were unsuccessful in a first semester mathematics course, and students who deferred enrollment in mathematics. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all three comparisons.

The results of the pairwise comparisons for the Black students in the sample are shown in Table 23. For Black students, there was a significant difference in retention rates between students who successfully completed a first-semester mathematics course and those who enrolled in but failed to complete a first semester mathematics course. There was also a significant difference in retention rates between successful first-semester mathematics students and those who deferred enrollment in mathematics. There was no significant difference in retention rates between Black students who were unsuccessful in a first-semester mathematics course and those who deferred enrollment in mathematics.

Table 23

Results of Pairwise Comparisons for Black Students

Comparison	Pearson chi-square	p value (Alpha)	Cramer's V
Successful enrollment vs. unsuccessful enrollment	33.65*	.000 (.017)	.32
Successful enrollment vs. deferred enrollment	29.72*	.000 (.025)	.26
Unsuccessful enrollment vs. deferred enrollment	0.86	.354 (.050)	.04

* p value \leq α

The results of the pairwise comparisons for the White students in the sample are shown in Table 24. For White students, there was a significant difference in retention rates between students who successfully completed a first-semester mathematics course and those who enrolled in but failed to complete a first semester mathematics course. There was also a significant difference in retention rates between successful first-semester mathematics students and those who deferred enrollment in mathematics. There was no significant difference in retention rates between White students who were unsuccessful in a first-semester mathematics course and those who deferred enrollment in mathematics.

Table 24

Results of Pairwise Comparisons for White Students

Comparison	Pearson chi-square	p value (Alpha)	Cramer's <i>V</i>
Successful enrollment vs. unsuccessful enrollment	9.62*	.002 (.025)	.15
Successful enrollment vs. deferred enrollment	12.91*	.000 (.017)	.17
Unsuccessful enrollment vs. deferred enrollment	0.12	.732 (.050)	.02

**p* value \leq *alpha*

The results of the pairwise comparisons for students of other races or ethnicities are shown in Table 25. For these students, there was a significant difference in retention rates between students who successfully completed a first-semester mathematics course and those who enrolled in but failed to complete a first semester mathematics course. However, for students in this group, there was no significant difference in retention rates between successful first-semester mathematics students and those who deferred enrollment in mathematics. There was also no significant difference in retention rates between students in this group who were unsuccessful in a first-semester mathematics course and those who deferred enrollment in mathematics.

Table 25

Results of Pairwise Comparisons for Students of Other Races or Ethnicities

Comparison	Pearson chi-square	p value (Alpha)	Cramer's <i>V</i>
Successful enrollment vs. unsuccessful enrollment	10.89*	.001 (.017)	.32
Successful enrollment vs. deferred enrollment	2.72	.099 (.050)	.14
Unsuccessful enrollment vs. deferred enrollment	3.92	.048 (.025)	.17

**p* value \leq *alpha*

Mathematics Performance, Retention, and Enrollment Status

The sixth research question pertained to the potential effect of a student's full-time or part-time enrollment status upon the relationship between first-semester mathematics performance and fall-to-fall retention. For students in the sample under study, to what extent does enrollment status influence the relationship between first-semester mathematics performance and fall-to-fall retention?

A cross-tabulation of the first-semester mathematics performance variable versus the fall-to-fall retention variable was conducted for the 795 students in the sample who were enrolled on a full-time basis and for the 723 students who were enrolled part-time. The results of this cross-tabulation appear in Table 26.

Table 26

First-Semester Mathematics Performance versus Retention by Enrollment Status

Enrollment Status	Enrolled and Successfully Completed		Enrolled but did not Successfully Complete		Deferred Enrollment in Mathematics		Total
	Retained (Percent)	Not Retained (Percent)	Retained (Percent)	Not Retained (Percent)	Retained (Percent)	Not Retained (Percent)	
Full-time	190 (65.3%)	101 (34.7%)	130 (43.8%)	167 (56.2%)	114 (55.1%)	93 (44.9%)	795
Part-time	57 (60.6%)	37 (39.4%)	52 (28.6%)	130 (71.4%)	150 (33.6%)	297 (66.4%)	723
Total	247 (64.2%)	138 (35.8%)	182 (38.0%)	297 (62.0%)	264 (40.4%)	390 (59.6%)	1518

For each enrollment status, a chi-square analysis for a two-way contingency table was applied to evaluate the significance of the relationship between first-semester mathematics performance and the retention rates reflected in Table 26. For full-time students in the sample, first-semester mathematics performance and fall-to-fall retention were found to be significantly related, Pearson $\chi^2(2, N = 795) = 27.49, p = .000$, Cramer's $V = .19$. For part-time students in the sample, first-semester mathematics performance and fall-to-fall retention were also found to be significantly related, Pearson $\chi^2(2, N = 723) = 30.34, p = .000$, Cramer's $V = .20$. Among students who enroll in and successfully complete a college-level mathematics course, 65.3% of full-time students

and 60.6% of part-time students were retained to the subsequent fall semester, compared to a retention rate of only 45.7% for all students in the sample.

Follow-up pairwise comparisons were conducted for each enrollment status to determine if there were significant differences in retention rates between students who successfully completed a first-semester mathematics course, students who enrolled in but were unsuccessful in a first semester mathematics course, and students who deferred enrollment in mathematics. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all three comparisons.

The results of these pairwise comparisons for full-time students are shown in Table 27. Among full-time students, there was a significant difference in retention rates between students who successfully completed a first-semester mathematics course and those who enrolled in but failed to complete a first semester mathematics course. There was also a significant difference in retention rates between successful first-semester mathematics students and those who deferred enrollment in mathematics. In addition, there was a significant difference in retention rates between students who were unsuccessful in a first-semester mathematics course and those who deferred enrollment in mathematics.

Table 27

Results of Pairwise Comparisons for Full-time Students

Comparison	Pearson chi-square	p value (Alpha)	Cramer's V
Successful enrollment vs. unsuccessful enrollment	27.44*	.000 (.017)	.22
Successful enrollment vs. deferred enrollment	5.31*	.021 (.050)	.10
Unsuccessful enrollment vs. deferred enrollment	6.24*	.013 (.025)	.11

* p value \leq α

The results of these pairwise comparisons for part-time students are shown in Table 28. Among part-time students, there was a significant difference in retention rates between students who successfully completed a first-semester mathematics course and those who enrolled in but failed to complete a first semester mathematics course. There was also a significant difference in retention rates between successful first-semester mathematics students and those who deferred enrollment in mathematics. However, for part-time students, there was no significant difference in retention rates between students who were unsuccessful in a first-semester mathematics course and those who deferred enrollment in mathematics.

