SULLIVAN, KRISTIE HUNEYCUPT. Using Student Characteristics in an Institutional Context to Examine Predictors of a Community College Student Passing a Developmental Education Course: A Multilevel Analysis. (Under the direction of Tamara V. Young.)

Community colleges are uniquely charged with providing postsecondary educational opportunities to students who are generally the least prepared to receive them (Rosenbaum, 2007). To increase access and success, community colleges offer a variety of pre-college level courses often paired with academic and student services. The courses and services for students who need remediation have been scrutinized by researchers and policy makers, some of whom argue that the programs are ineffective and expensive. Advocates for such programs refer to them as “social and moral imperatives” and credit them for democratizing higher education (Cohen, 2003; McCabe, 1998). The reality is that more than half of all postsecondary students enroll at community colleges (IPEDS, 2008); more than half of those require at least one developmental course (Bailey, 2004; developmental students are most likely to be students of color and low income (IPEDS, 2008; and fewer than one-third of developmental students persist to graduate from any postsecondary institution (Adelman, 2007; Cohen & Brawer 2003; Hagedorn, 2009). Empirical evidence shows that individual student characteristics are often associated with student outcomes (Calcagno, Bailey, Jenkins, Kienzl, & Leinbach, 2008; Bueschal, 2009; Boylan & Bliss 1997; Bettinger & Long 2005). Since community colleges have open admissions policies that allow little control over the characteristics of students who enroll at their institutions, the best opportunities for serving students lie in policies or programs that can mitigate these individual student level
effects. Drawing upon theoretical and empirical evidence of best practices in community colleges and developmental education, this study seeks to identify what institutional and student variables are associated with the passing grades of developmental students enrolled in community colleges across North Carolina. Using student and institutional data from the North Carolina Community College System database, the DataWarehouse, and a survey of chief academic officers from each of the 58 community colleges in North Carolina, hierarchical logistic regression modeling was used to answer the research question of what student and institutional variables predict student passing rates in developmental courses. This study explored the institutional factors that predict students passing developmental courses, especially with student populations that have characteristics that are significant negative predictors of passing. Results from hierarchical logistic regressions demonstrated that while student characteristics, such as gender, race/ethnicity, and age were statistically significant predictors of passing in developmental courses, variance in developmental students pass rates in mathematics, English, and reading courses was also attributed to institutional characteristics.
Using Student Characteristics in an Institutional Context to Examine Predictors of a Community College Student Passing a Developmental Education Course: A Multilevel Analysis

by
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A dissertation submitted to the Graduate Faculty of North Carolina State University in partial fulfillment of the requirements for the Degree of Doctor of Philosophy

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DEDICATION

To my family, kin and kindred, with much love and gratitude.
BIOGRAPHY

Kristie Sullivan is a first-generation college student who graduated from High Point University with Highest Honors, earning a Bachelors of Arts in English with a concentration in Writing. With dreams of graduate school, but no financial resources, she took a part-time job at a local community college and became committed to their mission. A job that was intended to help her earn money for graduate school became her life work.

Kristie’s work at community colleges began as a part-time literacy, Adult High School, GED instructor, and recruiter. She eventually became full-time and taught literacy to adults who worked at local manufacturing plants, working from 10:00pm to midnight with second and third shift employees and returning for a 6:00am to 8:00 am class for third and first shift workers. Determined to help *the least of these*, on the nights she was not teaching, she commuted three hours (each way) from her home to Appalachian State University to complete the Master of Arts in Reading with a concentration in Adult Literacy. She was promoted from the best job she ever had to faculty status and was asked to develop the reading curriculum for a developmental program.

In 1996, she accepted another faculty position at a different community college to teach reading and developmental English and soon became involved with developing and implementing learning communities. Her work with learning communities led to several conference presentations, including making keynote speeches and providing pre-conference workshops as well as consulting with colleges throughout the Southeast. In 2001, Kristie
took the second best job she ever had and became the founding director of a Student Support Services TRIO grant program named Project Promise.

Her continuing commitment to advancing the work of community colleges led her to the doctoral program in Educational Research and Policy Analysis at North Carolina State University. Since 2007 she has served as Dean of Planning and Research for Sandhills Community College. She has enjoyed more than twenty years of professional service to the community colleges of North Carolina.

Of all of this, the best parts of her life include falling in love with David Sullivan, marrying him, and having two amazing children with him, Grace and Jonathan.
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This study would not have been possible without the help of many kind and supportive people. First, I am deeply grateful for the encouragement and support of my committee chair, Dr. Tamara V. Young. Without your prodding, I would have remained unfinished. Your thoughtful comments and suggestions truly improved my work. To Dr. Robert Serow, I am grateful for your helping me begin this journey and for seeing me through to the end. To my other committee members, Dr. Kevin Brady and Dr. Paul Umbach, your service on my committee has been deeply appreciated.

Since I began this doctoral program, I have had two boyfriends, a fiancé, a wedding, a marriage, six pregnancies, one daughter, one son, four cars, two houses, five job interviews and three different jobs. My work has spanned nine Christmas seasons. While completing the coursework and dissertation, I presented at 48 conferences, and provided consulting for 17 different colleges. I mourned the loss of two very special grandparents and buried the greatest dog ever, my beloved mini-Schnauzer of 16 years. Fourteen times I celebrated the births of my friends’ children. Life is indeed what happens to you while you are busy doing something else.

My deepest gratitude goes to my family, friends, and colleagues who were so supportive and faithful while I was busy doing this something else. To my community college colleagues, I am grateful for your encouraging words and kind understanding when I rattled on about my research. I am grateful to my supervisor, Dr. John Turner for his support and for listening to my self-doubts and reminding me that they were just my doubts. To Dr.
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For my husband, David, I am especially grateful—he was, at times, a single parent, a cook, a housekeeper, a chauffeur, a nurse, a shopper, and at all times, the love of my life. You are not perfect, but your love is perfect for me. I will never finish thanking God for you. For my daughter, Grace, it is my hope that you will always be proud of your “Dr. Mommy”, and that we can spend the rest of our lives reading books, painting our nails, and finishing all of the “not right nows”. For my son Jonathan, thank you for attending the last semester of classes with me, and for kicking and stretching your way through the last course on hierarchical models. Just like your sister, you will always be a precious reminder of what really matters. In spite of the guilt I felt for going to class or closing the door to write, part of my motivation for finishing this degree was to set an example of what moms can do. For my own mother, I am grateful to have always been told that I could do anything and then be given the support and latitude to do it. My cup runneth over.
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Chapter One: Introduction

Overview

Community colleges are the youngest postsecondary institutions in the United States. The first junior college was established in Illinois in 1901 by J. Stanley Brown who was encouraged by the advocacy of William Rainey Harper (Bragg, 2001; Dougherty, 2004). Early community colleges were created as an extension of local high schools and were intended to serve recent high school graduates for preparation to transfer to four-year colleges and universities. In the 1930s, college leaders began to broaden the focus of the mission of junior colleges to include vocational technical programs with “terminal” degrees that would lead to employment (Frye, 1992). The term “community college” was established by the 1947 Truman Commission which called for junior colleges to support vocational and technical education as a means of improving and expanding access to postsecondary education. Coupled with the establishment of the G.I. Bill in 1944, the advocacy of the Truman Commission ushered in an age of access and opportunity to postsecondary education (Roueche & Baker, 1987). The G.I. Bill in particular is credited with community college expansion as enrollment in community colleges nearly doubled between 1944 and 1947 (Kane & Rouse, 1999). Aided by an increase in federal funds for vocational education, in the 1960s colleges adopted open access admission policies, which encouraged enrollment. As community colleges proliferated in the 1960s and 1970s, open access policies also increased the enrollment of academically underprepared students and extended the need for developmental education.
While developmental education policies and practice vary widely among institutions, common factors include having students complete a placement test that assesses basic skills in mathematics, English, and reading. Where deficiencies are determined by the placement test, students are directed to an appropriate level of remedial courses in one or more of these disciplines. Some colleges require students to complete all of their assigned developmental courses before progressing into college level courses or academic programs. To help students progress through developmental courses, colleges often offer various academic and student support programs. In spite of the efforts to encourage student success and to provide wider access to postsecondary education, the efficacy of developmental coursework and support programs is not well substantiated (Kozeracki, 2002; Oudenhoven, 2002; Bueschal 2009).

If community colleges are going to meet their missions of providing access to postsecondary education, thereby acting as a democratizing agent of higher education, then it is imperative that community colleges help students succeed in developmental education. Students who need remedial courses in English, reading, or mathematics are most often the students who would not have access to postsecondary education in any other way (Rosenbaum, Redline, & Stephan, 2007). These are students whom the universities will not admit, and arguably, cannot admit and maintain academic rigor (Dougherty 1994). These are also the students who lack the resources—financial and social or cultural—to attend four year institutions (Bailey, 2004). As such, the extent to which community colleges can improve the academic skills of developmental students and help them complete degree
programs or transfer successfully to baccalaureate granting institutions greatly impacts the degree to which community colleges fulfill their mission.

**Statement of the Problem**

At the heart of community college inclusivity is developmental education. For students who are not academically prepared for postsecondary work, developmental education is designed to ameliorate academic deficits so that students can proceed in their course work and complete college classes. Debates about the efficacy of community colleges often include developmental education (Ayers, 2009; Adelman, 2007; Dougherty & Townsend, 2006). With estimates of more than half of community college students needing remedial coursework, the success of developmental students is vital to colleges meeting their missions.

Research to investigate what colleges should or should not do to help developmental students advance provides mixed results about the effectiveness of developmental coursework and related support services and programs. Understanding the effectiveness is further complicated by student characteristics such as being low-income, first-generation, or a minority, all of which are negatively associated with student outcomes such as passing courses, being retained, or persisting to graduation or transfer (Harrell & Forney, 2003; Calcagno et al, 2008; Flowers & Pascarella, 2003). Additionally, much of the empirical research does not adequately represent students enrolled in developmental courses. For example, most large-scale analyses use non-representative student samples that include only First-Time-In-College (FTIC) or only students who are enrolled full-time (Calcagno et al, 2008; Bailey et al 2006; Bueschal 2009; Bettinger & Long 2005; Boylan, Bonham & Bliss,
According to IPEDS data, in fall 2008, fewer than 16% of students enrolled in a public 2-year college were considered FTIC (2008). In addition, some studies restrict the dataset further, using only full-time students or first-time, full time (FTFT) cohorts as is the case with IPEDS data. Using a sample that represents so little of the population raises questions about the generalizability of the results. Moreover, many studies have not controlled for differences in placement tests, cut scores or policies regarding mandatory assessment and placement (Boylan, Bonham, and Bliss, 1997). Given the limitations of the empirical research, we know very little about what institutional characteristics are associated with the student outcomes of students enrolled in developmental courses in community colleges.

**Purpose of the Study**

The purpose of this study is to investigate what institutional variables are associated with student pass rates in developmental courses in mathematics, English, and reading while controlling for individual student characteristics. This research attempts to replicate earlier research that uses non-representative student samples using a student sample that includes all students regardless of FTIC or full-time enrollment status.

**Research Questions**

1. What student characteristics are associated with a student passing a developmental course in mathematics, English, or reading?

2. What institutional variables are associated with student pass rates in developmental courses?
3. While controlling for student characteristics, what institutional characteristics, policies, and practices are associated with a student’s successful completion of developmental coursework in math, English, or reading?

**Significance of the Study**

There is some evidence that suggests that community colleges are not successful in educating or retaining developmental students (Oudenhoven, 2002; Perin, 2006). Additionally, research overwhelmingly shows that some of the challenges associated with developmental education are related to student characteristics (Bailey, 2004; Bettinger, 2005; Boylan, 1999). Therefore, research that identifies institutional variables that mitigate the negative influence of student characteristics on student outcomes can provide insight about how community colleges can help all students be successful.

Since successful completion of a developmental course is the first necessary step for progress along the education pathway towards a certificate, associate degree or transfer to a four-year institution, we must first understand how to improve developmental education. This research has several methodological advantages over similar studies. This research is significant in three primary ways: representative sample, statistical methods, and student outcome. First, the dataset used for this study is larger than any similar national or state-wide analyses, including more than 44,000 student records. This study focused on all students enrolled in developmental courses unlike previous research that focused either on 1) community college students, both developmental and non developmental, who were also classified as First-Time-In-College (FTIC) and/or First-Time-Full-Time (FTFT) (Pascarella,
Wolniak, & Pierson 2003; Calcagno et al, 2008; Goble, Rosenbaum, & Stephan 2008); 2) developmental students at both 2-year and 4-year colleges (Boylan 1999); 3) or developmental students at community colleges who were FTIC (Hagedorn & Kress, 2008; Oudenhoven 2002; Bailey et al, 2006). This study uses a more representative sample which more adequately represents the population of interest and allows for results to be generalized to all students in community college developmental courses, not just first-time or full-time students.

Institutional data includes all 58 community colleges in the North Carolina Community College System (NCCCS). Previous studies have cited research limitations in using data from colleges with varying policies and practices surrounding placement testing and mandatory enrollment in developmental courses. As a comprehensive system, N. C. has standard tuition, a common course catalog, and uniform performance measures. The NCCCS has also established mandatory assessment, directing colleges to use one of two approved placement tests. Test scores are evaluated using a system-wide standard for placement into common levels of courses within various disciplines, such as mathematics, English, and reading. The mandatory assessment, placement, and cut score policies went into effect during the fall 2008 semester; the same semester for the source of the data used in this study. These commonalities allow for comparisons among institutions that would not be possible if the analysis included institutions from different states or if the institutions studied had different policies regarding testing and placement.

Second, this research uses a multi-level model that allows for between institution effects while controlling for student characteristics. Similar research has used regression
analyses which does not account for the nested structure of students within institutions. Multilevel modeling allows for the separate estimation of variance between students (student level predictors) within the same community college and the variance between community colleges.

Third, this study focuses on student pass rates in remedial courses in mathematics, English, and reading as the dependent variable. Generally, previous studies of developmental education or community college students examined relationships between institutional variables or student characteristics on long-term outcomes such as retention, graduation, or transfer rates (Bailey et al, 2006; Bettinger & Long, 2002; Calcagno et al, 2008). With the exception of Boylan (1999) and recent work among Achieving the Dream researchers, few researchers have used pass rates as a dependent variable. Within the context of theories of student retention and persistence, early academic success plays an important role in whether a student meets his or her long term goals. By identifying variables that affect student pass rates, colleges can improve long-term student outcomes. Within the context of North Carolina, using pass rates as the dependent variable is appropriate since the passing rates of developmental students in individual community colleges is one of eight system wide performance measures used in the NCCCS accountability plan.

Limitations of the Study

Although one strength of this study is that the data comes from a community college system with mandatory testing, mandatory placement, and standard cut scores for assigning students to developmental courses, individual student record data do not include student test
scores. As a result, this study cannot control for differences in academic ability even though differences in academic ability are suggested by placement in various levels of developmental courses within each discipline. Furthermore, although students are required to complete remedial courses as a prerequisite to some college-level courses, students may delay enrolling in developmental courses. For all of these reasons, this study is careful to describe the students as those who enrolled in developmental courses not as students who needed developmental courses.

While there is little agreement about which dependent variables are appropriate indicators of the effectiveness of developmental education or community colleges, many large scale studies use multiple dependent variables. This study used only one dependent variable and attempted to explore the effect of student characteristics and institution level variables with thorough analyses that would have not been possible had the scope of the study focused on multiple dependent variables. Another limitation of the dependent variable is that passing was operationalized as a binary outcome of pass/fail, which limits the nature and extent of statistical analysis. The decision to treat this variable as dichotomous was made, in part, because of the arbitrary nature of grading practices. The decision as to whether a student has earned a letter grade of “A”, “B”, “C”, etc. is likely to be more subjective among faculty at different institutions than the determination of whether a student has met the NCCC system-wide standard course outcomes of pass or fail. Also, the NCCCS data that was used for this study converts local grading schemes into a standard system grading scheme with the primary purpose of determining pass or failure rates for performance measures. Thus, using pass rates as the dichotomous dependent variable is
consistent with the institutional accountability measures plan implemented by the NCCCS and mandated by the North Carolina General Assembly.

Since this study was not an experiment that randomly assigned students to community colleges, the possibility of selection bias must be considered as a possible limitation to internal validity. However, Bettinger and Long (2005) assume that since community colleges are predominately commuter institutions, students are more likely to attend colleges where they live. Also, while a student might select a community college on the basis of enrolling in a specialized vocational program, students enrolled in developmental courses are completing prerequisite courses that are offered at each of the 58 community college campuses in North Carolina. As such, students enrolled in remedial courses would have little reason to attend a community college outside of his or her service area.

Last, whether the student chose to enroll in developmental courses could create selection bias. This additional threat to internal validity is limited since in fall 2007, the NCCCS implemented mandatory placement and prerequisite course policies for all students. Therefore, any student who was documented as needing a developmental course would have to complete the course before taking college level courses with developmental prerequisites. Students could, however, delay taking developmental courses or enroll in college level courses with no developmental prerequisites.

**Definition of Key Terms**

This study uses the following definitions:

*Developmental education.* The term developmental education is often used interchangeably with remedial education or pre-college level courses. However, researchers
who focus primarily on developmental education define the term as a holistic approach to include course work below the college level with programs and services to support the intellectual, social, and emotional growth of the student (Boylan, Bonham & Rodriguez, 2000; Casazza, 1999, Higgbee, Arendale & Lundell, 2005, Kozeracki, 2002). For the purposes of this study, each term will be used interchangeably since the colleges included in this study offer varying degrees of comprehensive approaches that incorporate course offerings with academic or student services.

**Developmental course.** The terms developmental, remedial, or precollege often refers to any course with a course number lower than 100. The North Carolina Community College Curriculum Procedures Manual mandates that the numbers 050-099 be assigned to developmental courses. While these courses can be found in many different disciplines such as science or business, this study focuses on developmental courses offered within the disciplines of mathematics, English, and reading. Developmental courses do not count as credit towards completing degrees (Bueschel, 2009).

**Combined Course Library (CCL).** A list of courses and course descriptions of all courses that community colleges in North Carolina may teach. Colleges must use these course descriptions when offering any of these courses, and may not offer courses that are not in the CCL without approval.

**Placement tests.** Most entering students are required to take a placement exam to determine whether they have proficient skills in mathematics, English, or reading to enroll in college level courses (Bailey, 2009, Bueschel, 2009). In NC, the community college system
office requires colleges to use one of two approved placement tests each of which may be offered electronically or by paper and pencil.

Cut scores or cutoff point: These terms refer to placement scores used to assign students to developmental courses. Some research suggests that students who score one point above or one point below the cut score are very similar in terms of academic ability and have compared these students to estimate the effects of remediation (Bettinger & Long, 2005; Calcagno et al, 2007). Others have used the similarities in student ability to raise questions about the accuracy of placing students into courses based solely on placement test scores and to call for using multiple indices to determine which students need remediation. (Morante, 1999). In 2007, the NCCCS established system-wide cut scores that colleges must use to assign students to remedial courses.

Mandatory assessment. Advocated by most researchers and practitioners (Pascarella & Terenzini 2005; Boylan, 2002), mandatory assessment means that all students are required to take a college placement test. In fall 2008, the NCCCS implemented mandatory assessment practices system-wide. Colleges are allowed to make exceptions including using SAT or ACT scores as a proxy for placement testing.

Mandatory placement. Colleges that require students who test into developmental courses to enroll in those courses are said to have mandatory placement. Ed Morante (1999) argues that mandatory testing without mandatory assessment is unethical. In 2007, the NCCCS implemented mandatory placement practices system-wide.

Levels of developmental courses. Within disciplines that offer developmental courses, there are often “levels” of courses. For example, some colleges offer as many as
three or more levels of developmental coursework within a discipline (Bailey, 2009). In North Carolina most community colleges offer at least two levels of English and four or more levels of mathematics. Appendix A includes course descriptions for all developmental courses included in this analysis.

**Attrition.** This term is generally accepted to mean leaving college before completing educational goals (Schuetz & Barr, 2009).

**Persistence.** Used to describe whether a student stays in college beyond a given term. Often used interchangeably with retention although some researchers and practitioners use persistence to mean staying enrolled beyond a given term and until the student graduates or transfers to a four year institution.

**Retention.** Most often used to describe whether a student has remained enrolled in college within an academic term although the term may refer to the student remaining enrolled within an academic year or until graduation or transfer. For the purposes of this study, retention refers to whether the student completed the term.

**Pass rates.** The percent of students at each institution who enrolled in a developmental course in the fall 2008 term and who completed the course with a grade of “C” or better.

**Retention rates.** For the purpose of this study, retention rates refer to the percent of students at each institution who enrolled in a developmental course in the fall 2008 term and who completed the term regardless of whether they passed or failed the course. Students who leave a college before the drop date are not included in retention rates.
Drop date. The date in each term that serves as the cutoff point for whether a student can stop attending a course and receive a non-punitive grade. In North Carolina, drop dates are determined by each college.

College service area. Each community college in North Carolina is assigned a service area which typically includes one or two counties, but may include three or more contiguous counties. Section 18 of the Curriculum Procedures Reference Manual lists the service area for each of the 58 colleges and explains that colleges may serve students from outside of the service area, but colleges are expected to develop programs and services that meet the needs of the students and stakeholders within the counties in the designated service area.

Summary

This chapter has provided the impetus for the study of developmental education within the broader context of the community college mission and theories of student retention. This study attempts to understand the research questions related to what institutional variables can predict a student passing a developmental course in mathematics, English or reading. Chapter two provides an overview of relevant theoretical and empirical literature related to community colleges, developmental education, and student attrition. The discussion of the literature provides a conceptual framework for this study. Chapter three describes the methodology used to study the relationships between student characteristics, institutional variables and pass rates in developmental courses. This chapter includes a summary of the datasets and provides information about how the data were collected and organized. The chapter includes the detailed process used to identify and build the most
parsimonious hierarchical models. Chapter four presents the empirical results of the
descriptive statistics, model building processes, and final hierarchical logistic regression
analyses. Chapter five discusses the results of the analyses, offers conclusions drawn from
the results of the study, and provides recommendations for future research.
Chapter Two: Literature Review

Overview

Chapter two describes the theoretical and empirical literature relevant to this study. Specifically, four bodies of work inform this study. It begins with a discussion of community college theories (their missions and functions) and the history and characteristics of the North Carolina Community College System and its policies regarding developmental education. This chapter also summarizes the research related to developmental education, defining the discipline, and describing the student characteristics that influence student outcomes, such as pass rates, grade point averages, retention, graduation, and transfer to four-year colleges. The chapter includes information about the research that attempts to identify policies or practices that affect student outcomes and concludes with a conceptual framework taken from the relevant literature that guides this study.

Community Colleges

Theoretical perspectives

Initially, community colleges were viewed as a junior college, a means to augment high school preparation and a gateway to universities (Cohen & Brawer, 2003). As vocational education and open access resulted in more community colleges, these societal shifts also influenced changes in the mission for community colleges (Ayers, 2005; Bragg, 2001; Dougherty, 1994; Kane & Rouse, 1999). An industrial society needed skilled workers and community colleges were able to provide them at very little cost (Cohen & Brawer, 2003; Dougherty, 1994).
As community colleges began to educate more students and to claim a higher proportion of funds appropriated to education, theorists argued about the origins and functions of community colleges. Generally, there are four main perspectives: pluralist functionalism, institutionalism, Marxist instrumentalism, and neoliberalism (Ayers, 2005; Dougherty, 1994; Rhoads & Valadez, 1996).

From the pluralist functionalism perspective, community colleges are viewed as a means towards democratizing access to higher education. Community colleges originated in response to the needs of students, parents, business and industry, and local communities (Cohen & Brawer, 2003; Dougherty, 1994). By opening the door to opportunities in higher education to less abled students, community colleges also help universities preserve academic excellence (Dougherty, 1994; Rhoads & Valadez, 1996). Community colleges are institutions that give students, who would otherwise have no opportunity, a chance at postsecondary education and, as a result, opportunities for social and class mobility (Cohen & Brawer, 2003). Businesses support the growth of community colleges because they need mid-level occupations while state universities support their development to protect elitism in their enrollments. Overall, functionalists view the origin and expansion of community colleges as a means of expanding opportunity to the masses and view community college policy as a product of multiple constituents (students, family, business, local communities, and universities) (Dougherty, 1994).

The second and third theoretical approaches, instrumentalist Marxism and institutionalism are generally critical of community colleges. The common premise of these two perspectives is that community colleges perpetuate the inequalities of the social class
system by training midlevel workers for capitalists who grow wealthy from the labor of the working class. Instrumentalist Marxism, in particular, argues that community colleges support the social hierarchy in each generation (Pincus, 1986). Further, critical analyses of community colleges contend that rather than preserve the academic excellence of universities, community colleges protect selective admissions practices at universities attended by the capitalist class. By diverting students from universities to vocational tracks, community colleges help to ensure that there is no overabundance of baccalaureate degrees to compete in an over-educated workforce (Brint & Karabel, 1989; Rhoads & Valadez, 1996). Institutionalism and Marxist Instrumentalism’s theoretical explanations of community colleges contend that community colleges divert the dreams of students as evidenced through poor transfer performance and graduation rates. Data comparing the number of students who aspire to obtain a baccalaureate to the number who actually transfer and graduate with a baccalaureate is often used to substantiate these arguments (Dougherty, 1994). Marxist Instrumentalism also claims that community colleges preserve elite universities to preserve class differences in educational attainment rather than to serve the public interest. Karabel (1972), for example, alleged that there is a national educational planning elite who use community colleges to perpetuate the class system. In this way, the social reproduction facilitated by community colleges serves the best interest of a ruling wealthy class. Institutionalism stresses the internal dynamics of higher education, believing that the central concern to universities is to protect their academic and social exclusivity from underprivileged students pursuing social mobility. Thus, universities supported the growth of community colleges to protect themselves.
The fourth theoretical approach, neoliberalism, expanding on institutionalism and Marxist instrumentalism, argues that as long as community colleges serve the interests of business (the capitalist economy), then their focus is not on the needs of students. As a result, community colleges perpetuate social class inequalities. The Neoliberalism critique is based on the belief that during the 1990s community colleges shifted their focus from meeting the needs of learners to meeting the needs of business and industry (Levin, 2001). From this tradition, the mission of the community college has become focused on economic ends rather than educational ends (Ayers, 2005). To the neoliberalist critic, this transformation occurred at the expense of the learner. In this way, community college education no longer represents an opportunity for cognitive, intellectual and leadership development but becomes an investment in production and a means of human capital development. As community colleges cater to the needs of business and industry, concerns that should be driven by academia, such as program planning, teaching, learning, and assessment are determined by economic demands (Ayers, 2005).

Though these four analytical approaches differ in how they view the role of community colleges, they all relate to developmental education. In the view of pluralist functionalism, developmental education democratizes higher education by increasing access to students who need remedial courses. Further, this theoretical perspective argues that developmental education meets the needs of multiple stakeholders by helping individuals help themselves. Instead of providing social mobility, Instrumentalist Marxism and institutionalism view developmental education as a way of preserving social class by allowing the working class to attend college while assuring that they remain in the working
class. Training workers by increasing academic skills in developmental courses and providing access to certificates, diplomas and applied science degrees, according to neoliberalism, serves the needs of business and industry by increasing human capital.

The North Carolina Community College System

Fifty-eight individual community colleges make up the North Carolina Community College System (NCCCS) which was formally established by the General Assembly in 1963. The general statutes that established the system are clear about its vocational and technical mission:

The major purpose of each and every institution operating under the provisions of this Chapter shall be and shall continue to be the offering of vocational and technical education and training, and of basic, high school level, academic education needed in order to profit from vocational and technical education, for students who are high school graduates or who are beyond the compulsory age limit of the public school system ….

The Community Colleges System Office is designated as the primary lead agency for delivering workforce development training, adult literacy training, and adult education programs in the State.

The college transfer function of North Carolina’s community colleges was not recognized by the North Carolina General Assembly until 1987 when it granted the State Board of Community Colleges the power to allow a community college to add a college transfer program. The transfer program did not take away from its core mission, as indicated by this legislative directive: “Addition of the college transfer program shall not decrease an institution's ability to provide programs within its basic mission of vocational and technical training and basic academic education.”
In 1999, the General Assembly of North Carolina implemented a performance accountability plan. Revised in 2007, the plan established eight accountability measures with developmental education as the target of two measures: pass rates in developmental courses and the pass rates of developmental students in subsequent college-level courses (Harbour, 2002). Given this focus on developmental education as a major indicator of an institution’s performance suggests that policy makers understand that successfully providing educational opportunities to students who need remedial courses is central to realizing the mission of community colleges and satisfying the interests of multiple stakeholders.

**Developmental Education**

Hailed as the doorstop for the community college open door, developmental education burgeoned and research regarding community colleges and developmental education began to emerge in the late 1970s and early 1980s (Cohen & Brawer, 2003). Much of the early literature focused on defining developmental education and exploring its role in postsecondary education. The early literature regarding developmental education was not intended to be a critique as much it was intended to define, explore, and professionalize the discipline. Among the attempts at professionalization were investigations of the efficacy and impact of various pedagogy, organizational structures, and support interventions.

Researchers also explored the characteristics of developmental students by collecting data regarding student demographics, academic preparation, and aspirations. Studies demonstrated that students who attend community colleges are more likely to be older than traditional students; enroll part-time; have first-generation status; qualify as low income; work while attending school; have children or familial obligations; commute to campus; be a
minority; and qualify as academically disadvantaged as evidenced by high school academic records, standardized achievement or placement test scores, or their need for remedial coursework (Adelman, 1998; Bailey, 2004; Bryant, 2001; Calcagno et al, 2006; Cohen & Brawer, 2003; Goel, 2002; Harrell & Forney, 2003; Inman & Mayes, 1999; Kane & Rouse, 1999; Kozeracki, 2002; Pascarella et al., 2003; Schuetz, 2008; Shaw, 1999; Walpole, 2003).

Work by Harrell and Forney (2003), Inman and Mayes (1999), Pascarella and Terenzini (2003), and Pike and Kuh (2005), focused on the influence of influence of first-generation status on student persistence and attainment. Even when controlling for student characteristics such as income, ethnicity, sex, and age, empirical literature found that first generation status negatively impacts student achievement (Pascarella, Person, Wolniak, & Terenzini, 2004). Among the studies that have investigated this effect are considerations of the impact of social and cultural capital, which first-generation college students are thought to lack.

Additional studies regarding student characteristics have found that low income students are less likely to attend college even when determined academically prepared by standard predictors of academic success (George & Aronson, 2003; Harrell & Forney, 2003; Perna & Titus, 2004). Once enrolled, these students are more likely to attend community colleges instead of four year colleges or universities (Kane & Rouse, 1999; Paulsen & St. John, 2002), enroll part-time (Laden, 2004), work full-time (Cofer & Somers, 2001), require remedial courses (Inman & Mayes, 1999; Trotter, 2001; Walpole, 2003), and leave school because of financial difficulties (Kane & Rouse, 1999; Paulsen & St. John, 2002). Like first-generation students, who are often low-income, students from low income families often lack
the social and cultural capital to thrive in an educational environment (George & Aronson, 2003; Sacks, 2003; Walpole, 2003). Furthermore, when low income students graduate, they are less likely to capitalize on the myriad advantages of postsecondary education enjoyed by higher income students (Walpole, 2003) even when they attend selective institutions (Bowen & Bok, 2000).

Additional student characteristics that have been widely investigated include the effects on students who are a racial minority, students who attend college part-time, and students who commute to campus. While ethnic minorities comprise approximately 34% of the overall community college population, these students earn fewer than 29% of community college degrees (Laden, 2004). Among the barriers to minority student success are higher rates of remediation (Adelman, 1998; Hoyt, 1999) and a lack of social and cultural capital of the majority middle class (Valadez, 1993). Individual minority experiences tend to vary by ethnicity (Bryant, 2001; Hoyt, 1999). Empirical literature also finds that more than two-thirds of community college students are enrolled part-time (Bryant, 2001; McClenneney, 2004). Many of these students attend part-time because they are working full-time or have dependents (Cohen & Brawer, 2003; Hoyt, 1999; Laden, 2004). An estimated 23% of community college students spend 6 to 20 hours each week commuting to college classes (McClenneney, 2004). These students are at a higher risk of dropping out because of the competing demands on their time (Cofer & Somers, 2001).

Last, the most widely studied student level predictor of outcomes such as retention, passing courses, graduating, or transfer is academic ability. While most community colleges have admissions policies for degree-seeking students predicated on the single requirement of
completing a high school diploma or equivalency, the attainment of a high school diploma does not ensure the literacy or numeracy skills necessary to perform college level work. To help ensure students are ready for curriculum courses, most colleges offer mandatory placement tests to identify students who need remediation. For the purposes of this research, academically disadvantaged students are defined as those who are identified as needing remedial or developmental coursework which is typically offered in three general areas: reading, English, and math. In 2000, nearly half of first year community college students tested into one or more of these pre-college level courses compared to 20% of first year, four-year public college students (NCES, 2000b). Developmental math was required by 35% of first year college students, by writing 23%, and reading 20% (NCES, 2000b).