Table 28

Results of Pairwise Comparisons for Part-time Students

Comparison	Pearson chi-square	p value (Alpha)	Cramer's <i>V</i>
Successful enrollment vs. unsuccessful enrollment	26.67*	.000 (.017)	.31
Successful enrollment vs. deferred enrollment	24.11*	.000 (.025)	.21
Unsuccessful enrollment vs. deferred enrollment	1.47	.225 (.050)	.05

**p value ≤ alpha*

Mathematics Performance, Retention, and Financial Aid Status

The seventh research question pertained to the potential effect of a student's financial aid status upon the relationship between first-semester mathematics performance and fall-to-fall retention. For the purpose of the present study, financial aid status was defined as the student's eligibility for a federal Pell grant. For students in the sample under study, to what extent does financial aid status influence the relationship between first-semester mathematics performance and fall-to-fall retention?

A cross-tabulation of the first-semester mathematics performance variable versus the fall-to-fall retention variable was conducted for the 915 students in the sample who were eligible for a federal Pell grant and for the 603 students who were not eligible. The results of this cross-tabulation appear in Table 29.

Table 29

First-Semester Mathematics Performance versus Retention by Financial Aid Status

Financial Aid Status	Enrolled and Successfully Completed		Enrolled but did not Successfully Complete		Deferred Enrollment in Mathematics		Total
	Retained (Percent)	Not Retained (Percent)	Retained (Percent)	Not Retained (Percent)	Retained (Percent)	Not Retained (Percent)	
Pell-eligible	121 (63.0%)	71 (37.0%)	88 (29.1%)	214 (70.9%)	147 (34.9%)	274 (65.1%)	915
Not Pell-eligible	126 (65.3%)	67 (34.7%)	94 (53.1%)	83 (46.9%)	117 (50.2%)	116 (49.8%)	603
Total	247 (64.2%)	138 (35.8%)	182 (38.0%)	297 (62.0%)	264 (40.4%)	390 (59.6%)	1518

For each financial aid status, a chi-square analysis for a two-way contingency table was applied to evaluate the significance of the relationship between first-semester mathematics performance and the retention rates reflected in Table 29. For students in the sample who were Pell-eligible, first-semester mathematics performance and fall-to-fall retention were found to be significantly related, Pearson $\chi^2(2, N = 915) = 61.91, p = .000$, Cramer's $V = .26$. For students in the sample who were not Pell-eligible, first-semester mathematics performance and fall-to-fall retention were also found to be significantly related, Pearson $\chi^2(2, N = 603) = 10.51, p = .005$, Cramer's $V = .13$. Among students who enroll in and successfully complete a college-level mathematics course,

63.0% of Pell-eligible students and 65.3% of students who were not Pell-eligible were retained to the subsequent fall semester, compared to a retention rate of only 45.7% for all students in the sample.

Follow-up pairwise comparisons were conducted for each financial aid status to determine if there were significant differences in retention rates between students who successfully completed a first-semester mathematics course, students who enrolled in but were unsuccessful in a first semester mathematics course, and students who deferred enrollment in mathematics. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all three comparisons.

The results of these pairwise comparisons for Pell-eligible students are shown in Table 30. Among Pell-eligible students, there was a significant difference in retention rates between students who successfully completed a first-semester mathematics course and those who enrolled in but failed to complete a first semester mathematics course. There was also a significant difference in retention rates between successful first-semester mathematics students and those who deferred enrollment in mathematics. However, there was no significant difference in retention rates between Pell-eligible students who were unsuccessful in a first-semester mathematics course and those who deferred enrollment in mathematics.

Table 30

Results of Pairwise Comparisons for Pell-eligible Students

Comparison	Pearson chi-square	p value (Alpha)	Cramer's <i>V</i>
Successful enrollment vs. unsuccessful enrollment	55.20*	.000 (.017)	.33
Successful enrollment vs. deferred enrollment	42.33*	.000 (.025)	.26
Unsuccessful enrollment vs. deferred enrollment	2.68	.102 (.050)	.06

**p value* \leq *alpha*

The results of these pairwise comparisons for students who were not Pell-eligible are shown in Table 31. Among this group of students, there was a significant difference in retention rates between students who successfully completed a first-semester mathematics course and those who enrolled in but failed to complete a first semester mathematics course. There was also a significant difference in retention rates between successful first-semester mathematics students and those who deferred enrollment in mathematics. However, for students who were not Pell-eligible, there was no significant difference in retention rates between students who were unsuccessful in a first-semester mathematics course and those who deferred enrollment in mathematics.

Table 31
Results of Pairwise Comparisons for non-Pell-eligible Students

Comparison	Pearson chi-square	p value (Alpha)	Cramer's <i>V</i>
Successful enrollment vs. unsuccessful enrollment	5.68*	.017 (.025)	.12
Successful enrollment vs. deferred enrollment	9.78*	.002 (.017)	.15
Unsuccessful enrollment vs. deferred enrollment	0.34	.562 (.050)	.03

**p value* ≤ *alpha*

Mathematics Performance, Retention, and First-Generation Status

The eighth research question pertained to the potential effect of a student's status as a first-generation college student upon the relationship between first-semester mathematics performance and fall-to-fall retention. For students in the sample under study, to what extent does first-generation status influence the relationship between first-semester mathematics performance and fall-to-fall retention?

A cross-tabulation of the first-semester mathematics performance variable versus the fall-to-fall retention variable was conducted for the 366 students in the sample who were first-generation college students and for the 1152 students who were not first-generation. The results of this cross-tabulation appear in Table 32.

Table 32

First-Semester Mathematics Performance versus Retention by First-Generation Status

First- Generation Status	Enrolled and Successfully Completed		Enrolled but did not Successfully Complete		Deferred Enrollment in Mathematics		Total
	Retained (Percent)	Not Retained (Percent)	Retained (Percent)	Not Retained (Percent)	Retained (Percent)	Not Retained (Percent)	
First- Generation	57 (66.3%)	29 (33.7%)	35 (31.5%)	76 (68.5%)	68 (40.2%)	101 (59.8%)	366
Not First- Generation	190 (63.5%)	109 (36.5%)	147 (39.9%)	221 (60.1%)	196 (40.4%)	289 (59.6%)	1152
Total	247 (64.2%)	138 (35.8%)	182 (38.0%)	297 (62.0%)	264 (40.4%)	390 (59.6%)	1518

For each group, a chi-square analysis for a two-way contingency table was applied to evaluate the significance of the relationship between first-semester mathematics performance and the retention rates reflected in Table 32. For students in the sample who were first-generation college students, first-semester mathematics performance and fall-to-fall retention were found to be significantly related, Pearson $\chi^2(2, N = 366) = 25.32, p = .000$, Cramer's $V = .26$. For students in the sample who were not first-generation college students, first-semester mathematics performance and fall-to-fall retention were also found to be significantly related, Pearson $\chi^2(2, N = 1152) = 48.51, p = .000$, Cramer's $V = .20$. Among students who enroll in and successfully complete a

college-level mathematics course, 66.3% of first-generation college students and 63.5% of students who were not first-generation were retained to the subsequent fall semester, compared to a retention rate of only 45.7% for all students in the sample.

Follow-up pairwise comparisons were conducted to determine if, among first-generation students or among students who were not first-generation, there were significant differences in retention rates between students who successfully completed a first-semester mathematics course, students who enrolled in but were unsuccessful in a first semester mathematics course, and students who deferred enrollment in mathematics. The Holm's sequential Bonferroni method was used to control for Type I error at the .05 level across all three comparisons.