General consensus regarding the use of the terms developmental versus remedial education maintains that remedial education refers primarily to singular courses offered at the pre-college level. Developmental education is generally used to refer to a comprehensive set of academic and student services offered in conjunction with pre-collegiate courses (H. R. Boylan, 1999; Oudenhoven, 2002).

In general, most research indicates that the need for remediation is negatively linked to student success and is associated with the number and type of remedial courses required (Adelman, 1998; Cofer & Somers, 2001; Oudenhoven, 2002; Shaw, 2001). In many cases, there are two or more levels of courses in each developmental subject (Hagedorn & Kress, 2008; Parsad & Lewis, 2003; Perin, 2002). Academically disadvantaged students are more likely than other students to be low income and the least able to afford the additional time and expense of developmental courses (NCES, 2000a). In fact, some argue that minority and
low-income students are more likely to test into remedial education simply because they lack the social and cultural capital of the middle class (Howard, 2001; Shaw, 1999; Valadez, 1993). In addition, many remedial students have little confidence in their academic abilities because they are not likely to have had previously positive educational experiences (Inman & Mayes, 1999; Oudenhoven, 2002; Valadez, 1993).

Research suggests that academically unprepared students struggle to persist, often with low GPAs, and are, therefore, less likely to graduate (Adelman, 1998). There is also evidence that the type of remedial course required is correlated to success (Hoyt, 1999; Oudenhoven, 2002). Students in remedial courses are more likely to have lower GPAs, which also contributes negatively to persistence (Cofer & Somers, 2001; Hu & St. John, 2001; Kuh, Cruce, Shoup, Kinzie, Gonyea, 2008).

Exploring Outcomes and Institutional Characteristics
As theoretical and empirical literature regarding developmental education evolved from defining the discipline and investigating student effects, researchers also began to explore the effects of specific programs or services on student outcomes (Oudenhoven 2002; Pascarella, 2001; Rouche, Rouche, & Ely 2001; Townsend, 2007). Influenced by theories of student attrition and persistence, measures of student outcomes expanded to consider student engagement and connectedness as well as student satisfaction (Bailey, 2004; Bettinger & Long, 2005; Boylan, Bonham, & Tafari, 2005). Having started in the mid to late 1980s, researchers continued to explore the impact of developmental education on different and sometimes nontraditional or nonacademic student outcomes, including, but not limited to, the socioeconomic status of alumni who took remedial courses or their engagement in
The inclusion of different student outcomes was a considerable paradigm shift from an earlier focus on broad measures of graduation, employment, and transfer rates to more careful consideration of what happens to students from enrollment to graduation (Bailey et al., 2006; Roueche & Roueche, 2001). From this exploration, the most common outcome measures used in current research emerged: persistence, retention, pass rates, cumulative GPA, and successful completion of first curriculum or gate-keeper courses (Boylan, Bonham, & Rodriquez, 2000; Bragg, 2001). Research also began to include sensitivity to cultural differences and some researchers began to investigate differences in student characteristics by race, sex, and or socioeconomic status (Harrell & Forney, 2003). Specifically, researchers began to be interested in relationships between outcomes for students of color and various academic and student support initiatives (Green, 2006; McClenney, 2007).

In this decade, developmental education programs have come under fire as having little or no effect on student outcomes and, as such, researchers have begun to explore the costs of remediation (Oudenhoven, 2002; Saxon & Boylan, 2001). Developmental education was, at times, considered less of a door stop holding open the door of access, but as a trap door keeping students from success and averting minority and nontraditional students to a vocational or nonacademic path rather than empowering them to pursue their quest for social mobility (Valadez, 1993). Among the expenses researchers enumerated were the costs to taxpayers for the use of federal and state funds in grants to students and support of postsecondary institutions. In fact, some scholars proclaimed that taxpayers were “paying twice” for the teaching of skills that students should have learned in high school (Dougherty,
Reid, & Dougherty, Reid, & Nienhusser, 2006). Additional criticism of the expense of developmental education included the costs to students who paid for the courses, or who incurred the “opportunity costs” of time spent (from one term to two years) in courses that neither counted towards a degree nor seemed to afford them any real academic or occupational advantages (Bailey, 2004).

Debates about the costs of developmental education have also included policy makers, some of whom maintained that pre-college level courses do not belong in a university system. For instance, state leaders in New York, Florida, Missouri, South Carolina, Arizona, and California have mandated that remedial programs offered in four year university systems be relegated to community colleges (Bryant, 2001; Cohen, 2004; Cohen & Brawer, 2003; Kane & Rouse, 1999). City University of New York trustees also imposed a one year time limit for students to complete community college remediation (Oudenhoven, 2002). Other states have had conversations about taxpayers being “charged” by postsecondary institutions to complete the educational task elementary and secondary schools have already been paid to do (Saxon & Boylan, 2001). The estimated 60% of students who have just completed high school, and yet require remediation in college (Oudenhoven, 2002), are among the most troubling to policy makers. In Virginia, legislators threatened to bill the cost of remediation to the high schools who graduate under-prepared students with the cost of remediation (Dougherty, Reid, & Nienhusser, 2006).

While the conversations regarding the cost benefits of developmental education continued into the early part of the century, a new generation of literature emerged regarding developmental education’s efficacy. This era was ushered in by attention on community
colleges in general and developmental education in particular from researchers such as Ernest Pascarella, who had previously focused primarily on the cognitive affects of college on four-year institutions, and Thomas Bailey (whose contributions often contain a unique econometric perspective) and others working at the Center for Community College Research (established in 1996). Researchers began to understand and document the importance of a community college research agenda separate from four year institutions. Significant research from 2003 forward utilized large datasets from statewide collections or national databases such as NELS and NSSL and continued focus on the effects of developmental education on student outcomes, cost benefit analyses, and the role of institutional characteristics. Few large datasets have explored the effects of specific interventions or services. Rather these program or intervention-specific studies are limited scale, generally at one community college and including the effects of one intervention or service.

The work advanced by the Achieving the Dream (ATD) initiative has also helped to focus policy makers and practitioners on the usefulness and importance of using data to document ad evaluate the work of community colleges. The structure of the ATD datasets excludes all students except First Time in College (FTIC) students. By doing this, the investigators have a clear advantage in that there is a direct and appropriate comparison to the First-time, Full-time (FTFT) cohort data collected by the Department of Education through multiple programs such as Integrated Postsecondary Education Data Set (IPEDS), NSPS, and NELS for example. However, the matriculation patterns of community college students are well documented to establish a high incidence of “stop-outs” and lateral transfer (transfer from one community college to another). Therefore, FTIC or FTFT cohorts account
for few of the students enrolled at a given community college. According to IPEDS data from the National Center for Education Statistics (2008), in fall 2007, FTFT community college students accounted for fewer than 16% of all students enrolled in a public 2-year institution. The practice of discounting approximately 84% of the population of community college students raises legitimate questions about the generalizability of studies based on this work. Furthermore, ATD member colleges are selected because they have a disproportionately high number of minority students, raising additional concerns about the ability to draw conclusions about what might be relevant to all community colleges (Calcagno et al, 2008).

Like research regarding developmental education, decades of research related to student attrition have often focused on student characteristics (Cofer & Somers, 2001; Hoyt, 1999; E. T. Pascarella et al., 2003; Wilson, 2004). However, theoretical frameworks of retention, including Tinto’s Student Integration Model (1993) and Bean’s Student Attrition Model (1985), have suggested the significance of institutional characteristics, but have focused primarily on four year colleges and universities. In 2005, Bailey and Schuetz first called for an investigation of community college institutional characteristics that may affect student success. Both Schuetz and Bailey argue that since degree completion and transfer rates vary by institution, there are likely some institutional characteristics or practices that contribute to the variance in student outcomes. For example, a higher number of part-time faculty can discourage student/faculty interaction since part time faculty are typically not on campus as frequently and are less involved with student success initiatives (Schuetz, 2005). Using student data from the National Education Longitudinal Study of 1988 (NELS:88)
coupled with institutional data from the Integrated Postsecondary Education Data System (IPEDS), Bailey and fellow researchers were able to investigate whether institutional characteristics influenced student success by linking individual student information to individual community colleges, while controlling for student characteristics (Bailey et al, 2005). Specifically, their research considered institutional characteristics such as institutional size (measured by FTE); tuition levels, number of part-time faculty, divisional expenditures in administration, instruction and student services; level of financial aid; and emphasis on certificate or associate programs. For the purposes of their research, student success was defined by the completion of any degree (certificate, associate, or bachelors) and transfer rates. The study completed by Bailey and colleagues suggests that there is a negative relationship between institutional size and individual student success. For example, students at larger institutions are less likely to graduate and transfer. In addition, they found that student success is negatively related to a high number of part-time faculty and minority students.

While the research by Bailey and others reveals important information, the extent of institutional characteristics included in the analysis was extremely limited. Institutional characteristics such as testing and remedial placement policies and procedures, pedagogy, registration practices, and advising models were not included in the institutional characteristics that might influence student success. As the researchers concede, the institutional characteristics they investigated were limited to data available from the IPEDS dataset.
Titus (2004) collected similar data from the Beginning Postsecondary Student Survey (BPS:96/98) and the Integrated Postsecondary Education Data System (IPEDS) four year colleges. Controlling for student characteristics, he found that a higher expenditure per full-time equivalent student is positively associated with persistence while higher administrative expenditures was negatively associated with persistence (Titus, 2004). Titus also found that institutions with more selective admissions policies tend to have higher rates of persistence.

Since much of the empirical literature that studies instructional characteristics is limited to data that can be obtained from datasets from the National Center for Education Statistics (i.e. IPEDS or BPS), more work needs to be done that includes a wider range of institutional characteristics and that accounts for programs and practices widely that influence developmental education and are used by community colleges. In addition, many of these studies use single level regression techniques that are inappropriate statistical analyses. Hence, the purpose of this study is to use the findings from empirical literature regarding student and institution level variables to guide the inclusion of additional institutional characteristics to identify institutional predictors of students passing developmental courses. Figure 1 provides a conceptual framework for this study’s investigation of the interaction of student and institutional characteristics and the impact on a student passing a developmental course.
Empirical literature has used single level regression to study the effects of student characteristics on student outcomes or to study the effects of college characteristics on student outcomes. This study will use hierarchical logistic regression to study the effects of institutional characteristics, while controlling for student effects.

Summary

This chapter has presented theoretical and empirical literature related to community colleges, developmental education, and student outcome measures, all of which provide a conceptual framework for the research questions that guide this study. While researchers have studied the effects of student level variables and institution level variables on various student outcomes, this study uses a more rigorous methodological approach, hierarchical modeling to better understand the interaction effects among students and community colleges. Using this literature as a guide, chapter 3 outlines the research design that guided the methodology and analyses of the data for this study.
Chapter Three: Methodology

Overview

The purpose of this quantitative study was to conduct a state level analysis of the institutional and student characteristics that affect remedial student pass rates in developmental courses in North Carolina community colleges using multilevel modeling. Chapter three will give a description of the research design used for this study and the rationale for using this design. This chapter includes an explanation of how the variables were operationalized and data collected. A detailed discussion of the statistical procedures used to analyze the data concludes this chapter.

Research Design

Students have different characteristics or traits, and institutions often have different characteristics, as evidenced by the various programs available to students and differences in policies and practices that influence students passing a developmental course. As such, simple single level regression analysis is inadequate because it models all effects at a single level—either at the institutional or single level. Analysis at the student level assumes the same effects across institutions—all students within a college assume identical values on a variable. Ignoring the nonindependence of the data can lead to a standard error that is too small, inflating Type 1 error. When institution is the unit of analysis, aggregated student data can obscure relationships between variables, reducing statistical power. Since aggregating the data to the institution level and disaggregating to the student level leads to these statistical problems and does not allow for modeling the interaction between student level and institution level predictors, a multilevel model is appropriate. The advantages of
hierarchical modeling are that we can include two units of analysis, student and school, to
examine sources of variation in passing courses. Generally, level one variables are nested
within groups which are themselves characterized by level two variables. In this study,
descriptors pertaining to the students within developmental courses at a college are level one
variables. Descriptors associated with the community colleges are level two variables.
When combined, the two levels yield a model that considers the impact of both on the
probability of an individual student passing a course. Because the dependent variable of
whether a student passes a course is dichotomous, a nonlinear hierarchical logistic regression
is used. The level two institution model takes the general form:

\[
\log i t(\pi_i) \equiv \log \left(\frac{\pi_i}{1 - \pi_i}\right) = \beta_{0_{-j}} + \beta_{1_{-j}} x_{1_{-ij}} + \beta_{2_{-j}} x_{2_{-ij}} + \ldots + \beta_{p_{-j}} x_{p_{-ij}} + \epsilon_{ij}
\]

where \(\pi_{ij}\) represents the dependent variable of the probability of passing for the \(i\)th student
within college \(j\). (The subscripts \(i\) and \(j\) represent individuals and colleges respectively.)
This hierarchical logistic regression contains an intercept, \(\beta_{0_{-j}}\) which is allowed to vary
across \(j\) colleges. The slopes of the level one variables, represented by \(\beta_{p_{-j}}\), are also
allowed to vary across institutions. For this study, the level one predictor variables were
student characteristics. \(\epsilon_{ij}\) is the error term and represents deviations from the mean passing
for student \(i\) in college \(j\).
The level two institution model takes the general form:

\[ \beta_{0,j} = \gamma_{0,0} + \gamma_{0,1}u_{1,j} + \ldots + \gamma_{0,q}u_{q,j} + \tau_{0j} \]
\[ \beta_{1,j} = \gamma_{1,0} + \gamma_{1,1}u_{1,j} + \ldots + \gamma_{1,q}u_{q,j} + \tau_{1j} \]
\[ \beta_{2,j} = \gamma_{2,0} + \gamma_{2,1}u_{1,j} + \ldots + \gamma_{2,q}u_{q,j} + \tau_{2j} \]
\[ \vdots \]
\[ \beta_{p,j} = \gamma_{p,0} + \gamma_{1,p}u_{1,j} + \ldots + \gamma_{p,q}u_{q,j} + \tau_{pj} \]

There are \( q \) possible level two predictors (indicated by the variables \( u_1 \) through \( u_q \) and \( \gamma \) is the coefficient which represents the intercepts or slopes. \( \gamma_{0,0} \) through \( \gamma_{p,0} \) represent intercepts and \( \gamma_{0,1} \) through \( \gamma_{q,p} \) are slopes and both are commonly referred to as “fixed effects.” The \( \beta \) values are all referred to a “random effects” (Raudenbush and Bryk 2002). Every variable subscripted with a \( j \) is assumed to have a different value for each institution. Each college can have a different average pass rate (or intercept), and a different impact (slope) of student level variables such as race or sex. Since intercepts and slopes vary by college, a level two model can explain why they vary. Hypotheses as to why intercepts and slopes vary guide the inclusion of institution level independent variables (Titus 2004). The purpose of the study is to examine which student and institution factors are related to an individual student passing a developmental course.

To justify the use of a multilevel model, it is helpful to look at the variance in the dependent variable at the student level and at the institution level. Partitioning the variance into two components allows us to determine the extent to which the dependent variable of passing varies across community colleges (Raudenbush & Bryk 2002). To determine the
amount of variance across institutions, the intraclass correlation coefficient or ICC is calculated (Raudenbush and Bryk). Because the dependent variable was a dichotomous variable, the variance was heteroscedastic at the student level, and the ICC was not a useful way to justify the use of a multilevel model (Titus 2004).

Assumptions

Research using hierarchical linear modeling is based on five assumptions (Hox, 1995): independent observations; adequate sample size; random grouping; normal distribution and random error variance. First, independent observations are assumed only at level two, making this model useful when data are nested within classes, institutions, or communities. Level two predictors are independent in this study; thus, this assumption is not violated. Second, adequate sample size is required. Kreft (1996) found there was adequate statistical power with 30 groups of 30 observations each; 60 groups with 25 observations each; 150 groups with 5 observations each. The number of groups has more effect on statistical power than the number of observations, though both are important. Power for individual-level estimates depends on the number of individuals observed, and power for second level estimates depends on the number of groups. This study used a sample size of 58 institutions (groups) with more than 35 observations (student level data) in each group, thus it has adequate statistical power. Sample size also impacts the number of institution level variables that may be included. Since there were at least 10 institutions per institution-level predictor in the model as Raudenbush & Bryk (2002) suggest, there are not too many predictors given the sample size. In addition, to build the most parsimonious hierarchical model, only institution level variables that were significant at an alpha of p < .05 using a
simple regression analyses were included in the final hierarchical models. A third assumption underlying hierarchical modeling is that institutions or group level units of analysis are assumed to be a random sample from a population. This study uses all 58 community colleges in the state of North Carolina, thus it is a nonrandom sample. However, significance testing with nonrandom data is common due to its usefulness as a decision criteria. The fourth assumption is normal distribution. Descriptive statistics were used to determine that continuous and categorical data were normally distributed (Hox 1995). However, many of the variables in this study were dichotomous, so assumptions of normality are not applicable. Fifth, and last, is the assumption of random error variance. While slope and intercept are expected to vary across groups, regression error terms are not.  

**Research Questions**

This study uses multilevel modeling to analyze student- and institution-level data to address the following research questions:

1. What student characteristics are associated with a student passing a developmental course in mathematics, English, or reading?

2. What institutional variables are associated with student pass rates in developmental courses?

3. While controlling for student characteristics, what institutional characteristics, policies, and practices are associated with a student’s successful completion of developmental coursework in math, English, or reading?
**Data Collection**

Data for this analysis were collected from two primary sources: the North Carolina Community College System office database (DataWarehouse) and from a survey completed by the chief academic officers at each of the 58 community colleges in North Carolina. See Appendix B for the survey instrument.

**Student level variables**

The student level variables were taken from the NCCCS office DataWarehouse and included all degree-seeking students enrolled in a developmental mathematics, English, or reading course in fall 2008. North Carolina Community College System office staff provided the student level data on the relevant variables to the researcher after removing information that identified students, thereby ensuring compliance with the Federal Educational Right to Privacy Act (FERPA).

**Institution level variables**

Compositional and institutional variables were obtained from the NCCCS office DataWarehouse database; organizational variables were obtained from a survey administered to the chief academic officers of each of the 58 North Carolina community colleges with the exception of the course method of instruction (traditional or distance learning) which was taken from the DataWarehouse. A survey collected data regarding what institutional academic and support services were available at each community college. Additional data were collected regarding policies and practices related to advising, tutor training, and financial aid. To administer the survey, a list of chief academic officers and their email addresses was obtained from NCCCS. The chief academic officers at each of the 58 North
Carolina community colleges were first invited to complete the survey through an email sent to their office email address on September 15, 2009. Chief academic officers were asked to complete the survey through an online program called Zoomerang. The survey was available from September 15, 2009 to October 10, 2009. A second email request was sent to the chief academic officers who had not completed the survey by September 30, 2009. After the second request, 100% of the chief academic officers completed the survey. While the survey response was 100%, it is important to note that all respondents did not answer every question. As a result, there was some missing data in the survey analysis. Ultimately, only those survey items for which more than 56 colleges provided a response were included in the analysis. Appendix B includes a copy of each email sent as well as a copy of the survey.

Additional institution level data related to size by FTE and unduplicated headcount, the percent of minority students at the institution, the percent of Pell recipients at the institution, and the percent of transitional students at the institution were collected from the system office DataWarehouse.

**Description of Sample Data**

The dependent variable in the two level hierarchical logistic regression models was the probability of a student passing a developmental course in mathematics, English, or reading. For the institution level linear regressions, the dependent variable was the aggregate pass rate for an institution. Table 3.1 define the variable, identifies the data source, and explains how the variable was operationalized.
Regard the dichotomous dependent variable, it is important to note that while each community college is permitted to devise its own grading scheme, the DataWarehouse creates a field that standardizes each of the college’s grades into a system-wide standard grading scheme. This system-wide grading standard is used to analyze data for the NC Community College Performance Standards which include pass rates in developmental courses. The standard grading scheme was used for this analysis to ensure like comparisons of grades across colleges. A student was considered “passing” if he or she completed the course with a grade of “C” or better, which is also consistent with the state-wide performance measures mandated by the State Board of Community Colleges.

The independent variables include both individual student characteristics and institutional variables. Each student and institution level variable was selected because earlier empirical research has either identified the variable as having an effect on student outcomes in postsecondary education or is promoted as encouraging student engagement, which is believed to be positively associated with student outcomes such as pass rates.

**Student level variables**

Individual student level variables include student demographic characteristics such as age, sex, race or ethnicity, number of developmental courses taken, whether the student
enrolled in a traditional or online course, level of developmental course taken, and socioeconomic status as indicated by whether the student received a federal Pell grant. Each variable is defined and operationalized in Table 3.2.

Table 3.2.
Student Level Independent Variables

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Definition</th>
<th>Operationalized</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>Student reported sex.</td>
<td>Binary variable</td>
<td>Student record dataset NCCCS DataWarehouse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 = male 1 = female</td>
<td></td>
</tr>
<tr>
<td>Low income</td>
<td>Students who receive Pell have household incomes at or below 150% of the federal poverty limit. Therefore, a student receiving Pell was used as a proxy for low-income status.</td>
<td>Binary variable</td>
<td>Student record dataset NCCCS DataWarehouse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 = Pell recipient 1 = not Pell recipient</td>
<td></td>
</tr>
<tr>
<td>Race/Ethnicity</td>
<td>Student reported race/ethnicity.</td>
<td>Categorical variable</td>
<td>Student record dataset NCCCS DataWarehouse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0= White 1= Black 2= Hispanic 3= American Indian 4= Asian/Pacific Islander 5= Other/Unknown/Multiple Races</td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>Student’s age in fall 2008; taken from date of birth reported by student</td>
<td>Continuous variable</td>
<td>Student record dataset NCCCS DataWarehouse</td>
</tr>
<tr>
<td>Course Number (i.e. 070, 080, 090)</td>
<td>Course numbers within disciplines indicate the level of the course. Lower numbers indicate lower levels.</td>
<td>Categorical variable</td>
<td>Student record dataset NCCCS DataWarehouse</td>
</tr>
<tr>
<td>Method of Instruction</td>
<td>Traditional courses are taught face to face and may employ a variety of teaching strategies including using computer aided instruction. Distance learning classes may be hybrid or fully online.</td>
<td>Binary variable</td>
<td>Student record dataset NCCCS DataWarehouse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0 = traditional course 1 = online course</td>
<td></td>
</tr>
<tr>
<td>Number of developmental courses</td>
<td>Number of different developmental courses taken by the student in fall 2008. Students in three developmental courses took a class in mathematics, English, and reading.</td>
<td>Categorical variable</td>
<td>Student record dataset NCCCS DataWarehouse</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 = 1 course 2 = 2 courses 3 = 3 courses</td>
<td></td>
</tr>
</tbody>
</table>
Student level data were obtained from the North Carolina Community College System office database (DataWarehouse). This database serves as a repository for all student records from each of the 58 community colleges. The data is organized by term and by academic year and is updated after each semester when each college submits the Curriculum Registration, Progress, and Financial Aid Report (CRPFAR). The data submitted in the CRPFAR is the college’s official record of each individual student’s demographic characteristics, enrollment information, and course record information, including data such as grades, credit hour completion, and GPA.

For the purposes of this study, student record data were collected for all students who were enrolled in a developmental course in mathematics, English or reading during the fall semester of 2008. Section 23 of the NCCCS Curriculum Procedures Reference Manual mandates that the numbers 050-099 shall be assigned to developmental courses; therefore, developmental courses were identified by selecting course prefixes in mathematics, English or reading with a course number less than 100. For example, any English course prefix ENG with a course number less than 100 is considered a developmental course, so the data for any student enrolled in ENG 095, ENG 090, ENG 085, ENG 080, ENG 075, ENG 070, and ENG 060 was collected in this study.

The student record data collected for this analysis included demographic characteristics (age, sex, and race/ethnicity), course records, and financial aid records. Course records included the course discipline (mathematics, English or reading); the course number, which indicates the level of developmental course; the course grade, including drop or withdrawal status; and the method of instruction (traditional or Internet/hybrid). Financial
aid records included each type of financial aid awarded (federal, state, or institutional). In
the analysis, receipt of a Pell grant was used as an indication of socioeconomic status since
students who received Pell grants have household incomes at or below 150% of the federal
poverty level.

**Institution level variables**

The institution level variables are organized as compositional, institutional, or
organizational in tables 3.3, 3.4, and 3.5 respectively. Each table includes a definition of the
variable, how it was operationalized and the data source. Data was collected for each of the
58 community colleges in North Carolina. The colleges are governed by the State Board of
Community Colleges through the NCCCS office, so many of the compositional and
institutional variables such as institutional size, percent minority, percent receiving Pell (low-
income), etc., use uniform reporting measures or standards.

The institutional variables included in this study were selected from three different
categories used in other research: compositional, institutional, and organizational (Titus
2004; Bailey 2005; Schuetz & Barr 09; Pascarella & Terenzini 2005). Compositional
characteristics include variables that reflect the student body, including the percent of
minority students, the percent of low income students (defined as the percent receiving Pell
grants), and the percent of transitional or non-degree seeking students enrolled. Table 3.3
describes each compositional variable, including how it was operationalized and the source.
Table 3.3.

Institution Level Variables: Compositional

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Definition</th>
<th>Operationalized</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percent of white students</td>
<td>Percent of the 07-08 total unduplicated headcount who were reported as white.</td>
<td>Continuous variable; mean for institution</td>
<td>NCCCS DataWarehouse</td>
</tr>
<tr>
<td>Percent of low income students</td>
<td>Percent of the 07-08 total unduplicated headcount who were reported as receiving a federal Pell grant.</td>
<td>Continuous variable; mean for institution</td>
<td>NCCCS DataWarehouse</td>
</tr>
<tr>
<td>Percent of transitional students</td>
<td>Percent of the 07-08 total unduplicated headcount who were non-degree seeking.</td>
<td>Continuous variable; mean for institution</td>
<td>NCCCS DataWarehouse</td>
</tr>
<tr>
<td>Percent of minority students enrolled in developmental courses.</td>
<td>Percent of the students in the fall 2008 cohort who were enrolled in a developmental course and reported as a minority.</td>
<td>Continuous variable; mean for institution</td>
<td>Student record dataset NCCCS DataWarehouse</td>
</tr>
</tbody>
</table>

Institutional variables include institutional size as determined by unduplicated headcount and full-time equivalency (FTE) enrollment. Since these variables are similar and may measure some of the same constructs, none of these variables were included in the same analyses, but were analyzed individually. Institutional variables often include the urbanicity and selectivity of an institution. Since few of the community colleges in North Carolina are located in urban areas, this variable was not included in the study. A measure of selectivity would have been inappropriate given the open admissions policies of the NCCCS. Information about institutional variables can be found in Table 3.4.
Table 3.4.

Institution Level Variables: Institutional

<table>
<thead>
<tr>
<th>Independent Variable</th>
<th>Definition</th>
<th>Operationalized</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Institutional Size:</td>
<td>The unduplicated number of students taking at least one course in the academic year 2007-2008.</td>
<td>Continuous variable</td>
<td>NCCCS DataWarehouse</td>
</tr>
<tr>
<td>Unduplicated Headcount</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Institutional Size:</td>
<td>The full-time equivalency reflects how many students would be on campus if each student was enrolled with 12 or more credit hours. The formula is used to determine funding to the colleges for the number of students served.</td>
<td>Continuous variable</td>
<td>NCCCS DataWarehouse</td>
</tr>
<tr>
<td>FTE</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Size</td>
<td>Includes students enrolled in curriculum and continuing education courses.</td>
<td>Continuous variable</td>
<td>NCCCS DataWarehouse</td>
</tr>
</tbody>
</table>

Organizational variables include the student support services and academic intervention offered by an individual community college. This study was most interested in the effect of organizational variables since colleges are able to control local policy and practice. Table 3.5 gives information regarding the organizational variables included in this analysis.
Table 3.5.
Institution level variables: Organizational

<table>
<thead>
<tr>
<th>Variable</th>
<th>Definition</th>
<th>Operationalized</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Centralized developmental program</td>
<td>Developmental courses are coordinated by one department within the college unlike decentralized programs that embed courses in departments.</td>
<td>Binary variable: 1 = centralized 0 = not centralized</td>
<td>Survey of chief academic officers</td>
</tr>
<tr>
<td>Learning Communities</td>
<td>Used with developmental courses, learning communities link two or more courses together by having faculty collaborate to integrate the curriculum, often thematically.</td>
<td>Binary variable: 1 = offers learning communities 0 = does not offer</td>
<td>Survey of chief academic officers</td>
</tr>
<tr>
<td>Method of Instruction (traditional or distance learning)</td>
<td>Traditional courses are taught face to face. Distance learning classes may be hybrid or online. The institution level variable was the percent of students taking developmental courses online.</td>
<td>Continuous variable; mean for institution</td>
<td>Student record dataset NCCCS DataWarehouse</td>
</tr>
<tr>
<td>Tutoring</td>
<td>Providing academic help outside of the classroom, usually in a one-to-one setting.</td>
<td>Binary variable 0 = no tutoring 1 = tutoring</td>
<td>Survey of chief academic officers</td>
</tr>
<tr>
<td>Tutor training</td>
<td>This variable considers whether the college offers five or more hours of training annually.</td>
<td>Binary variable 0 = no training 1 = has training</td>
<td>Survey of chief academic officers</td>
</tr>
<tr>
<td>Skills labs in Math</td>
<td>Labs are focused on math skills and may provide computer software to improve skills. Some labs may employ staff to help students strengthen skills.</td>
<td>Binary variable 0 = no math lab 1 = has math lab</td>
<td>Survey of chief academic officers</td>
</tr>
<tr>
<td>Skills labs in English</td>
<td>Labs are focused on English skills and may provide computer software to help students improve skills. Some labs may employ staff to work with students.</td>
<td>Binary variable 0 = no English lab 1 = has English lab</td>
<td>Survey of chief academic officers</td>
</tr>
<tr>
<td>Supplemental Instruction (SI)</td>
<td>Most models employ an “expert learner” who attends the course with students and then holds group study sessions outside of class time.</td>
<td>Binary variable 0 = no SI 1 = has SI</td>
<td>Survey of chief academic officers</td>
</tr>
<tr>
<td>Special advising students</td>
<td>Special advising models for developmental students often assign students who need two or more developmental courses to developmental faculty.</td>
<td>Binary variable 0 = no program 1 = has program</td>
<td>Survey of chief academic officers</td>
</tr>
<tr>
<td>Early Alert System</td>
<td>Early in the term, faculty alert support staff about students who need services. Staff members contact students to assist and monitor progress.</td>
<td>Binary variable 0 = no system 1 = has system</td>
<td>Survey of chief academic officers</td>
</tr>
<tr>
<td>Financial aid to students</td>
<td>Financial aid may be awarded from federal, state, or institutional funds.</td>
<td>Binary variable 0 = No 1 = Yes</td>
<td>Survey of chief academic officers</td>
</tr>
<tr>
<td>Childcare facilities</td>
<td>Campus-based childcare facilities allow students to attend class by providing childcare.</td>
<td>Binary variable 0 = no facility 1 = has facility</td>
<td>Survey of chief academic officers</td>
</tr>
<tr>
<td>Funds for financial emergencies</td>
<td>Some campuses use institutional funds from donors or development offices to aid students with financial emergencies.</td>
<td>Binary variable 0 = Does not have 1 = Does have funds</td>
<td>Survey of chief academic officers</td>
</tr>
</tbody>
</table>
Data Analysis

All data analysis was done using SAS version 9.2. This analysis began with an exploration of the raw data. There was no other missing data for any of the student variables. Ten students who were enrolled at more than one college during the fall 2008 were removed from the dataset. In addition, some colleges offer “fast-tracking” programs that allow students to complete two developmental courses in the same term. Thus, students were enrolled in two levels of courses within the same discipline. Having students enrolled in more than one level of courses within the same term created a concern about how to include them in the dataset. Thus, these students were removed from the dataset since the effects of “fast-tracking” programs were not part of this research. Removing these students did not exclude any other colleges from the analyses. The original dataset also included a field to determine whether the student was enrolled full-time or part-time. However, since students do not receive college credit for remedial courses when the data was retrieved from the database, each student was erroneously labeled as part-time. Therefore, the student characteristic of being enrolled full time or part-time had to be eliminated from the study.