The results of these pairwise comparisons for first-generation students are shown in Table 33. Among this group of students, there was a significant difference in retention rates between students who successfully completed a first-semester mathematics course and those who enrolled in but failed to complete a first semester mathematics course. There was also a significant difference in retention rates between successful first-semester mathematics students and those who deferred enrollment in mathematics. However, among first-generation students, there was no significant difference in retention rates between students who were unsuccessful in a first-semester mathematics course and those who deferred enrollment in mathematics.

Table 33

Results of Pairwise Comparisons for First-generation Students

Comparison	Pearson chi-square	p value (Alpha)	Cramer's <i>V</i>
Successful enrollment vs. unsuccessful enrollment	36.75*	.000 (.017)	.23
Successful enrollment vs. deferred enrollment	39.60*	.000 (.025)	.22
Unsuccessful enrollment vs. deferred enrollment	0.02	.890 (.050)	.01

**p value* \leq *alpha*

The results of these pairwise comparisons for non-first-generation students are shown in Table 34. Among this group of students, there was a significant difference in retention rates between students who successfully completed a first-semester mathematics course and those who enrolled in but failed to complete a first semester mathematics course. There was also a significant difference in retention rates between successful first-semester mathematics students and those who deferred enrollment in mathematics. However, among non-first-generation students, there was no significant difference in retention rates between students who were unsuccessful in a first-semester mathematics course and those who deferred enrollment in mathematics.

Table 34

Results of Pairwise Comparisons for non-First-generation Students

Comparison	Pearson chi-square	p value (Alpha)	Cramer's V
Successful enrollment vs. unsuccessful enrollment	23.50*	.000 (.017)	.34
Successful enrollment vs. deferred enrollment	15.47*	.000 (.025)	.25
Unsuccessful enrollment vs. deferred enrollment	2.18	.140 (.050)	.09

* p value \leq alpha

Summary

The analysis of the data available for all first-time-in-college, degree-seeking students enrolled at the college under study in fall semester 2011 offers compelling evidence of a significant relationship between first-semester mathematics performance and fall-to-fall retention. For the entire sample of 1518 students, the fall-to-fall retention rate was found to be 45.7%. However, for the 385 students who enrolled in and successfully completed a mathematics course in the first semester of enrollment, the retention rate was found to be 64.2%.

By contrast, unsuccessful first-semester enrollment in mathematics was found to have a significant exacerbating effect on student attrition. While, for the entire sample, the fall-to-fall attrition rate was 54.3%, the 479 students who enrolled in but failed to complete a first-semester mathematics course successfully experienced an attrition rate of 62.0%.

Students in the sample who deferred a first enrollment in mathematics until after the first semester were retained at a somewhat higher rate than students who experienced

unsuccessful first-semester mathematics enrollments. Among the 654 students who exercised the option to defer enrollment in mathematics, 264 (40.4%) were retained to the subsequent fall and 390 (59.6%) were not retained.

The retention patterns described above consistently prevailed irrespective of a student's readiness for college-level mathematics. Moreover, for the most part, the relationship between first-semester mathematics performance and fall-to-fall retention retained its significance within each of the demographic constituencies investigated in this study.

A thorough review of the findings produced by this study will be presented in the following chapter. In addition, implications for practice and further research, including the limitations of the research design employed, will be discussed.

CHAPTER 5

CONCLUSIONS AND DISCUSSION

In the fall semester of 2011, approximately 8 million students were enrolled in credit coursework in community colleges across America. (AACC, 2013). Sadly, most of those students would not remain enrolled long enough to obtain a degree or certificate signifying academic program completion and nearly 45% of them would depart before the start of their second year of college (ACT, 2012).

From fall 2011 to fall 2012, Virginia's community colleges experienced an attrition rate of 58%, representing over 115,000 departures (VCCS, 2013). It is estimated that only about 20% of those departures can be explained by graduation or successful transfer.

In addition to the fact that enrollment is a major factor in determining how community colleges are currently funded in virtually every state (Cohen & Brawer, 2003), there is evidence of a trend toward performance-based funding in higher education. That is, more and more states are expected to apply performance metrics to funding formulas that govern the allocation of public funds to colleges and universities. It is reasonable to assume that student retention and program completion will be among the metrics considered.

Thus, it is increasingly important that community college practitioners identify with precision the factors that contribute to student retention and attrition behaviors. A review of the research surrounding college student retention revealed that there are many factors that contribute to a student's decision to remain enrolled or to depart prematurely.

However, a general consensus was found among researchers that academic performance is among the most impactful of these factors.

There are many ways to measure academic performance. Researchers commonly investigate the relationship between retention and grade point average (Feldman, 1993; Snell & Mekies, 1993; Hawley & Harris, 2005-2006; Craig & Ward, 2007-2008) or course credit hours successfully completed (Adelman, 1999; McCormick, 1999; Voorhees & Zhou, 2000; Szafran, 2001). For degree-seeking students, though, it may be possible to focus investigation upon more specific curricular course requirements that are generally common across most, if not all, degree programs, but may present a barrier to retention and program completion.

Since nearly all degree-seeking community college students encounter mathematics coursework as a program requirement, it is worthwhile to study the relationship between retention and academic performance in mathematics. Moreover, for the community college student population, an investigation into the relationship between mathematics performance and the retention must begin with the recognition that most community college students are not prepared for college-level mathematics at the time of their first semester of enrollment. Over 70% of the students chosen for this study were found not to be ready to enroll in the first college-level mathematics course required in their chosen degree program. These students were thus faced with completing at least one developmental mathematics course before embarking upon satisfaction of the mathematics requirements in their respective curricular programs. It is also worthwhile, therefore, to determine if the relationship between retention and academic performance in mathematics differs based upon student readiness for college mathematics.

The primary purpose of the present study was to assess the significance of the relationship between first-semester mathematics performance and fall-to-fall retention among first-time-in-college, degree-seeking community college students. This study was conducted for the purpose of providing a meaningful contribution to the research surrounding college student retention by lending a measure of specificity to the academic performance construct.

To these ends, the study was designed to address the following research questions:

1. For students in the sample under study who are recommended for developmental mathematics based upon placement test scores, are there significant differences in fall-to-fall retention rates among those who, in their first semester of enrollment, successfully complete a developmental mathematics course, those who enroll in a developmental mathematics course but fail to complete it successfully, and those who postpone developmental mathematics coursework until after the first semester?
2. For students in the sample under study who are recommended for college-level mathematics based upon placement test scores, are there significant differences in fall-to-fall retention rates among those who, in their first semester of enrollment, successfully complete a college-level mathematics course, those who enroll in a college-level mathematics course but fail to complete it successfully, and those who postpone college-level mathematics coursework until after the first semester?

In addition, the review of the literature suggested that certain demographic characteristics have been found to have a mitigating effect on the relationship between

student retention and the factors to which it is related. This study explored a number of these demographics, including student gender, student age, student race or ethnicity, full-time or part-time enrollment status, financial aid status, and first-generation status to determine if the significance of the relationship between first-semester mathematics performance and fall-to-fall retention was altered when examined within any of the resulting demographic subgroups. Specifically, the following research questions were also addressed:

3. For students in the sample under study, to what extent does gender influence the significance of the relationship between first-semester mathematics performance and fall-to-fall retention?
4. For students in the sample under study, to what extent does student age influence the significance of the relationship between first-semester mathematics performance and fall-to-fall retention?
5. For students in the sample under study, to what extent does race or ethnicity influence the significance of the relationship between first-semester mathematics performance and fall-to-fall retention?
6. For students in the sample under study, to what extent does enrollment status influence the significance of the relationship between first-semester mathematics performance and fall-to-fall retention?
7. For students in the sample under study, to what extent does financial aid status influence the significance of the relationship between first-semester mathematics performance and fall-to-fall retention?

8. For students in the sample under study, to what extent does first-generation status influence the significance of the relationship between first-semester mathematics performance and fall-to-fall retention?

The study consisted of applying quantitative analysis to *ex post facto* data pertaining to first-semester mathematics performance and fall-to-fall retention for 1518 first-time-in-college, degree-seeking students who were enrolled in fall semester 2011. Descriptive statistics were employed to characterize the sample in terms of the demographic variables under study and in terms of the mathematics readiness, first-semester mathematics performance, and fall-to-fall retention of the students in the sample. Chi-square analysis was used to determine if first-semester mathematics performance and fall-to-fall retention were significantly related within each of two subgroups – students who were deemed not to be ready for college-level mathematics upon entry and students who were deemed to be ready for college-level mathematics in the first semester of enrollment. Chi-square analysis was also used to conduct follow-up, pairwise comparisons within each subgroup to determine if there were significant differences in retention rates experienced by students who successfully completed a first-semester mathematics course, students who enrolled in a first-semester mathematics course but failed to complete it successfully, and students who deferred enrollment in mathematics coursework until after the first semester.

Chi-square analysis was then applied to investigate whether the significance of the relationship between first-semester mathematics performance and fall-to-fall retention among all students in the sample was affected by each of the demographic factors of gender, age, race or ethnicity, enrollment status, financial aid status, and first-generation

status. For each demographic variable, chi-square analysis was also used to conduct follow-up, pairwise comparisons within each demographic category to determine if there were significant differences in retention rates experienced by students who successfully completed a first-semester mathematics course, students who enrolled in a first-semester mathematics course but failed to complete it successfully, and students who deferred enrollment in mathematics coursework until after the first semester.

The study produced three major findings applicable to both the college-math-ready and not-college-math-ready subgroups. With only occasional exceptions, these three findings were also applicable across all demographic constituencies.

First, students who successfully completed a first-semester mathematics course, whether college-level or developmental-level, experienced a fall-to-fall retention rate nearly 20% higher than that experienced by the sample as a whole. While very few studies were found to investigate the relationship between mathematics performance, specifically, and retention, this finding was not unexpected and was consistent with the findings of other researchers who reported academic performance, in general, to be significantly related to retention (Spady, 1970; Astin, 1975; Alexander, Riordan, Fennessey, & Pallas, 1982; Adelman, 1999). This finding was also consistent with Wolfle (2012) who found no significant difference in retention rates between successful developmental mathematics students and students identified as college-ready at the time of entry.

A second major finding from the present study was that students who enrolled in but failed to complete a first-semester mathematics course, whether developmental-level or college-level, experienced a fall-to-fall retention rate approximately 10% lower than

that experienced by the sample as a whole. This finding, too, was consistent with prior research suggesting a significant relationship between academic performance, in general, and retention behaviors. Taken together, with the finding associated with successful first-semester mathematics performance described above, the present study supports the conclusions reached by Parker (2005) who found significant relationships between degree attainment and percentage of mathematics coursework successfully completed.

The third major finding from the present study was that there was no significant difference in retention rates experienced by students who deferred enrollment in mathematics and those who unsuccessfully enrolled in a first-semester mathematics course. This unexpected result is likely explained by a mistaken assumption that a student's decision to defer enrollment in mathematics is attributable to factors very different from those that contribute to unsuccessful enrollment in mathematics and, ultimately, to persistence. However, this finding differs from that of Fike & Fike (2012) who found that, among developmental mathematics students, the likelihood of fall-to-fall retention was much greater for students who deferred enrollment in mathematics than for students who failed mathematics in their first semester.

Identification of particular academic factors that may relate to student persistence is expected to be beneficial to college administrators, academic advisors, counselors, and students seeking to make informed decisions that will increase the likelihood that students will achieve their educational goals. The findings of this study, if confirmed by similar research applied to larger populations of similar type, should prove to be of significant value in establishing mathematics performance as one of those identifiable factors. Therein lies a dilemma, however. While successful enrollment in mathematics

seems to have a positive effect on retention rates, unsuccessful enrollment and deferral of enrollment seem to have an opposite effect. As long as course success rates in mathematics remain disturbingly low, encouraging students to enroll in mathematics coursework is a high-risk strategy for improving retention.

Mathematics Performance and Retention for the Sample Population

Of the 1518 first-time-in-college students enrolled in a two-year degree program at the community college under study in fall semester 2011, only 693 (45.7%) remained enrolled by the following fall semester. While some of the students no longer enrolled may have successfully transferred to another institution without the benefit of having earned the degree they had chosen to pursue in fall 2011, historical data from the Virginia Community College System suggests that the vast majority of these students prematurely departed higher education altogether.

If first-semester mathematics performance is indeed related to fall-to-fall retention, student readiness for college-level mathematics may be a contributing factor to high student attrition rates. Among the students in the sample chosen for this study, only 444 (29.2%) were found to be ready for college-level mathematics in their first semester of enrollment at the college. The college under study offers a robust developmental mathematics program for students in need of remediation, but students often defer enrollment in mathematics beyond the first semester of enrollment, regardless of readiness level. Approximately 43% of the 1518 students in this study postponed enrollment in mathematics until after their first semester.

The remaining 864 students chose to enroll in a first-semester mathematics course. However, for college-level and developmental-level courses combined, only 385

students successfully completed the course, a success rate of 44.6%. Pursuant to the focus of this study, the retention rate demonstrated by these successful mathematics students was 64.2%, nearly twenty percentage points higher than the retention rate for the entire sample. On the other hand, unsuccessful first-semester enrollment in mathematics was found to put students at greater risk of failure to persist. Of the 479 students in the sample who enrolled in first-semester mathematics but failed to complete it, 297 were not retained to fall semester 2012, an attrition rate of 62%, about eight percentage points higher than the attrition rate for the entire sample. Students who deferred enrollment in mathematics beyond the first semester fared only slightly better than students who enrolled but were unsuccessful. As referenced above, 654 (43.1%) of the students in the sample postponed enrollment in mathematics. Only 264 (40.4%) of these students were retained to fall 2012, thus representing an attrition rate of 59.6%.