While the student data was first analyzed in the aggregate, there is literature to suggest that students enrolled in developmental mathematics may have different characteristics than those enrolled in developmental English and reading (Perin, Adelman 2004). In addition, there is some evidence to suggest that students in the lowest levels of developmental courses are different from students in the higher levels, particularly with regards to mathematics (McCabe 2000). Thus, the student level data was disaggregated by the three disciplines and the descriptive analysis was repeated for each subset of data. In
addition, within each subset of data for each discipline, the levels of courses were examined. For mathematics, six different levels of courses were offered. However, not all levels of courses were offered at each community college. One course, MAT 075 was offered at only one institution. Additionally, a review of the Combined Course Library, finds that students who are seeking an associate in applied science degree or an associate in arts degree are not usually required to complete a developmental math course beyond MAT 070. Therefore, a student enrolled in MAT 080 or 090 would likely seek a degree in a specialized area. In keeping with a focus on developmental students with low academic skills, the researcher decided to use a data subset for mathematics that included only the lowest three levels of courses. For English, most colleges offered and most students enroll in the highest two levels. The lowest level English course description indicates that it is most appropriate for nonnative English speaking students. In addition, the course descriptions from the Combined Course Library, explain that ENG 080 and 085 are the same level of English courses. The 085 course combines developmental English and reading and is used at some institutions that choose not to offer a separate reading course. ENG 090 and ENG 095 are structured similarly. As a result, ENG 080 and 085 were combined as one level of courses and ENG 090 and 095 were combined as a second level of course. These two levels were used in the data subset for English. The data subset for reading was the smallest dataset and included two levels of reading courses. With each data subset defined, descriptive statistics were used to determine measures of central tendency and variability. During this exploratory analysis, the data was checked for missing values and outliers. Because the data was categorical, the
shape of the distribution was considered, but it was not normal. For this study, having the
descriptive statistics for each dataset was useful to note differences among the groups.

A similar process was used to analyze the raw data for the institution level variables
taken from the DataWarehouse. There were no missing data for any of the colleges.
Descriptive statistics gave a snapshot of the differences among the 58 North Carolina
Community Colleges. In addition to the institutional variables derived from the NCCCS,
institutional variables were also based on the survey administered to the chief academic
officers. Last, mean institution levels for some variables, such as percent minority in
developmental courses, were calculated directly from the student database.

After generating the descriptive statistics for the variables obtained from the NCCCS
DataWarehouse, the survey data was analyzed. Because the survey was designed to collect
binary responses, a principal component analysis, which is a form of factor analysis, was
used to determine which responses could be combined into a single variable. Principal
component analysis was appropriate not only because of the dichotomous responses, but also
because the researcher, based on a thorough review of the literature, had an intuitive
understanding of which responses were most likely related. Reducing the survey variables
by combining correlated variables is helpful in order to avoid an unwieldy number of
institution level variables. However, none of the results of the principal component analysis
was used in any of the institution level regressions or correlations, nor were they included in
the final hierarchical logistic regression.

Instead of using the results of the principal component analysis, two indices were
developed to group responses into categories of academic support and student support.
Using evidence from the literature as a guide, two indices were developed to group responses into institutional levels of academic support and student support. Seven survey responses were identified as indicators of academic support and seven additional responses were identified as indicators of student support. Academic support included variables that were thought to assist students with academic needs such as tutoring, learning labs, and supplemental instruction. A positive response indicated the presence of a program or policy thought to have an effect on student outcomes. Colleges with 0-2 positive responses were ranked as having low levels of academic support; colleges with 3-4 positive responses were ranked as medium; and colleges with 5-7 positive responses were ranked as having high levels of academic support. An index of student support was created using the same methodology with the seven responses determined to be indications of student support. Student support included variables thought to help students with and nonacademic needs such as childcare and financial aid.

Exploratory regression analyses were necessary both to answer the research question, and to select the most appropriate variables for the final hierarchical models while avoiding complications of collinearity. The exploratory analyses included regressions and correlations at both the student and institution level. The first logistic regression included all students regardless of the developmental course(s) each was taking. Additional logistic regressions were performed by discipline and by level for each course. Table 3.6 includes the logistic regressions that were used to analyze student level data.
For this study, five sets of multilevel analyses were used to analyze differences in the three similar, but subsets of the original student dataset. The datasets disaggregated the student data by discipline to analyze differences among students enrolled in mathematics, English, and reading and by the levels of courses selected within each discipline. For each data subset and the institution datasets, descriptive statistics were used to learn more about each variable in the sample. Descriptive statistics were used to find the appropriate measures of central tendency, variability, and the shape of the distribution for each variable (where appropriate) and to determine whether the assumption of normality was met for student level continuous and categorical variables.

A multivariate linear regression was used to determine whether any institution level variables were a significant predictor of an institution’s pass rate in each developmental course. This second regression was also repeated for each data subset using the same institution level variables as independent variables and the pass rate in the discipline as the dependent variable. In addition, a stepwise selection procedure was used to refine the model
to only include significant variables. Stepwise regression involves reanalyzing the regression several times, adding or deleting variables from the equation in order to obtain a final model containing only variables found to be significant at an alpha of 0.05. In a model with multiple independent variables, the variance explained by some variables may change when other variables are entered into the model. Some variables may lose their predictive validity with the addition of other variables. Stepwise regression is used to determine which variables have the strongest predictive validity, and, as a result, indicates which variables should be included in the model and which should be removed. This process was performed automatically by SAS. Additional regressions were used to examine interaction effects to determine whether there were significant interactions among variables which should be included in the hierarchical model. Again, to examine interaction effects this regression was repeated for each discipline. Pearson correlations were also included so that variables with a correlation coefficient higher than .60 (absolute value) could be eliminated from the model to avoid issues with multicollinearity.

Finally, using the variables identified as significant during the model building analysis, three hierarchical logistic regression models were built to determine which model was the best fit for this analysis. Each model used the dependent variable of a student’s probability of passing developmental mathematics.

In each hierarchical logistic regression for the initial run, the intercepts and slopes of level one variables were assumed to have random effects that could be modeled as linear functions of the two significant level two variables that had emerged as significant from the exploratory linear regressions. For math these included percent white, percent taking math
via distance learning, whether a school offered tutoring, and whether it had a math lab.

These level two variables were not included simultaneously, as this would have given models that were overly complex. Instead, the institutional variables were fed into the hierarchical model two at a time, with the effects noted for each combination of level two variables.

The level two variables included only those that were found to be significant at an alpha of $p < 0.05$ during the exploratory logistic regressions. The equations with six level one variables and two level two variables are modeled:

$$ \log \pi_{ij} = \log \left( \frac{\pi_{ij}}{1 - \pi_{ij}} \right) = \beta_{0_{ij}} + \beta_{1_{ij}}x_{1_{ij}} + \beta_{2_{ij}}x_{2_{ij}} + \beta_{3_{ij}}x_{3_{ij}} + \beta_{4_{ij}}x_{4_{ij}} + \beta_{5_{ij}}x_{5_{ij}} + \beta_{6_{ij}}x_{6_{ij}} + \epsilon_{ij} $$

$$ \beta_{0_{ij}} = \gamma_{0,0} + \gamma_{0,1}u_{1_{ij}} + \gamma_{0,2}u_{2_{ij}} + \tau_{0_{ij}} $$
$$ \beta_{1_{ij}} = \gamma_{1,0} + \gamma_{1,1}u_{1_{ij}} + \gamma_{1,2}u_{2_{ij}} + \tau_{1_{ij}} $$
$$ \beta_{2_{ij}} = \gamma_{2,0} + \gamma_{2,1}u_{1_{ij}} + \gamma_{2,2}u_{2_{ij}} + \tau_{2_{ij}} $$
$$ \beta_{3_{ij}} = \gamma_{3,0} + \gamma_{3,1}u_{1_{ij}} + \gamma_{3,2}u_{2_{ij}} + \tau_{3_{ij}} $$
$$ \beta_{4_{ij}} = \gamma_{4,0} + \gamma_{4,1}u_{1_{ij}} + \gamma_{4,2}u_{2_{ij}} + \tau_{4_{ij}} $$
$$ \beta_{5_{ij}} = \gamma_{5,0} + \gamma_{5,1}u_{1_{ij}} + \gamma_{5,2}u_{2_{ij}} + \tau_{5_{ij}} $$
$$ \beta_{6_{ij}} = \gamma_{6,0} + \gamma_{6,1}u_{1_{ij}} + \gamma_{6,2}u_{2_{ij}} + \tau_{6_{ij}} $$

Where $\pi_{ij}$ = probability that the $i$th student in institution $j$ passes the developmental math class. Additionally, the specific level one variables were $x_1 = \text{math course number (level)}$, $x_2 = \text{sex}$, $x_3 = \text{race}$, $x_4 = \text{Pell (measure of SES)}$, $x_5 = \text{method of instruction in math course}$, $x_6 = \text{number of developmental courses taken}$. The level two variables took on the values too such as $u_1 = \text{percent White student population}$, and $u_2 = \text{mean number of student taking developmental math through distance education}$ or $u_1 = \text{tutoring availability}$ and $u_2 = \text{math lab availability}$. Multiple combinations of level two variables were tried, but there were never more than two used in the complete model at one time or the model became over-
parameterized, resulting in both processing and interpretation problems. When the equations for the random intercepts and random slopes are substituted into the first equation, the overall equation that the SAS procedure modeled is:

$$\log \frac{\pi_t}{1 - \pi_t} = \gamma_{0,0} + \tau_{0j} + (\tau_{1j} + \gamma_{1,0})x_{1_{-j}} + (\tau_{2j} + \gamma_{2,0})x_{2_{-j}} + (\tau_{3j} + \gamma_{3,0})x_{3_{-j}}$$

$$+ (\tau_{4j} + \gamma_{4,0})x_{4_{-j}} + (\tau_{5j} + \gamma_{5,0})x_{5_{-j}} + (\tau_{6j} + \gamma_{6,0})x_{6_{-j}} + \gamma_{0,1}u_{1_{-j}} + \gamma_{0,2}u_{2_{-j}}$$

$$+ \gamma_{1,1}x_{1_{-j}}u_{1_{-j}} + \gamma_{1,2}x_{1_{-j}}u_{2_{-j}} + \gamma_{2,1}x_{2_{-j}}u_{1_{-j}} + \gamma_{2,2}x_{2_{-j}}u_{2_{-j}} + \gamma_{3,1}x_{3_{-j}}u_{1_{-j}} + \gamma_{3,2}x_{3_{-j}}u_{2_{-j}}$$

$$+ \gamma_{4,1}x_{4_{-j}}u_{1_{-j}} + \gamma_{4,2}x_{4_{-j}}u_{2_{-j}} + \gamma_{5,1}x_{5_{-j}}u_{1_{-j}} + \gamma_{5,2}x_{5_{-j}}u_{2_{-j}} + \gamma_{6,1}x_{6_{-j}}u_{1_{-j}} + \gamma_{6,2}x_{6_{-j}}u_{2_{-j}}$$

$$+ \epsilon_{ij}$$

The second hierarchical model assumed only the intercept to be a random variable that could be modeled as a function of the same two institution level variables used in the first model: the percent of White students at an institution and the percent of students taking math through distance learning for example. The student level variables remained the same as those used in the first model, which included only the student variables that were statistically significant at alpha p < .05 using simple logistic regressions. This equation simplified to:

$$\log \frac{\pi_t}{1 - \pi_t} = \beta_{0,0} + \beta_{1,0}x_{1_{-j}} + \beta_{2,0}x_{2_{-j}} + \beta_{3,0}x_{3_{-j}} + \beta_{4,0}x_{4_{-j}} + \beta_{5,0}x_{5_{-j}} + \beta_{6,0}x_{6_{-j}} + \epsilon_{ij}$$

$$\beta_{0,0} = \gamma_{0,0} + \gamma_{0,1}u_{1_{-j}} + \gamma_{0,2}u_{2_{-j}} + \tau_{0j}$$

Which combine to give the hierarchical equation that was modeled as:

$$\log \frac{\pi_t}{1 - \pi_t} = \gamma_{0,0} + \tau_{0j} + (\tau_{1j} + \gamma_{1,0})x_{1_{-j}} + (\tau_{2j} + \gamma_{2,0})x_{2_{-j}} + (\tau_{3j} + \gamma_{3,0})x_{3_{-j}}$$

$$+ (\tau_{4j} + \gamma_{4,0})x_{4_{-j}} + (\tau_{5j} + \gamma_{5,0})x_{5_{-j}} + (\tau_{6j} + \gamma_{6,0})x_{6_{-j}} + \gamma_{0,1}u_{1_{-j}} + \gamma_{0,2}u_{2_{-j}}$$

$$+ \epsilon_{ij}$$
The third hierarchical model considered did not include any institution level variables, but assumed a random intercept independent of any level two variables. The same student level variables used in the two previous hierarchical modes were also used in the third model:

$$\log \frac{\pi_i}{1 - \pi_i} = \beta_0 + \beta_1 x_{1,i} + \beta_2 x_{2,i} + \beta_3 x_{3,i} + \beta_4 x_{4,i} + \beta_5 x_{5,i} + \beta_6 x_{6,i} + \epsilon_{ij}$$

In the event that all of these models proved to be significant, the -2 log-likelihood fit statistics in conjunction with degrees of freedom were compared to determine if the additional complexity is statistically justified in determining the best model for understanding student performance. In this study, the third hierarchical model was used for the final hierarchical analyses for mathematics, English and reading.

**Summary**

Chapter 3 has explained the research design, described the variables selected, and detailed the methods used to collect and analyze the raw data used in this study. Specifically, this study was interested in whether institutional variables can predict whether a student passes a developmental course and whether any institution level predictors interact with student-level predictors. All student record data and some institution level data were collected from the NCCCS office database, the DataWarehouse. Additional institutional variables were collected through a survey administered to the chief academic officers of each of the 58 North Carolina community colleges. Survey data were analyzed three ways: 1) using principal component analysis to attempt to combine the responses into a few key variables, 2) via the combination of survey questions into index variables to assign low,
medium, or high levels of academic and student support to each college, and 3) using each survey item as a separate independent variable. Data were analyzed in SAS using appropriate descriptive statistics, and inferential statistics, including hierarchical logistic regression models. The model building analyses included using logistic regression models to consider which student level variables were significantly associated with individual students passing a developmental course and several multivariable linear regression models to evaluate which level two variables were significantly correlated with an institution’s mean pass rate. These descriptive and inferential statistics were used to help build the most parsimonious hierarchical logistic regression models to investigate which institutional characteristics and student level characteristics predict the probability of a student passing a developmental course in one of the 58 North Carolina community colleges. Chapter four presents the empirical results from these analyses.
Chapter Four: Results

Overview

This chapter presents the quantitative findings for this study. The results are organized into three sections. The first section provides the details of the data screening and descriptive statistics. In addition, the first section discusses the results of the model building analyses, including the use of inferential statistics such as Pearson correlations, ANOVA, and simple linear and logistic regression models. The second section explains the three different hierarchical models that were used to determine which model provided the best fit based on -2 log likelihood statistics and AIC and presents the result of each. The third and final section presents the results of the final three hierarchical models by discipline.

Data Analyses

The data analyses began with an examination of the student level data. After looking at the complete dataset of 44,076 student records, the data was divided into subsets of mathematics, English, and reading so that pass rates in each discipline could be studied. A description of the original dataset is shown in Table 4.1. Ten students were removed from the dataset because they were enrolled at two different community colleges simultaneously. An early review of the raw data indicated that several students were enrolled in more than one level of courses within the same discipline during the fall semester. Known as “fast-tracking”, some colleges choose to offer one developmental course during the first half of the semester and the second developmental course during the second half of the semester so that students can complete their developmental courses more quickly. Since this study sought to use passing as the dependent variable, “fast-tracking” students were problematic. Including
each student’s course, passing, and their student characteristics twice was not an acceptable solution; neither was including only the first or second course taken within the semester. Since the “fast-track” students accounted for less than 1% of the student dataset, these students were removed from the analyses for each discipline. Exploring the raw data also revealed that a field that indicated a student’s course load as full-time or part-time was erroneously reporting all students as part-time. This column of data was removed from the database.

Data analyses also included logistic regressions with student level variables and linear regressions with institution level variables to determine which predictor variables should be included in the final hierarchical models. The section that follows provides an overview of the descriptive analysis for each dataset by discipline as well as an explanation of the inferential statistics for each discipline beginning with the student level variables and concluding with institution level variables, again disaggregated by discipline. The survey analysis is included as part of the exploratory analysis of institution level variables. Tables have been provided to summarize results and to simplify comparisons among the discipline specific datasets.