The primary goal of the present study was to determine if the relationship between first-semester mathematics performance and fall-to-fall retention remained significant regardless of a student's entry-level mathematics readiness. Of secondary interest to this investigation was to determine if certain demographic characteristics affected the significance of this relationship. To reach these determinations, a series of research questions was formulated. The findings pertinent to those questions are presented below.

Mathematics Performance, Retention, and College Readiness

To address the first two research questions, the sample population was divided into two subgroups - those students who were deemed ready to enroll in college-level mathematics as of the first semester of college enrollment and those students deemed to

be in need of remediation prior to enrolling in a first college-level mathematics course. For each subgroup, chi-square analysis was conducted to determine if the relationship between first-semester mathematics performance and fall-to-fall retention was significant. That is, within each subgroup, were there significant differences between the retention rate reported for the entire sample and the retention rates reported based upon first-semester mathematics performance.

The Developmental Mathematics Subgroup

Among the 1518 students in the sample population, 1074 (70.8%) were deemed not to be ready for college-level mathematics upon entry to the college in fall 2011. Each of these students would have received an advising recommendation to complete at least one developmental-level mathematics course in order to qualify for enrollment in the first college-level mathematics course required in their respective program of study.

Within this subgroup, 605 students, 56.3% of the subgroup population, enrolled in a developmental-level, first-semester mathematics course. However, only 254 students, 42% of the enrollees, successfully completed that first course. First-semester mathematics performance was found to be significantly related to fall-to-fall retention for first-time-in-college, degree-seeking, developmental students.

For the entire developmental mathematics subgroup, the fall-to-fall retention rate was 42.6%, representing 458 students. The 160 students in the developmental mathematics subgroup who enrolled in and successfully completed their first-semester mathematics course, though, experienced a fall-to-fall retention rate of 63%. This retention rate is consistent with that of students in the entire sample population who enrolled in and successfully completed a first-semester mathematics course, as reported

above, and was found to be significantly higher, statistically, than the 35.6% retention rate reported for the 125 developmental students who enrolled in and failed to complete a first-semester mathematics course.

Deferral of enrollment in recommended developmental mathematics course is discouraged by academic counselors and advisors at the college under study because it further postpones a student's opportunity to fulfill curricular math requirements, which cannot begin until prescriptive developmental coursework is completed. Nonetheless, 469 (43.7%) of the students in this subgroup deferred enrollment in mathematics until after the first semester. The retention rate for math-deferring students in this subgroup was 36.9%, marginally better than, but statistically indistinguishable from, that experienced by unsuccessful developmental math course enrollees.

In answer to the first research question, it must be concluded that, among students in the sample who were recommended for developmental mathematics based upon placement test scores, there were significant differences in fall-to-fall retention rates among those who, in their first semester of enrollment successfully completed a developmental mathematics course and those who enrolled in a developmental mathematics course but failed to complete it successfully. In addition, it was found that developmental mathematics students who enrolled in and successfully completed a first-semester mathematics course experienced significantly higher fall-to-fall retention rates than did developmental mathematics students who deferred enrollment in mathematics until after the first semester.

The College-Level Mathematics Subgroup

Among the 1518 students in the sample population, 444 (29.2%) were deemed to be ready for college-level mathematics upon entry to the college in fall 2011. Within this subgroup, 259 students, 58.3% of the subgroup population, enrolled in a college-level, first-semester mathematics course. However, only 131 of these students, 50.6% of the enrollees, successfully completed that first course. As was the case for developmental mathematics students, first-semester mathematics performance was found to be significantly related to fall-to-fall retention for first-time-in-college, degree-seeking, college-ready mathematics students.

For the entire college-level mathematics subgroup, the fall-to-fall retention rate was 52.9%, representing 235 students. The 131 students in the college-level mathematics subgroup who enrolled in and successfully completed their first-semester mathematics course, though, experienced a fall-to-fall retention rate of 66.4%. This retention rate is consistent with that of students in the entire sample population who enrolled in and successfully completed a first-semester mathematics course, as reported above, and was found to be significantly higher, statistically, than the 44.5% retention rate reported for the 128 college-level students who enrolled in and failed to complete a first-semester mathematics course.

In the college-level subgroup, 185 (41.7%) of the students deferred enrollment in mathematics until after the first semester. The retention rate for math-deferring students in this subgroup was 49.2%, marginally higher than, but statistically indistinguishable from, that experienced by unsuccessful college-level math course enrollees.

In answer to the second research question, it must be concluded that, among students in the sample who were recommended for college-level mathematics based upon placement test scores, there were significant differences in fall-to-fall retention rates among those who, in their first semester of enrollment, successfully completed a college-level mathematics course and those who enrolled in a college-level mathematics course but failed to complete it successfully. In addition, it was found that college-level mathematics students who enrolled in and successfully completed a first-semester mathematics course experienced significantly higher fall-to-fall retention rates than did college-level mathematics students who deferred enrollment in mathematics until after the first semester.

Mathematics Performance, Retention, and Demographic Characteristics

The remaining research questions developed for this study pertained to whether the significance of the relationship between first-semester mathematics performance and fall-to-fall retention was affected by selected demographic characteristics of the sample population. In particular, the study investigated the effects of student gender, student age, student race or ethnicity, full-time or part-time enrollment status, student financial aid status, and student first-generation status upon the relationship between mathematics performance and retention.

Mathematics Performance, Retention, and Student Gender

Of the 1518 students in the population sample, 814 students were male and 703 were female. One student failed to provide gender information. Among the males in the sample, 344 (42.3%) were retained to fall semester 2012. Among the females in the sample, 349 (49.6%) were retained. Regardless of student gender, however, significant

differences in retention rates were found depending upon first-semester mathematics performance.

For the male population, a 61.1% retention rate was reported for the 190 students who enrolled in and successfully completed a first-semester mathematics course, a rate significantly higher, statistically, than the 37.2% retention rate reported for the 274 males in the sample who were unsuccessful in a first-semester mathematics course. Similarly, the 195 female students who enrolled and successfully completed a first-semester mathematics course were retained at a rate of 67.2%, significantly higher, statistically, than the 39% retention rate reported for the 205 females who were unsuccessful in a first-semester mathematics course.

Deferral of mathematics enrollment until after a student's first semester appeared to have a greater negative effect on the male students than on the females. The 350 male students who deferred math enrollment experienced a retention rate of only 36%, slightly lower than that of students who unsuccessfully enrolled. The 303 females who deferred math enrollment were retained at a 45.5% rate. However, for both males and females, the retention rates experienced by students who deferred enrollment in mathematics were statistically indistinguishable from the rates experienced by students in each gender subgroup who enrolled in a first-semester mathematics course but failed to complete it successfully.

In answer to the third research question, it must be concluded that student gender did not affect the significance of the relationship between first-semester mathematics performance and fall-to-fall retention. Regardless of gender, students who enrolled in and successfully completed a first-semester mathematics course experienced significantly

higher retention rates than those who enrolled in a first-semester mathematics course but failed to complete it successfully. In addition, regardless of gender, students who enrolled in and successfully completed a first-semester mathematics course experienced significantly higher retention rates than those who deferred enrollment in mathematics.