Initial descriptive statistics examined the entire student database of 44,066 unique student records for all students enrolled in a developmental mathematics, English, or reading course in the fall 2008 semester at one of 58 North Carolina community colleges. Of these students, 35,603 were enrolled in a developmental mathematics class; 16,269 were enrolled in a developmental English class, and 11,663 were enrolled in a developmental reading class. Clearly, most students were enrolled in a developmental math class and the fewest number of
students were enrolled in a developmental reading class. Among these students, 66.40% enrolled in only one developmental course, in either discipline: mathematics, English, or reading. Roughly one-quarter, or 23% of the students enrolled in two or more developmental courses, and 10.60% enrolled in a developmental course in all three disciplines.

After exploring the entire student dataset by each independent variable, the dataset was divided into three subsets by discipline. The discipline specific datasets were further pared into smaller subsets by examining the level of courses offered by each college and the enrollment patterns among students. Table 4.1 provides an overview comparison of the four datasets by sex, percent minority, percent low-income, percent taking courses through distance learning (DL), percent taking more than one developmental course during the fall term, percent passing, percent persisting to spring, and percent persisting to fall 2008. This table is only meant to compare differences among the datasets. No tests of significance were conducted to see if the means were significantly different.

The mathematics dataset included the course MAT 075, which was taught at only one college; therefore, the students enrolled in MAT 075 were removed from the dataset. After removing MAT 075, there were five levels of developmental mathematics. A review of course descriptions and course taking patterns revealed that the two higher level math courses were not required for most applied science degrees. In addition, students enrolled in the two higher level developmental mathematics courses were less likely to take developmental English or reading courses. To justify more fully the removal of the higher level mathematics courses, a logistic regression with the full mathematics dataset and a second logistic regression with the reduced mathematics dataset were used for comparison.
While the same student level predictor variables remained significant in both models, interaction effects for sex and race as well as sex, race, and low-income, became significant predictors in the reduced dataset. At the institution level, two linear regressions were used to compare the full mathematics dataset and the reduced dataset. The results of these were very similar, finding that the percent of students taking mathematics through distance learning courses offered by a college was a significant and negative predictor of a student passing developmental mathematics and that the percent of white students enrolled in a college was a significant and positive predictor of a student passing. In neither linear regression were there any other significant level two independent variables. Given that this study was most interested in predictor variables for the lowest level developmental students, the reduced dataset, containing 28,668 student records was selected to be the focus of the final hierarchical model for mathematics.

With the higher level mathematics courses removed, the final mathematics dataset included 28,668 students enrolled in the three lowest levels of developmental courses. The lowest of the three levels of courses, MAT 050 enrolled 8.88% of the students in the dataset with 39.61% enrolled in MAT 060 and 51.51% of all students enrolled in the highest of the three levels MAT 070. As detailed in Table 4.1, compared to the datasets for English and reading, students in mathematics enrolled in other developmental courses at lower rates. Students also tended to take mathematics courses through distance learning at higher rates. Students enrolled in mathematics courses also had the lowest passing and retention rates of the three disciplines.
The original student dataset for all students enrolled in a developmental English class contained four levels of classes. The two lowest level courses were found to be offered at 17 of the 58 community colleges. Thus, students in these two levels were removed from the dataset in order to make the institutions more comparable. The remaining two levels of English courses were created by combining ENG 080 and ENG 085 into one level and ENG 090 and ENG095 into the second level. As explained in the course descriptions included in Appendix A, the 080 and 085 courses are the same level of English instruction; however, 085 combines developmental English with developmental reading just as ENG 095 does. The final reduced dataset for developmental English students contained 15,222 student records with 5,082 or 33.39% of those students enrolled in the lower of the two levels of English courses. Compared to students enrolled in math and reading, students enrolled in developmental English were more likely to be minority students and were slightly more likely to be male. The pass and retention rates for developmental English and reading were similar with both disciplines having higher pass and retention rates than students in developmental mathematics. Table 4.1 provides additional comparisons among the four datasets.

The student dataset for reading originally included three levels of courses; however, since only 15 of 49 community colleges that offered developmental reading courses offered the lowest level, RED 070, it was removed from the dataset. Of the remaining two levels, approximately one-third enrolled in the lowest level reading course with two-thirds of all students enrolled in a reading course taking the highest level. Table 4.1 provides a comparison of the students in the reading dataset to the students included in the other
datasets. For example, students in reading had a mean age of 20 compared to mathematics where the mean age was 23. The percent of male students was lowest in developmental reading while the percentage of minority students was highest compared to the other disciplines. The percent passing and percent retained was also higher for students enrolled in developmental reading courses. Last, students in developmental reading were less likely to take their courses through distance learning than students enrolled in developmental mathematics or developmental English courses.

Table 4.1

Descriptive Statistics by Dataset

<table>
<thead>
<tr>
<th>Datasets by Course Discipline</th>
<th>All</th>
<th>Mathematics</th>
<th>English</th>
<th>Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student Sample Size</td>
<td>40,076</td>
<td>28,668</td>
<td>15,222</td>
<td>11,000</td>
</tr>
<tr>
<td>Age (median)</td>
<td>22</td>
<td>23</td>
<td>21</td>
<td>20</td>
</tr>
<tr>
<td>Percentage male</td>
<td>35.38%</td>
<td>32.96%</td>
<td>38.67%</td>
<td>32.09%</td>
</tr>
<tr>
<td>Percentage minorities</td>
<td>47.00%</td>
<td>47.51%</td>
<td>54.18%</td>
<td>39.21%</td>
</tr>
<tr>
<td>Percentage low SES</td>
<td>43.81%</td>
<td>47.03%</td>
<td>48.38%</td>
<td>51.11%</td>
</tr>
<tr>
<td>Percentage taking DL</td>
<td>19.54%</td>
<td>17.31%</td>
<td>15.00%</td>
<td></td>
</tr>
<tr>
<td>Percentage taking more than one developmental course</td>
<td>33.56%</td>
<td>40.90%</td>
<td>81.56%</td>
<td>80.39%</td>
</tr>
<tr>
<td>Percent passing</td>
<td>61.41%</td>
<td>60.42%</td>
<td>66.27%</td>
<td>67.57%</td>
</tr>
<tr>
<td>Percent retained</td>
<td>74.20%</td>
<td>71.66%</td>
<td>77.24%</td>
<td>78.36%</td>
</tr>
<tr>
<td>Percent persist spring</td>
<td>74.41%</td>
<td>75.08%</td>
<td>75.57%</td>
<td>74.97%</td>
</tr>
<tr>
<td>Percent persist fall</td>
<td>54.96%</td>
<td>55.35%</td>
<td>55.91%</td>
<td>55.45%</td>
</tr>
</tbody>
</table>
With the exception of the percentage of males and the percentage of minorities, the datasets for English and reading were similar. The dataset for mathematics had lower pass and retention rates, more students taking courses through distance learning, and a higher number of older students. The largest difference among the three disciplines was whether students were enrolled in more than one developmental course. Figure 2 shows that more than half of the students enrolled in mathematics were taking only one developmental course, while more than 80% of English and reading students were taking more than one course with just under 40% of each dataset taking three developmental courses.

![Figure 2](image)

Figure 2. A visual representation of the number of developmental courses taken by the students within each dataset. Students who took a developmental mathematics course were enrolled in only developmental course at higher rates than students who enrolled in developmental English or reading.

The institution level variables were organized as compositional, institutional, and organizational variables. With the exception of the percent of developmental courses offered through distance learning, the compositional and institutional variables were taken from the
NCCCS DataWarehouse. Data was collected for each of the 58 community colleges; however, the dependent variable (pass rate) was missing for three of the 58 colleges. Those three colleges were removed from the analyses. In addition, some colleges elect to teach developmental English and reading classes as integrated courses. As a result, while there were 55 colleges included in the institution level datasets for mathematics and English, only 45 colleges were included in the reading analysis.

To obtain additional institution level variables, a survey was administered to the chief academic officers of each of the 58 community colleges in order to obtain information about institutional policies or programs. Organizational variables regarding what programs or services were available were collected from the survey analysis. The survey data was analyzed several different ways. First, a principal component analysis was used to attempt to reduce the variables. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy was used to determine whether to combine data. With a KMO statistic of 0.47, there was no support for combining questions into factors. Therefore, no results of the principal component analysis were used to establish level two variables.

Next, a pair of indices was developed by dividing the survey questions into two categories: academic support and student support. Questions that were related to academic support functions such as tutoring, support labs, early alert programs, etc. were considered an index of the level of academic support an institution provides to developmental students. Likewise, questions related to student support were considered an index of the level of support services offered by an institution. There were seven questions in each category.
Each question had a dichotomous response of yes or no. Table 4.2 lists each variable that was included in the academic support or student support index.

Table 4.2

Variables Used to Create Academic and Student Support Indices from Survey Data.

<table>
<thead>
<tr>
<th>Academic Support program or practice</th>
<th>Student Support program or practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use professional tutors</td>
<td>Early alert program</td>
</tr>
<tr>
<td>Tutors receive 5 or more hours of annual training</td>
<td>Embedded courses or stand alone developmental department.</td>
</tr>
<tr>
<td>Certified tutoring program</td>
<td>Students required to meet with advisor prior to registration</td>
</tr>
<tr>
<td>Use supplemental instruction</td>
<td>Student Support Services Trio grant</td>
</tr>
<tr>
<td>Skills lab available</td>
<td>Special advising program for developmental students</td>
</tr>
<tr>
<td>Designated developmental math lab</td>
<td>Emergency funds for students</td>
</tr>
<tr>
<td>Designated developmental English lab</td>
<td>Childcare facility on campus</td>
</tr>
</tbody>
</table>

Colleges were assigned one point for each positive response, meaning the institution offered the program or service. Colleges with 0-1 positive responses were given a rating of low level of support; colleges with 2-4 positive responses were given a rating of moderate level of support; colleges with 5-7 positive responses were given a rating of high level of support. This process was used for both academic and student support using the questions assigned to each respective category. After coding each college as low, moderate, or high for academic support and as low, moderate, or high for student support, the data were analyzed in a linear regression using mathematics passing rate as the dependent variable.

The academic support index was not significant ($p = 0.15$) nor was the student support index ($p = 0.70$) at an alpha of $p < .05$). An ANOVA analysis using the three levels
of academic support (low, moderate, and high) showed no difference among the mean passing rates of the colleges in any of the groups. In other words, colleges ranked as having high levels of academic support had similar mean passing rates to those with low levels of academic support. The ANOVA was repeated for the three levels of student support with similar findings of no differences among the colleges grouped as having low, moderate, or high levels of student support.

Last, each dichotomous survey question was considered for inclusion in a linear regression. Although 100% or 58 colleges responded to the survey, there were some missing responses to some items. Because SAS will exclude an institution with one missing response, only survey items with 56 or more responses were included in the linear regression. Seventeen individual survey items were included in the first linear regressions. Using mean pass rates as the dependent variable each time, the regression was repeated with a reduced set of variables (those with the lowest p-values). The final linear regression for mathematics passing identified eight significant level two variables. Using the same process described for mathematics, linear regressions were also used to determine whether there were any significant survey items as predictors of pass rates in English and developmental reading. Unlike mathematics and reading, no survey items were significant predictors of mean passing rates in developmental English. The linear regression for reading pass rates using the survey variables identified two significant level two variables: the percent of full-time English faculty, and whether a college offered funds for students who repeated developmental courses.
After the descriptive statistics were generated for each student level variable, inferential statistics, including parameter analysis via logistic regressions and Pearson correlations were used to identify which variables were significant predictors of a student passing courses within each respective developmental discipline. For each dataset, the first logistic regression was followed by a second logistic regression to include consideration of interaction effects. Stepwise regressions were used to identify if and how each level one predictor variable affected the significance or effect size of the other variables and to help determine which independent variables should be included in the final hierarchical model. Pearson correlations were used to look for variables that might be correlated to avoid issues with collinearity.

While the effect size varied, the same level one variables that were statistically significant predictors of a student passing English were also statistically significant predictors of a student passing reading. Sex, race, and method of instruction were all statistically significant predictors of a student passing a course in all three disciplines. While age was a predictor of passing English or reading, it was not a significant predictor of a student passing mathematics. The logistic regressions for mathematics also indicated that course level, socio-economic status, and the number of courses taken were significant predictors of passing mathematics. None of these variables were predictors of a student passing English or reading.

Inferential statistics were also used to help determine which institution level variables should be included in the hierarchical model. The SAS stepwise selection process aided
identification of optimal linear regression models. In addition, Pearson correlations were used to see if any of the independent variables were highly correlated with each other.

Pearson correlation coefficients were calculated for institution level variables using SAS PROC CORR to look for variables that were correlated. Variables with a correlation of .85 or higher (absolute value) are considered too highly correlated to be included in the same model because of issues with collinearity. In this analysis the MeanPell (percent of students in developmental courses who are receiving a Pell grant) and the percent of Pell recipients at each institution had an R value of -0.88, which precluded both variables use in the exploratory regression model and, subsequently, the final hierarchical model. Also, the percent White students at a college and the percent of minority students enrolled in developmental courses at a college had an R value of -0.98, so only one of these variables was included in subsequent analyses. The coefficients and R values are reported in Table 4.3 for the compositional institution level variables.

Table 4.3

Pearson Correlation Coefficients for Institution Level Variables: Compositional

<table>
<thead>
<tr>
<th></th>
<th>Mean Math Pass</th>
<th>Mean English Pass</th>
<th>Percent Minority in developmental</th>
<th>Percent White</th>
<th>Percent low-income students in developmental</th>
<th>Percent low-income all students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Math Pass</td>
<td>1.00</td>
<td>0.33*</td>
<td>-0.21</td>
<td>0.27*</td>
<td>-0.05</td>
<td>-0.05</td>
</tr>
<tr>
<td>Mean English Pass</td>
<td>0.33*</td>
<td>1.00</td>
<td>-0.08</td>
<td>0.24</td>
<td>-0.01</td>
<td>0.05</td>
</tr>
<tr>
<td>Percent Minority in developmental</td>
<td>-0.21</td>
<td>-0.24</td>
<td>1.00</td>
<td>-0.98**</td>
<td>-0.44**</td>
<td>0.50**</td>
</tr>
<tr>
<td>Percent White</td>
<td>0.28*</td>
<td>0.24</td>
<td>-0.98**</td>
<td>1.00</td>
<td>0.43**</td>
<td>-0.51**</td>
</tr>
<tr>
<td>Percent low-income students in developmental</td>
<td>-0.05</td>
<td>-0.01</td>
<td>-0.44**</td>
<td>0.43**</td>
<td>1.00</td>
<td>-0.88**</td>
</tr>
<tr>
<td>Percent low-income all students</td>
<td>-0.05</td>
<td>0.046</td>
<td>0.50**</td>
<td>-0.51**</td>
<td>-0.88**</td>
<td>1.00</td>
</tr>
</tbody>
</table>
Table 4.3 also shows that there is a small ($r = 0.27$), but statistically significant correlation between the percent of white students at an institution and the mean pass rate for math, but not for the mean pass rate of English. There is also a slight correlation between an institution’s mean math pass rates and mean English pass rates, $r = 0.32$.

Table 4.4 includes the results of a Pearson correlation with some compositional variables and the institutional variable of size as measured by unduplicated headcount and FTE.

**Table 4.4**

Pearson Correlation Coefficients for Institution Level Variables: Compositional and Institutional

<table>
<thead>
<tr>
<th></th>
<th>Mean Math Pass</th>
<th>Mean English Pass</th>
<th>Unduplicated Headcount</th>
<th>Percent low-income all students</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Math Pass</td>
<td>1.00</td>
<td>0.33*</td>
<td>-0.21</td>
<td>-0.05</td>
</tr>
<tr>
<td>Mean English Pass</td>
<td>0.33*</td>
<td>1.00</td>
<td>-0.11</td>
<td>0.05</td>
</tr>
<tr>
<td>Unduplicated Headcount</td>
<td>-0.21</td>
<td>-0.11</td>
<td>1.00</td>
<td>-0.42**</td>
</tr>
<tr>
<td>Percent low-income all students</td>
<td>-0.05</td>
<td>0.05</td>
<td>-0.42*</td>
<td>1.00</td>
</tr>
<tr>
<td>FTE$^a$</td>
<td>-0.23</td>
<td>-0.11</td>
<td>0.99**</td>
<td>-0.40**</td>
</tr>
<tr>
<td>Total size 2008$^b$</td>
<td>-0.25</td>
<td>-0.13</td>
<td>0.97**</td>
<td>-0.44**</td>
</tr>
</tbody>
</table>

In Table 4.4 the percent of low-income students at an institution is moderately and negatively correlated with the size of the institution. In other words, the more students who are enrolled in curriculum courses at an institution, the fewer the number of students who are receiving Pell grants. The percent of low-income students is also negatively and significantly
correlated to other indicators of institutional size such as FTE and the total institutional size, which includes noncredit continuing education courses.