Mathematics Performance, Retention, and Student Age

Of the 1518 students in the population sample, 1072 were between 18 years of age and 21 years of age, a traditional age range for first-time college students. Among students in this age group, 495 (46.2%) were retained to fall semester 2012. The number of students in this age range who enrolled in a first-semester mathematics course was 649 (60.5%) and 290 of them successfully completed that course, a success rate of 44.7%. For those 290 successful students, the rate of retention was 63.4%, a rate significantly higher than the 39.6% reported for the 359 unsuccessful first-semester math students in this age group. The retention rate among the 423 students in this age group who deferred enrollment in mathematics was 40%, a rate statistically indistinguishable from the retention rate reported for unsuccessful first-semester mathematics students in this age group.

There were 111 students in the sample population who were under the age of 18. Among students in this age group, 49 (44.1%) were retained to fall semester 2012. The number of students in this age range who enrolled in a first-semester mathematics course was 74 (66.7%) and 29 of them successfully completed that course, a success rate of 39.2%. For those 29 successful students, the rate of retention was 58.6%. Among the 45 unsuccessful first-semester math students in this age group, 20 (44.4%) were retained to fall semester 2012. The retention rate among the 37 students in this age group who

deferred enrollment in mathematics was 32.4%. However, for this age group, the relationship between first-semester mathematics performance and fall-to-fall retention was found not to be significant. For students under the age of 18, the differences in retention rates between successful first-semester math students, unsuccessful first-semester math students, and students who did not enroll in a first-semester math course were statistically indistinguishable. This finding might be explained, in part, by the fact many such students are participants in the college's dual enrollment program, taking first-semester college classes while still enrolled in high school. Dual enrollment students often choose to continue their education after high school at an institution other than the community college that offered the dual enrollment classes. Such students would therefore be reported as "not retained" for reasons having little to do with first-semester performance in mathematics.

There were 84 students in the sample population who were between the ages of 22 years old and 24 years old. Among students in this age group, 31 (36.9%) were retained to fall semester 2012. The number of students in this age range who enrolled in a first-semester mathematics course was 32 (38.1%) and 13 of them successfully completed that course, a success rate of 40.6%. For those 13 successful students, the rate of retention was 61.5%. Among the 19 unsuccessful first-semester math students in this age group, only 4 (21.1%) were retained to fall semester 2012. The retention rate among the 52 students in this age group who deferred enrollment in mathematics was 36.5%. However, for this age group, the relationship between first-semester mathematics performance and fall-to-fall retention was found not to be significant. For students between the ages of 22 and 24, the differences in retention rates between successful first-semester math students,

unsuccessful first-semester math students, and students who did not enroll in a first-semester math course were statistically indistinguishable. This finding might be explained, in part, by the low percentage of students in this age group who chose to enroll in a first-semester mathematics course. As mentioned above, approximately 38.1% of the students in this age group enrolled in a first-semester mathematics course, compared to 56.9% of the sample population who chose to do so.

There were 251 students in the sample population who were 25 years of age or older. Among students in this age group, 118 (47%) were retained to fall semester 2012. The number of students in this age range who enrolled in a first-semester mathematics course was 109 (49.5%) and 53 of them successfully completed that course, a success rate of 48.6%. For those 53 successful students, the rate of retention was 71.7%, a rate significantly higher, statistically, than the 28.6 retention rate reported for 56 unsuccessful first-semester math students in this age group. The retention rate among the 142 students in this age group who deferred enrollment in mathematics was 45.1%. This rate was significantly lower, statistically, than the rate reported for successful first-semester math students in this age group, but significantly higher, statistically, than that reported for unsuccessful first-semester math students in this age group.

In answer to the fourth research question, it must be concluded that student age did, indeed, affect the significance of the relationship between first-semester mathematics performance and fall-to-fall retention. For students in the 18-21 year-old and 25-and-over age groups, first-semester mathematics performance and fall-to-fall retention were significantly related. However, differences in retention rates among students in the under-

18 and 22-24 year-old age groups, based upon first-semester mathematics performance, were not statistically significant.

Mathematics Performance, Retention, and Student Race or Ethnicity

Of the 1518 students in the population sample, 666 were Black, 665 were White, and 187 were of other races or ethnicities. Among Black students, 225 (33.8%) were retained to fall semester 2012. Among White students, 361 (54.3%) were retained. There were 107 students of other races or ethnicities who were retained, a retention rate of 57.2%. The number of Black students who enrolled in a first-semester mathematics course was 337 (50.6%) and 114 of them successfully completed that course, a success rate of 33.8%. The number of White students who enrolled in a first-semester mathematics course was 419 (63%) and 217 of them successfully completed that course, a success rate of 51.8%. The number of students of other races or ethnicities who enrolled in a first-semester mathematics course was 108 (57.8%) and 54 of them successfully completed that course, a success rate of 50%. Regardless of student race or ethnicity, significant differences in retention rates were found depending upon first-semester mathematics performance.

The 114 Black students who successfully completed a first-semester mathematics course experienced a fall-to-fall retention rate of 58.8%, significantly higher, statistically, than the 26.5% retention rate reported for the 223 Black students who were unsuccessful in a first-semester math course. The 217 White students who successfully completed a first-semester mathematics course experienced a retention rate of 65%, significantly higher, statistically, than the 50% retention rate reported for the 202 White students who were unsuccessful in a first-semester math course. The 54 students of other races or

ethnicities who were successful in first-semester mathematics were retained at a rate of 72.2%, significantly higher, statistically than the 40.7% retention rate among the 54 such students who were unsuccessful in a first-semester math course.

The 329 Black students who deferred enrollment in mathematics were retained at a 30.1% rate, statistically indistinguishable from the retention rate experienced by Black students who were unsuccessful in a first-semester math course. The 246 White students who deferred enrollment were retained at a 48.4% rate, statistically indistinguishable from the retention rate experienced by White students who were unsuccessful in a first-semester math course. The 79 students of other races or ethnicities who deferred enrollment in mathematics were retained at a 58.2% rate, statistically indistinguishable from the retention rate reported for such students who were unsuccessful in a first-semester math course. In addition, however, the retention rate among students of other races or ethnicities who deferred enrollment in mathematics was also statistically indistinguishable from the retention rate reported for such students who successfully completed a first-semester math course.

In answer to the fifth research question, it must be concluded that the significance of the relationship between first-semester mathematics performance and fall-to-fall retention was largely unaffected by student race or ethnicity. Statistical analysis revealed that retention rates among students who enrolled in and successfully completed a first-semester mathematics course remained significantly higher than the retention rates reported students who were unsuccessful in a first-semester math course, regardless of student race or ethnicity. Findings were somewhat mixed, however, for students who deferred enrollment in mathematics. For Black students and for White students, retention

rates among students who were successful in a first-semester math course were significantly higher than those reported for students who deferred enrollment in mathematics. For students of other races or ethnicities, however, there was no significant difference between retention rates reported for students who were successful in a first-semester math course and retention rates among students who deferred enrollment in mathematics. For all three race or ethnicity subgroups, there was no significant difference between retention rates reported for students who were unsuccessful in a first-semester math course and retention rates reported for students who deferred enrollment in mathematics.

Mathematics Performance, Retention, and Enrollment Status

Of the 1518 students in the population sample, 795 students were full-time and 723 were part-time. Among the full-time students in the sample, 434 (54.6%) were retained to fall semester 2012. Among the part-time students in the sample, 259 (35.8%) were retained. Regardless of enrollment status, however, significant differences in retention rates were found depending upon first-semester mathematics performance.

For full-time students, a 65.3% retention rate was reported for the 291 students who enrolled in and successfully completed a first-semester mathematics course, a rate significantly higher, statistically, than the 43.8% retention rate reported for the 297 full-time students who were unsuccessful in a first-semester math course. Similarly, the 94 part-time students who enrolled in and successfully completed a first-semester mathematics course were retained at a rate of 60.6%, a rate significantly higher, statistically, than the 28.6% retention rate reported for the 182 part-time students who were unsuccessful in a first-semester math course.

The 207 full-time students who deferred enrollment in mathematics were retained at a rate of 55.1%. This rate was found to be significantly lower than the retention rate reported for full-time students who successfully completed a first-semester math course, but significantly higher than the retention rate reported for full-time students who were unsuccessful in a first-semester math course. The 447 part-time students who deferred enrollment in mathematics were retained at rate of 33.6%. This rate was found to be significantly lower than the retention rate reported for part-time students who successfully completed a first-semester math course, but statistically indistinguishable from the retention rate reported for part-time students who were unsuccessful in a first-semester math course.

In answer to the sixth research question, it must be concluded that the significance of the relationship between first-semester mathematics performance and fall-to-fall retention was largely unaffected by student enrollment status. However, full-time students who deferred enrollment in mathematics experienced a significantly higher retention rate than full-time students who were unsuccessful in a first-semester math course.

Mathematics Performance, Retention, and Financial Aid Status

Of the 1518 students in the population sample, 915 students were Pell-eligible and 603 were not Pell-eligible. Among the Pell-eligible students in the sample, 356 (38.9%) were retained to fall semester 2012. Among the students in the sample who were not Pell-eligible, 337 (55.9%) were retained. Regardless of financial aid status, however, significant differences in retention rates were found depending upon first-semester mathematics performance.

For Pell-eligible students, a 63% retention rate was reported for the 192 students who enrolled in and successfully completed a first-semester mathematics course, a rate significantly higher, statistically, than the 29.1% retention rate reported for the 302 Pell-eligible students who were unsuccessful in a first-semester math course. Similarly, the 193 students who were not Pell-eligible and who enrolled in and successfully completed a first-semester mathematics course were retained at a rate of 65.3%, a rate significantly higher, statistically, than the 53.1% retention rate experienced by students who were not Pell-eligible and who were unsuccessful in a first-semester math class.

The 421 Pell-eligible students who deferred enrollment in mathematics experienced a retention rate of 34.9%, statistically indistinguishable from the retention rate reported for Pell-eligible students who were unsuccessful in a first-semester math course. The 33 students who were not Pell-eligible and who deferred enrollment in mathematics experienced a retention rate of 50.2%, statistically indistinguishable from the retention rate experienced by students who were not Pell-eligible and who were unsuccessful in a first-semester math course.

In answer to the seventh research question, it must be concluded that student financial aid status did not affect the significance of the relationship between first-semester mathematics performance and fall-to-fall retention. Regardless of financial aid status as determined by Pell-eligibility, students who enrolled in and successfully completed a first-semester mathematics course experienced significantly higher retention rates than those who enrolled in a first-semester mathematics course but failed to complete it successfully. In addition, regardless of financial aid status, students who

enrolled in and successfully completed a first-semester mathematics course experienced significantly higher retention rates than those who deferred enrollment in mathematics.

Mathematics Performance, Retention, and First-Generation Status

Of the 1518 students in the population sample, 366 students were identified as first-generation college students and 1152 were identified as not first-generation. Among the first-generation students in the sample, 160 (43.7%) were retained to fall semester 2012. Among the students in the sample who were not first-generation, 533 (46.3%) were retained. Regardless of first-generation status, however, significant differences in retention rates were found depending upon first-semester mathematics performance.

For first-generation students, a 66.3% retention rate was reported for the 86 students who enrolled in and successfully completed a first-semester mathematics course, a rate significantly higher, statistically, than the 31.5% retention rate reported for the 111 first-generation students who were unsuccessful in a first-semester math course. Similarly, the 299 students who were not first-generation and who enrolled in and successfully completed a first-semester mathematics course were retained at a rate of 63.5%, a rate significantly higher, statistically, than the 39.9% retention rate reported for the 368 students who were not first-generation and who were unsuccessful in a first-semester math course.

The 169 first-generation students who deferred enrollment in mathematics experienced a fall-to-fall retention rate of 40.2%, statistically indistinguishable from the retention rate reported for first-generation students who were unsuccessful in a first-semester math course. Similarly, the 485 students who were not first-generation and who deferred enrollment in mathematics experienced a fall-to-fall retention rate of 40.4%,

statistically indistinguishable from the retention rate reported for students who were not first generation and who were unsuccessful in a first-semester math course.

In answer to the eighth research question, it must be concluded that first-generation status did not affect the significance of the relationship between first-semester mathematics performance and fall-to-fall retention. Regardless of first-generation status, students who enrolled in and successfully completed a first-semester mathematics course experienced significantly higher retention rates than those who enrolled in a first-semester mathematics course but failed to complete it successfully. In addition, regardless of first-generation status, students who enrolled in and successfully completed a first-semester mathematics course experienced significantly higher retention rates than those who deferred enrollment in mathematics.

Summary

While it must continue to be acknowledged that there are many factors that contribute to the persistence behaviors exhibited by community college, prior research has established that academic integration into the institution, usually assessed by various measures of academic performance, is paramount among them. The findings of this study offer compelling evidence of the significance of the relationship between one such measure of academic integration, first-semester mathematics performance, and the fall-to-fall retention of first-time-in-college, degree-seeking students.

The retention rate for students in this study who enrolled in and successfully completed a first-semester mathematics course was found to be 64.2%, nearly twenty percentage points higher than the 45.7% retention rate experienced by the sample population overall. Improvements in retention rates of this approximate magnitude were

found to occur among successful first-semester mathematics students irrespective of whether the students were enrolled in a college-level mathematics course or in a developmental mathematics course for purposes of remediation. Moreover, such improvements in retention rates among successful first-semester mathematics students prevailed across all demographic constituencies, irrespective of student gender, student age, student race or ethnicity, full-time and part-time enrollment status, financial aid status, and first-generation status.

These encouraging findings must be tempered, however, by the risks associated with the relationship between unsuccessful, first-semester enrollment in mathematics and retention. The retention rate for students in the sample who enrolled in but failed to complete a first-semester mathematics course successfully was only 38%, significantly lower than the 45.7% retention rate reported for the sample population overall. This dramatic difference was found to prevail for students who enrolled in a developmental mathematics course. The retention rate for students who were unsuccessful in a first-semester college-level mathematics course was 44.5%, only marginally lower than the sample population overall. The risks associated with unsuccessful first-semester enrollment in mathematics are exacerbated by the demonstrated success rates in these courses. The success rates in first semester developmental mathematics courses were found to be 42%, while the success rates in first-semester college-level courses were found to be 50.6%.

Given the risks of unsuccessful first-semester enrollment in mathematics, this study also investigated retention rates among students in the sample who deferred enrollment in mathematics until after the first semester of college. Among developmental

mathematics students, those who deferred enrollment in mathematics experienced a retention rate of only 36.9%. However, college-level mathematics students who deferred enrollment in mathematics experienced a retention rate of 49.2%, marginally higher than the 45.7% retention rate experienced by the sample population overall.

Implications for Practitioners

The findings of this study are a first step in establishing the significance of the relationship between first-semester mathematics performance and fall-to-fall retention for first-time-in-college, degree-seeking community college students. The study has, therefore, provided a worthwhile contribution to the body of research on retention of community college students from their first semester of enrollment into their second year of study. Should the findings of this study be affirmed by further research, community college practitioners should begin to consider how findings such as these can be converted into actionable strategies.

The present study found that students who successfully complete a first-semester developmental-level mathematics class and students who successfully complete a first-semester college-level mathematics class experience a fall-to-fall retention rate 20% higher than that experienced by all first-time-in-college, degree-seeking students. In all likelihood, however, this is not a cause-and-effect relationship. That is, successful mathematics students are not retained because they are good math students. Rather, it is more likely that the personal characteristics that foster success in mathematics, such as intellectual ability, self-efficacy, and strong work ethic, are the same characteristics that foster persistence. If students are to be encouraged to enroll in mathematics coursework in the first semester of college, then mathematics educators should embrace the

opportunity to employ instructional methods that develop the student behaviors that contribute not only to success in mathematics, but to success in the overall educational endeavor.

By contrast, unsuccessful first-semester enrollment in developmental mathematics or college-level mathematics led to retention rates that were 10% lower than those experienced by all first-time-in-college, degree-seeking students. The negative implications of this finding are compounded by success rates in mathematics classes that hover around 50% for college-level classes and 40% for developmental classes. Mathematics educators must begin to question why success rates in mathematics are so much lower than those reported in other areas of general education. Are we teaching mathematics in ways that encourage conceptual understanding or in ways that encourage rote memorization? Are we teaching mathematical principles from a contextualized perspective that is relevant to the students' fields of study? Are we assessing learning in mathematics in the most effective ways?

In this study, math avoidance, as manifested by a student's decision to defer enrollment in mathematics until after the first-semester, proved to be indistinguishable from unsuccessful first-semester enrollment in its relationship to fall-to-fall retention. While this result was not expected, it offers further insight to community college practitioners with regard to advising students. Degree-seeking students should be encouraged to enroll in mathematics in their first semester, but, more urgently, mathematics educators should be encouraged to explore ways to improve success rates, including significant course redesign to assure consistency of desired learning outcomes, significant reengineering of instructional methodologies, and significant remodeling of

traditional techniques used to assess student learning. In addition, since developmental-level mathematics students are a greater risk of being unsuccessful in a first-semester mathematics class, colleges should be encouraged to work closely with secondary school partners to improve student readiness for college-level mathematics upon admission.

While this study has identified a specific academic performance factor that was found to be significantly related to student retention, practitioners should focus on actionable findings. The analysis of the effect of demographic characteristics upon the relationship between first-semester mathematics performance and fall-to-fall retention produced results that were interesting primarily because, with only rare exceptions, differences in retention rates were found to adhere to similar patterns irrespective of demographic constituency. If the significance of the relationship between mathematics performance and retention had been found to vary dramatically based upon certain demographic characteristics, such findings would not likely be practically actionable. Practitioners would not be inclined to advise students with regard to first-semester mathematics enrollment based upon the student's gender, age, race, or first-generation status. Findings related to enrollment status or financial aid status might have been somewhat more actionable had they differed from findings pertaining to the sample as a whole, but such differences did not exist.

As policymakers seek to hold colleges and universities accountable for student success, factors that can improve retention rates and encourage persistence to a degree or to successful transfer will become increasingly important to community colleges and their leaders. Empirical evidence provided by this study and other research of its type can

help to identify specific strategies that increase the likelihood that students will remain enrolled and achieve their educational goals.

Limitations and Delimitations

The research design developed for this study presented certain inherent limitations that may be considered mitigating factors when assessing the internal validity of the findings. Specifically, it must be recognized that causality is not to be inferred from *ex post facto* correlational analysis. That is, strong correlations between independent and dependent variables do not imply a cause-and-effect relationship

The present study was delimited by its susceptibility to selection bias. The sample under study was a cohort of community college students enrolled in the fall semester of one selected academic year at a single community college. Thus, the generalizability of the findings to students enrolled at this institution in other terms or in other years and to students at other institutions remains to be established. Also, students selected for this study were first-time-in-college, degree-seeking students. Generalizability of the findings to students who are not enrolled in college for the first time, who are enrolled in a certificate program, or who are non-curricular also remains to be established.

The chi-square, two-way contingency analyses were not controlled for other measures of academic achievement, such as total credit hours completed, grade point average, or second semester performance in mathematics that could reasonably be expected to influence fall-to-fall retention behaviors. Moreover, the study did not investigate non-cognitive factors that have been shown by other researchers to correlate with student persistence.

Finally, the present study did not attempt to distinguish retention rates based upon the levels of difficulty of the various developmental and college-level mathematics courses taken by students in the first semester of enrollment nor did it include consideration of second-semester mathematics performance of first-year students upon retention to the following fall semester. Such factors might reasonably be expected to mitigate the findings of this study.

Recommendations for Further Research

The findings, limitations, and delimitations associated with this study suggest several topics for further study. In addition to replication of this study for the purposes of substantiating the findings, there are related research questions that were not investigated.

Investigations into the relationship between mathematics performance and retention for students who are not enrolled in college for the first time and for students who deferred enrollment in mathematics in their first semester but eventually enrolled in a first mathematics course would be worthwhile. Studies into the relationship between mathematics performance and retention among students in certificate programs or students who are non-curricular, while potentially interesting, may be problematic. Such students may not be facing curricular mathematics requirements.

Further research into the relationship between mathematics performance and retention that distinguishes findings based upon the level of difficulty of mathematics courses on a course-by-course basis would be of interest. For example, does the significance of this relationship differ for students who take engineering calculus and students taking general education mathematics course requiring less prerequisite math skill?

Finally, studies to determine whether the significance of the relationship between mathematics performance and retention is affected when controlling for other measures of academic achievement, such as total credit hours completed, grade point average, or second semester performance in mathematics that could reasonably be expected to influence fall-to-fall retention behaviors would be of value. In addition, studies to investigate the effect upon this relationship of non-cognitive factors that have been shown by other researchers to correlate with student persistence would be of interest.

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RESEARCH PROJECTS

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