**Three Hierarchical Logistic Regression Models**

In hierarchical models, slopes and intercepts can be designated as fixed or random effects. To determine which model best fit this study, four hierarchical logistic regressions were modeled and the -2 log-likelihood statistic was used to determine which model was the best fit. The model with the lowest -2 log-likelihood statistic for English and reading was a model in which the institution level variables were not included, only a random intercept was used for level two. All level one variables that were found to be significant during the exploratory logistic regression were included in the model and were considered fixed effects. In each exploratory model described below, the student and institution datasets for mathematics was used. Once the model with the best fit was identified, the same model was used for English and reading.

The first hierarchical model that was built assumed that the intercepts and slopes of all student level variables were assumed to be random variables that were linear functions of two level two variables: the percent of white students enrolled at an institution and the percent of students taking math via distance learning. The two institution level variables were the only ones included because they were the only variables found to be significant at an alpha of \( p < .05 \) using simple linear regressions. In each case, passing mathematics was used as the dependent variable. In the first model, three student level variables were significant at an alpha of \( p < .05 \), sex, race, and pell and each had small effect sizes. None of the institution level effects were significant at \( p < .05 \).
The second hierarchical model assumed random intercepts and fixed slopes for the student level variables, modeling them as a function of the percent of White students at an institution and the percent of students taking math via distance learning. In this case, all of the level one variables are significant predictors of whether a student passes a developmental math course; however, the two institution level variables are not statistically significant with values of \( p = .52 \) for percent White and \( p = .82 \) for mean math distance learning. Some of the random intercepts for each college were significant.

The third and final hierarchical model included no level two variables, using only a random intercept to represent each college, and was run in SAS using the GLIMMIX procedure. The level one variables that were included were the same as in the first and second exploratory models: sex, race, pell (as a measure of ses), method of instruction, and number of courses taken. This model had the lowest -2 log-likelihood statistic, indicating that it had the best fit of the three exploratory hierarchical models. A comparison of statistically significant variables showed that the effect size and significance of each variable was similar to the effect size and significance from the second model with random intercepts for level one variables. There were also several significant random intercepts among the 55 colleges.

**Final Hierarchical Models by Discipline**

The third exploratory hierarchical model became the final hierarchical logistic regression model used to analyze the mathematics, English, and reading datasets. No significant institution level variables were included in any of the three models, except the
intercept coefficients for each college. The coefficients and significance varied by discipline and by college.

The final math model included six significant student level variables: level of course (course number), sex, race/ethnicity, instructional method, socioeconomic status (low-income), and number of courses. Each of the variables remained significant in the hierarchical model as shown in Table 4.5. The level two intercept had an estimate of 0.21 with a standard error of 0.04, suggesting that 21% of the variance in the pass rates in developmental mathematics among the colleges could be attributed to institutional differences.

The analysis for math indicates significant differences among students with different racial and ethnic backgrounds as well as differences among the course levels and the number of developmental courses taken. Table 4.5 provides the odds ratio estimates and significance for each variable and each level of the variables.
Table 4.5

Final Mathematics Hierarchical Logistic Regression Displaying Coefficients, Odds Ratios, and Confidence Limits for Significant Level One Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Odds Ratio</th>
<th>95% confidence limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Course Number</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MAT 050 (level one)</td>
<td>0.31***</td>
<td>1.36</td>
<td>(1.23, 1.51)</td>
</tr>
<tr>
<td>MAT 060 (level 2)</td>
<td>0.29***</td>
<td>1.34</td>
<td>(1.27, 1.42)</td>
</tr>
<tr>
<td>MAT 070 (level 3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>-0.37***</td>
<td>0.69</td>
<td>(0.65, 0.73)</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race/Ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native American</td>
<td>-0.02</td>
<td>0.98</td>
<td>(0.87, 1.11)</td>
</tr>
<tr>
<td>Asian</td>
<td>0.49***</td>
<td>1.64</td>
<td>(1.30, 2.06)</td>
</tr>
<tr>
<td>Multi-racial/unknown/ other</td>
<td>-0.13</td>
<td>0.88</td>
<td>(0.73, 1.06)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.13</td>
<td>1.14</td>
<td>(0.99, 1.32)</td>
</tr>
<tr>
<td>Black</td>
<td>-0.53***</td>
<td>0.59</td>
<td>(0.56, 0.63)</td>
</tr>
<tr>
<td>White</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Method of Instruction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional course</td>
<td>0.45***</td>
<td>1.56</td>
<td>(1.43, 1.72)</td>
</tr>
<tr>
<td>Distance learning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low-income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receiving Pell</td>
<td>-0.13***</td>
<td>0.88</td>
<td>(0.83, 0.93)</td>
</tr>
<tr>
<td>Not receiving Pell</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of developmental courses taken</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.31***</td>
<td>1.37</td>
<td>(1.27, 1.48)</td>
</tr>
<tr>
<td>2</td>
<td>0.16***</td>
<td>1.17</td>
<td>(1.08, 1.27)</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05  **p < .01  ***p < .001

The hierarchical logistic regression for English and reading yielded similar results.

The significant student level variables that were included in both models were: age, sex,
race, and method of instruction. Table 4.6 displays the results from the hierarchical logistic regression for English.

Table 4.6

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Odds Ratio</th>
<th>95% confidence limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.26***</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.02***</td>
<td>1.02</td>
<td>(1.01, 1.02)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>-0.42***</td>
<td>0.65</td>
<td>(0.61, 0.70)</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native American</td>
<td>-0.19*</td>
<td>0.83</td>
<td>(0.71, 0.97)</td>
</tr>
<tr>
<td>Asian</td>
<td>0.35**</td>
<td>1.42</td>
<td>(1.11, 1.88)</td>
</tr>
<tr>
<td>Multi-racial/unknown/other</td>
<td>-0.42***</td>
<td>0.66</td>
<td>(0.53, 0.81)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.07</td>
<td>1.07</td>
<td>(0.90, 1.28)</td>
</tr>
<tr>
<td>Black</td>
<td>-0.51***</td>
<td>0.60</td>
<td>(0.56, 0.65)</td>
</tr>
<tr>
<td>White</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instructional Method</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional course</td>
<td>0.33***</td>
<td>1.39</td>
<td>(1.27, 1.53)</td>
</tr>
<tr>
<td>Distance learning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of developmental</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>courses taken</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.12*</td>
<td>1.13</td>
<td>(1.03, 1.25)</td>
</tr>
<tr>
<td>2</td>
<td>0.05</td>
<td>1.05</td>
<td>(0.97, 1.15)</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05   **p < .01   ***p < .001

While there were no significant level two predictors for students passing developmental English, there were significant differences in the likelihood that some groups of students would pass. Specifically, groups who have a higher probability of passing
English are older students who are 1.7% more likely to pass than younger students; Asian students who are 42.2% more likely to pass than White students; students enrolled in traditional courses who are 39.2% more likely to pass than those enrolled in distance learning courses; and students enrolled in only one developmental course who tend to pass at rates 13.1% higher than those enrolled in three developmental courses. When compared to the respective reference groups there were also some categories of students who were statistically significantly less likely to pass developmental English. Males were 65% less likely to pass English than reading. Some racial ethnicities were also less likely to pass English than the reference group of White students. Among these, Blacks were 60.4% less likely than Whites to pass English; Native Americans were 83% less likely than Whites to pass English; and student who identify as multi-racial/other were 65.7% less likely than Whites to pass developmental English. There was no significant difference in the probability of passing math among Hispanic students and White students.

The third and final hierarchical logistic regression analyzed reading with results that were similar the results for students enrolled in developmental English. Five student level variables remained significant in the hierarchical model: age, sex, race/ethnicity, and instructional method. With regards to age, older students had a slightly higher probability of passing reading than younger students. While this finding had a high degree of statistical significance, the practical significance was very small. However, the practical significance of the probability of a student passing a traditional course was much higher, 72%, compared to students enrolled in courses via distance learning. In addition, males had a lower probability, 61%, of passing reading than females. Last, differences among racial groups
indicate that Asian students have a higher probability of passing developmental reading than White students while Black students have a 61% less probability of passing than White students. Table 4.7 displays the results of the final hierarchical regression for the reading dataset.

Table 4.7

Final Reading Hierarchical Logistic Regression Displaying Coefficients, Odds Ratios, and Confidence Limits for Significant Level One Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Odds Ratio</th>
<th>95% confidence limits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.32**</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>0.02***</td>
<td>1.02</td>
<td>(1.01, 1.02)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>-0.49***</td>
<td>0.61</td>
<td>(0.56, 0.67)</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race/Ethnicity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native American</td>
<td>-0.10</td>
<td>0.90</td>
<td>(0.74, 1.11)</td>
</tr>
<tr>
<td>Asian</td>
<td>0.50**</td>
<td>1.65</td>
<td>(1.21, 2.23)</td>
</tr>
<tr>
<td>Multi-racial/unknown/ other</td>
<td>-0.22</td>
<td>0.80</td>
<td>(0.61, 1.06)</td>
</tr>
<tr>
<td>Hispanic</td>
<td>0.17</td>
<td>1.11</td>
<td>(0.90, 1.40)</td>
</tr>
<tr>
<td>Black</td>
<td>-0.49***</td>
<td>0.61</td>
<td>(0.55, 0.68)</td>
</tr>
<tr>
<td>White</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instructional Method</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traditional course</td>
<td>0.54***</td>
<td>1.72</td>
<td>(1.47, 1.99)</td>
</tr>
<tr>
<td>Distance learning</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p < .05  **p < .01  ***p < .001
Summary

Chapter four has provided the details of the results of the data analysis for each of the three datasets, including descriptive statistics for level one and level two variables, inferential statistics for level one and level two variables, survey analyses, preliminary hierarchical models, and the three final hierarchical models. Chapter five will highlight the significant findings while recognizing the limitations of this study and suggesting additional research.
Chapter Five: Conclusions

Overview

The previous chapter described the results of the statistical analyses conducted to examine what institutional characteristics predict whether a student will pass a developmental course in a community college. This final chapter presents key findings highlighting central themes related to students, institutions, and academic disciplines. Additionally, this chapter provides a discussion of the limitations of this study, theoretical and practical implications of the research findings, and recommendations for future research.

Major Findings

The major findings of the research were gleaned from the single level regression analyses at the student and institutional levels and from the hierarchical logistic regression models. Although the single level regression analyses were used to help build an appropriate hierarchical model, the results of these analyses yielded some interesting information. If this research had used only single level regression analyses of only institutional variables, several institutional characteristics would have emerged as significant predictors of a student passing a developmental course. For example, at the institutional level, having childcare on campus and having a Student Support Services TRIO grant were both statistically significant predictors of a student passing developmental math. When these variables were included in a two level hierarchical model that controlled for student-level variables, however, they no longer remained significant. This shift from significant in a single level institutional analysis to nonsignificant after controlling for student predictors with a two level hierarchical model occurred for other institutional variables such as having a math lab, providing tutoring on
campus, offering financial aid for students who repeat developmental courses, having a high number of full-time math faculty, having a higher percentage of white students, and using faculty advisors as opposed to student services advisors or having a collaborative advising model. Each of these variables was a significant predictor of a student passing a course when the unit of analyses was a single level regression. However, each of these variables was no longer significant when entered into a hierarchical regression model.

The results of the three final hierarchical models found no significant institutional characteristic, policy, or program. In every instance where single level regressions of institutional variables found significant positive predictors of a student passing a developmental course, the variable was not significant in a hierarchical model that controlled for student level variables. In other words, institutional variables that appeared to positively predict passing only did so for students with characteristics that already predisposed them to higher passing rates. These findings differ from earlier studies which found that institutional size, having a centralized developmental program, having a high percentage of white students, or having training for tutorial programs were positive predictors of student outcomes such as passing developmental courses or retention (Boylan, 1999; Bueschal, 2009; Calcagno et al, 2008; Perin, 2002; Quick, 2005; Rosenbaum & Stephan, 2008). With the exception of having a high percentage of white students, all of the research cited above, used single level regression models. The use of a more rigorous analysis, in this case, hierarchical modeling may explain why this study found no significant relationship between any institution level variables and a student passing developmental English or reading.
Next, findings from this study support earlier research that shows that some student level variables, such as age, race and gender, are predictors of student outcomes (Calcagno et al, 2006; Goble, Rosenbaum, & Stephan, 2008). Perhaps most interesting were the differences in student level predictor variables among the three disciplines: mathematics, English, and reading. For example, age was a significant predictor of a student passing English or reading, but not math, and being low-income and taking a lower course level were significant predictors of passing math, but not English or reading.

Race categories were also significant predictors of passing mathematics, English, or reading, the relationships between racial categories varied by discipline. The effects for mathematics, English, and reading were similar in that Asian students had a higher probability of passing mathematics (64%), English (42%), and reading (65%) than the White reference group. Blacks, on the other hand, had a lower probability of passing mathematics (61%), reading (59%), and English (60%) than the White reference group. This finding is especially troublesome as it suggests a trend toward overall lower academic performance for Black students, which is unrelated to subject matter. There were no other significant differences in passing mathematics or reading among the White reference group and the racial categories of Native American; Multi-racial, unknown, other; or Hispanic students. However, there were significant differences in a student passing English among the White reference group and four of the five racial categories. These differences seem to suggest that English skills are impacted by underlying social constructs more than mathematics or reading skills. In addition, finding no significant difference between the passing rates of Hispanic students and White students in any of the three disciplines seems to suggest that the Hispanic
students who attend community colleges in North Carolina are less likely to be non-native or English as a Second Language students than Hispanic students who attend community colleges in other states with higher immigration rates, like Florida, Texas, and California.

The effects of sex varied by discipline as well. For example, males had a lower probability of passing mathematics (69%), English (65%), and reading (61%) than females. This finding is similar to the lower probability of Black students passing a developmental course in that it crosses disciplines and seems indicative of broader social concerns that extend beyond the academic realm. Alternately, the lower probability of pass rates for some racial minorities and males could be related to pedagogical practices in the classroom that may not be culturally relevant or may be gender biased. Classroom level research is needed to investigate whether school practices are disadvantaging some students.

Another significant student level variable that was consistently a negative predictor of a student passing a developmental course was whether a student enrolled in a distance learning or traditional course. In each discipline, a student who was enrolled in a course offered via distance learning had a lower probability of passing than students who took traditional versions of the same courses. The practical significance was highest in reading with distance learning students having a 72% less chance of passing than students in a traditional course section. The smallest discrepancy between online and traditional courses was in English, when distance learning students had a probability of passing that was 39% less than for those enrolled in traditional courses. Although this variable was treated as a student level variable and not an institution level variable, its significance has implications for policy and practice. Specifically, community colleges should look at student outcomes
by course delivery method and reconsider whether offering developmental courses via distance learning is in the best interest of their students. It is important to note that for the purposes of this study, no distinction was made between fully online courses and hybrid courses as both were considered distance learning.

Finally, two significant student level variables were predictors of a student passing developmental mathematics, but not English or reading. The level of math course and the income status of a student were significant in the final hierarchical mathematics model. Being low-income gave a student an 88% lower probability of passing mathematics than a higher income peer. With strong statistical and practical significance for mathematics, it is surprising that this variable was not significant in either single level regressions or hierarchical logistic regressions in English or reading. Exploring this variable was beyond the scope of this project but could be an interesting consideration for future research.

Similarly, the level of course taken was significant only for mathematics. More surprisingly, the lower the course level, the greater the probability of a student passing as compared to the higher reference group. For example, a student enrolled in MAT 050, the lowest level mathematics course, had a 36% higher probability of passing the course than a student enrolled in MAT 070. A student in MAT 060 had a 34% higher probability of passing compared to a MAT 070 student. There are no other findings in this study to explain why this might be true. Perhaps students who are enrolled in lower level courses receive more support services or perhaps these courses are less difficult to pass. Further research should explore the differences among the various levels of mathematics more fully.
While females were overrepresented in developmental courses, student data indicates that males are more likely to enroll in developmental English than any other remedial course. Males are also less likely to pass a developmental course, regardless of discipline.

**Limitations**

One limitation of this study was not having reliable data to determine whether students were enrolled part-time or full-time. Empirical research generally finds that part-time students are less likely to pass courses or to be retained. Without this measure, the study could not account for the variance in student outcomes attributable to part-time or full-time enrollment. Additionally, this study did not include a direct measure of each student’s academic ability. While the use of various levels of developmental courses suggests a hierarchy of skills, there was no direct measure to assure that students were adequately assessed and placed in courses. Research by Adelman (1996, 1008, 2004) and Bahr (2007) have also used enrollment in course levels as an indication of academic ability; their research which provides a precedent for this analysis. The mandatory assessment and placement policies implemented in fall 2007 by the NCCCS should also provide some degree of confidence that students were placed in appropriate levels. Nonetheless, it is important to think of the students as those who *enrolled* in developmental courses and not as students who *needed* developmental courses. To illustrate the point further, there are some applied science programs, such as cosmetology and emergency medical services, whose state licensing agencies allow students to complete licensing requirements without ever completing the associate in applied science degree. These students can avoid remedial courses and the requisite college level math, English, and humanities courses by taking all of the program
courses and completing the licensing requirements, but never fulfilling the degree requirements. Thus, students who are actually enrolled in developmental courses are likely a subset of those who need developmental courses.

A third significant limitation of this study is that it does not include measures of the quality of the institutional programs or services within institutions. Survey data from each of the community colleges was only able to discern whether a service or practice was implemented. In addition, no data was collected to gauge the level of student participation in programs or services such as tutoring or supplemental instruction. Individual student records did not contain data indicating whether a student participated in academic or student support services. Therefore, an institution may have a highly effective tutoring program, but the aggregated institutional results of all students obscure the positive effect the program may have on the students who actually participate in the program (Bailey 2009). Lastly, this study did not include measures of students’ attitude, self-efficacy, or motivation (Bettinger and Long 2005, Calcagno et al 2008, Pascarella 2001). Differences in student outcomes might be attributed to additional student characteristics that were unaccounted for in this study.

**Theoretical and Practical Implications**

The findings in this study have several theoretical and practical implications related to policymakers, practitioners, and researchers. First, policymakers need to carefully consider two areas that have increasingly impacted developmental education. One of those areas is statewide accountability schemes. In a 2009 review of 10 states with state-wide accountability programs, all programs included a measure related to developmental education
and eight of those states included passing rates as a performance measure (Dougherty, Hare, & Natow 2009). If, as these finding indicate, student characteristics such as gender and race, are strong predictors of a student passing a developmental course, then using passing rates in developmental courses as a measure of institutional performance could be unfair to institutions with a disproportionate number of male students and students who are racial minorities. Given that the accountability measures are tied to performance funding for five of ten states (North Carolina is one of them), then the stakes are even higher for colleges who may need additional resources to serve students who need the most support. The results also suggest that policymakers carefully consider prescriptive policy making that either restricts or requires policies or practices or endorses a program or practice over another. When policymakers embrace or encourage a particular policy, program or practice, colleges are often forced to redirect limited resources. This can be particularly harmful when the empirical evidence of a best practice is based on a nonrepresentative sample or not evaluated by models that do not include student level predictors.

Second, practitioners should carefully investigate student outcomes in various course delivery formats on their individual campuses with an eye towards either eliminating or revising distance learning in developmental courses or alternatively, learning more about the characteristics of students who are successful in nontraditional course formats. Some colleges are now requiring user skills assessments before students enroll in distance learning courses. Practitioners should consider whether these requirements appear to impact student outcomes on their campuses. Practitioners would also be well served to
attention to populations with the lowest probabilities of passing and to explore various pedagogies that might work well with those populations.

Third, higher education researchers should carefully consider the appropriateness of single level regression techniques when evaluating the impact of institution level characteristics. As this analysis indicated, the statistical significance of predictors changed when we controlled for both student and institution variables. Among the reasons why student characteristics and institutional characteristics must be considered in hierarchical models is the increased pressures from the use of accountability measures, and the increased widespread publication of the measures in federal mandates such as Student Right to Know and Consumer Information outlined in the 2008 Higher Education Opportunity Act. Because of these pressures and, in some cases, funding opportunities, colleges are eager to implement the next best practice touted in the literature. Researchers should be able to publish findings with a high degree of confidence that recommendations related to policy or practice can result in positive outcomes for students and institutions.

**Recommendations for Future Research**

The results did show that there was considerable variance in the passing rates of students among the community colleges studied even when accounting for the differences in student characteristics. Therefore, this study suggests that the variance in students passing developmental courses is attributable to institution level variables that were not accounted for among the variables included in this study, particularly with regard to students passing developmental English or reading.
One way to better measure the effects of institution level variables would be to include a measure of the quality of academic programs or services. For example, an open math lab for developmental students may not have the same attributes of an open math lab at another community college. One math lab might be staffed with professional tutors or faculty who work with students individually, while another program might use lab assistants whose primary responsibility is to monitor computer software usage. This study deemed all math labs alike. A second way to strengthen this study would be to include a measure of student participation so that the outcomes of students who participated in a program or service, such as tutoring, could be compared according to the extent of the student’s participation. Last, while this study attempted to include a wide range of institutional variables, additional institutional characteristics should also be included in future research of student outcomes. Some additional organizational institution level variables to consider include peer mentoring programs, the use of program evaluation for developmental courses, classroom instructional techniques, faculty training, and the use of part-time and full-time faculty.

This study’s findings give rise to new questions for future research that investigates the student level predictors of passing developmental courses in the three disciplines studied. For example, why is age a significant predictor of passing a developmental English or reading class, but not a significant predictor of passing mathematics? Likewise, why are method of instruction and socioeconomic status significant predictors of passing mathematics, but not English or reading? Each of these variables should be considered within the context of institutional effects. Potentially, English and reading skills are affected by underlying cultural constructs that are heavily influenced by environmental factors.
Previous research has examined the relationship between low mathematics skills and low literacy skills, arguing the importance of understanding their interdependence (Adelman 1986; Perin, Keselman & Monopli, 2003). With regard to method of instruction, a more thorough investigation of the differences among various delivery models such as traditional, hybrid, or fully online instruction is warranted since these variables were significant at the student level and at the institution level in simple linear regressions, but were not the focus of this research.

A review of the descriptive statistics found that 66.4% of the students who enrolled in remedial courses took only one course. Specifically, students who were enrolled in mathematics were the least likely to enroll in developmental English or reading. When the dataset was reduced to include only the students enrolled in the three lowest level math courses, then students were more likely to be low-income or a racial minority. Students in the lowest level math courses were also more likely to enroll in developmental English or reading courses. Of the students who were enrolled in developmental English or reading, more than 80% took more than one remedial course. All of this information suggests that students who enroll in the lower level developmental courses are less academically prepared for college and tend to be disproportionately low-income and racial minorities. Therefore, future research that investigates the effects of various institutional characteristics, programs, or policies, should consider carefully the differences among students enrolled in various levels of developmental coursework or placement test scores. Identifying institutional variables that help the lowest level remedial students pass developmental courses could have important policy implications.
In addition to looking at whether a student passes a course as the dependent variable, future research should consider what outcomes are appropriate indicators of effective developmental courses or programs. Bolyan and Saxon (1999) argue that the primary purpose of remedial courses is to prepare students for college level work. Therefore, an appropriate measure of the effectiveness of developmental programs might be how well students perform in the first college level mathematics, English, or humanities course, such as introductory psychology or sociology. An investigation of grade point averages in non-developmental courses or grades in first curriculum courses could be used as an indication of whether the developmental courses taken and passed had helped students become better academically prepared. Additional student outcomes such as retention, persistence, and grade point averages in subsequent terms should also be included in future research.

Research should include the exploration of student engagement and academic success in tandem. For example, the data included in this study indicated that within term retention was higher than passing rates in each of the three disciplines. Similarly, persistence from fall 2008 to spring 2009 for the same cohort of students was also higher than the fall 2008 pass rates, which suggests that even when students are not passing developmental courses, they remain enrolled in college. A look at whether the same students were enrolled in fall 2009, one year later, showed persistence rates below the fall 2008 passing rates. While investigating the academic progress of these students was beyond the scope of this study, it raises the question of whether these students left with any college credits or whether they left with poor academic standing, which could preclude the receipt of financial aid should the student decide to return to college. In either case, the student would not have benefited from
retention efforts, suggesting that perhaps the research emphasis on retention or engagement without a focus on academic performance is misguided. Arguably, the student could leave college worse than when he started considering the cost of tuition or loss of financial aid, opportunity costs of time and/or money spent in college, the consequences of a low grade point average in returning to college or earning financial aid, and the demoralizing effect of failure.
REFERENCES


**APPENDIX A**

The following is a list of course descriptions for the developmental courses referenced in this study.

**Developmental Mathematics Course Descriptions**

**MAT 050  Basic Math Skills**
This course is designed to strengthen basic math skills. Topics include properties, rounding, estimating, comparing, converting, and computing whole numbers, fractions, and decimals. Upon completion, students should be able to perform basic computations and solve relevant mathematical problems.

**MAT 060  Essential Mathematics**
This course is a comprehensive study of mathematical skills which should provide a strong mathematical foundation to pursue further study. Topics include principles and applications of decimals, fractions, percents, ratio and proportion, order of operations, geometry, measurement, and elements of algebra and statistics. Upon completion, students should be able to perform basic computations and solve relevant, multi-step mathematical problems using technology where appropriate.

**MAT 070  Introductory Algebra**
This course establishes a foundation in algebraic concepts and problem solving. Topics include signed numbers, exponents, order of operations, simplifying expressions, solving linear equations and inequalities, graphing, formulas, polynomials, factoring, and elements of geometry. Upon completion, students should be able to apply the above concepts in problem solving using appropriate technology. *This course is also available through the Virtual Learning Community (VLC).*

**MAT 075  Geometry**
This course is designed to provide the student with a basic understanding and working knowledge of the fundamentals of plane and solid geometry. Consideration is given to the undefined terms of geometry, geometrical definitions, properties, postulates, theorems, and proofs. Topics include the study of congruence and similarity, parallel lines, triangles, quadrilaterals, polygons, circles, constructions, surface areas, and volumes.

**MAT 080  Intermediate Algebra**
This course continues the study of algebraic concepts with emphasis on applications. Topics include factoring; rational expressions; rational exponents; rational, radical, and quadratic equations; systems of equations; inequalities; graphing; functions; variations; complex numbers; and elements of geometry. Upon completion, students should be able to apply the above concepts in problem solving using appropriate technology.
**MAT 090 Accelerated Algebra**  
This course covers algebraic concepts with emphasis on applications. Topics include those covered in MAT 070 and MAT 080. Upon completion, students should be able to apply algebraic concepts in problem solving using appropriate technology.

**Developmental English Course Descriptions**

**ENG 080 Writing Foundations**  
This course introduces the writing process and stresses effective sentences. Emphasis is placed on applying the conventions of written English, reflecting standard usage and mechanics in structuring a variety of sentences. Upon completion, students should be able to write correct sentences and a unified, coherent paragraph. *This course does not satisfy the developmental reading and writing prerequisite for ENG 111 or ENG 111A.*

**ENG 085 Reading & Writing Foundations**  
This course uses whole language to develop proficiency in reading and writing for college. Emphasis is placed on applying analytical and critical reading skills to a variety of texts and on introducing the writing process. Upon completion, students should be able to recognize and use various patterns of text organization and compose effective paragraphs. *This course integrates ENG 080 and RED 080. This course does not satisfy the developmental reading and writing prerequisites for ENG 111 or ENG 111A.*

**ENG 090 Composition Strategies**  
This course provides practice in the writing process and stresses effective paragraphs. Emphasis is placed on learning and applying the conventions of standard written English in developing paragraphs within the essay. Upon completion, students should be able to compose a variety of paragraphs and a unified, coherent essay. *This course satisfies the developmental writing requirement for ENG 111 and ENG 111A.*

**ENG 095 Reading & Composition Strategies**  
This course uses whole language to strengthen proficiency in reading and writing for college. Emphasis is placed on applying critical reading skills to narrative and expository texts and on using the writing process. Upon completion, students should be able to comprehend, analyze, and evaluate college texts and to compose essays in preparation for college writing. *This course integrates ENG 090 and RED 090. This course satisfies the developmental reading and writing prerequisites for ENG 111 and ENG 111A.*
Developmental Reading Course Descriptions

**RED 080    Intro to College Reading**
This course introduces effective reading and inferential thinking skills in preparation for RED 090. Emphasis is placed on vocabulary, comprehension, and reading strategies. Upon completion, students should be able to determine main ideas and supporting details, recognize basic patterns of organization, draw conclusions, and understand vocabulary in context. *This course does not satisfy the developmental reading prerequisite for ENG 111 or ENG 111A.*

**RED 090    Improved College Reading**
This course is designed to improve reading and critical thinking skills. Topics include vocabulary enhancement; extracting implied meaning; analyzing author’s purpose, tone, and style; and drawing conclusions and responding to written material. Upon completion, students should be able to comprehend and analyze college-level reading material. *This course satisfies the developmental reading prerequisite for ENG 111 or ENG 111A.*
APPENDIX B

Survey Instrument Administered to Chief Academic Officers

The following survey was administered through an online service called Zoomerang.

Academic Support and Student Services

Tutoring
1. Is tutoring available on campus for all students?
   a. Yes
   b. No
If yes,
   i. Who provides tutoring? (Check all that apply)
      1. Peers
      2. Professional tutors
      3. Volunteers
   ii. Do tutors receive more than 5 hours of tutoring annually?
      1. Yes
      2. No
      3. Unsure/not aware
   iii. Is your tutoring program certified by either the College Reading and Learning Association or the National Tutoring Association?
      1. Yes
      2. No

Supplemental Instruction
1. Does your institution use supplemental instruction to support developmental education courses in reading, English, or mathematics?
   a. Yes
   b. No
   1. if yes, please indicate which course(s) _____________________

Skills Labs
1. Apart from tutoring, does your college offer a skills lab with staff, faculty, or software to help developmental students build skills outside of the classroom?
   a. Yes
   b. No

2. Do you have a designated math skills lab that supports developmental students?
   a. Yes
   b. No
3. Do you have a designated English or writing lab for developmental students?
   a. Yes
   b. No

Advising and Registration
1. Does your institution have an “early alert” program to identify early in the term students who may have academic difficulty (the program may involve faculty, advisors, and student services staff who collaborate to offer these types of programs? 
   a. Yes
   b. No

2. Do you offer online registration?
   a. Yes
   b. No

   If yes, are students required to register online?
   a. Yes
   b. No

3. Are students required to meet with an advisor prior to registration?
   a. Yes
   b. No

4. At your campus, who is primarily responsible for advising and registering students?
   a. Faculty
   b. Student services staff
   c. Use a collaborative model

5. Do you have a Student Support Services or TRIO grant?
   a. Yes
   b. No

Developmental Education Policies
1. Do you offer a specialized advising program for students who place into developmental education courses?
   a. Yes
   b. No

2. Does your institution have a stand-alone developmental education department or are your developmental courses embedded in other academic departments?
   a. Stand-alone independent developmental education department
   b. Developmental courses are embedded within academic departments
3. Does your institution require students to pass an exit exam (other than a regular course exam?) in order to receive institutional credit for developmental course? This exam might be a standardized assessment.
   a. Yes
   b. No

4. Approximately how many full time faculty teach developmental English on your campus?
   a. 0-1
   b. 2-3
   c. 4-5
   d. More than 5

5. Approximately how many full time faculty teach developmental math on your campus?
   a. 0-1
   b. 2-3
   c. 4-5
   d. More than 5

Financial Aid Policies
1. Do you have emergency funds available to students who need them for personal financial emergencies (e.g. gas money, car repairs, utility bills, etc.)?
   c. Yes
   d. No

2. Do you have a childcare facility on your campus that students may use as daycare for their children?
   a. Yes
   b. No

3. Is financial aid available for students who repeat developmental courses?
   a. Yes
   b. No
Email Request to Chief Academic Officers

Dear Colleague,

My name is Kristie Sullivan, Dean of Planning and Research at Sandhills Community College and doctoral candidate in the Educational Research and Policy Analysis department at North Carolina State University (NCSU). My dissertation, with Dr. Tamara V. Young, at NCSU, investigates the impact of institutional characteristics, policies, and practice on the outcomes of developmental community college students in North Carolina. As such, I hope you are willing to help me by participating in a brief survey of the Chief Academic Officers at all 58 North Carolina Community Colleges.

This survey asks instructional administrators fewer than twenty general questions about policy and practice at your institution. These questions focus on policies and practices related to academic and student support, developmental education, and financial aid.

Completing the survey should take no more than 7-10 minutes. The survey is completely anonymous and only aggregate results will be presented. If you wish to receive the results of this survey, please respond to this email with “survey results” in the subject line.

Your contribution is imperative to the success of this study, which will analyze data from all 58 NC community colleges.

Thank you in advance for your support.

To take the survey, please follow this link: