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ACCEPTANCE

This dissertation, COMPARISON OF THREE METHODS OF PLACEMENT AND ADVISEMENT INTO FRESHMEN MATHEMATICS COURSES AND THE EFFECT ON EVENTUAL DEGREE COMPLETION, by JOHN WALTER COTTER, was prepared under the direction of the candidate's Dissertation Advisory Committee. It is accepted by the committee members in partial fulfillment of the requirements for the degree Doctor of Philosophy in the College of Education, Georgia State University.

The Dissertation Advisory Committee and the student's Department Chair, as representatives of the faculty, certify that this dissertation has met all standards of excellence and scholarship as determined by the faculty. The Dean of the College of Education concurs.

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ABSTRACT

COMPARISON OF THREE METHODS OF PLACEMENT AND ADVISEMENT INTO FRESHMEN MATHEMATICS COURSES AND THE EFFECT ON EVENTUAL DEGREE COMPLETION

by

John Walter Cotter

Statement of the Problem

The national six-year graduation rate is less than 60 percent. This alarming yet consistent feature of higher education has led researchers like Bean (1980), Tinto (1975, 1993), Astin (1993), Adelman (1999), Braxton (2000) and DesJardins (2002) to create a body of research which attempts to explain the causes of student attrition and suggest possible interventions. Learning Communities and Freshman Experience courses are two efforts to improve retention which are derived from this research.

The purpose of this study was to test portions of Tinto's longitudinal model of institutional departure that relates academic fit to persistence and degree completion. The study examined placement testing and advising procedures and the effects these procedures have on eventual degree completion. The results of this study should inform the academic community about the efficacy of using a placement test to promote academic fit for first time freshmen enrolled in mathematics courses.

Method

This quantitative study was an ex-post facto, quasi experimental design which compared three procedures for placement into the initial college mathematics course and

the impact on retention and eventual degree completion. The data for this study was obtained from existing data sources. Logistic regression was used to compare the three placement methods and the effect on the odds of eventual degree completion.

Results

While the placement instrument did provide some useful information for placement decisions about some courses, it does not provide as much information as other available measures, in particular, the high school history expressed as the grade point average.

Quality point production at the end of the first year was found to be a strong predictor of eventual graduation. The results suggest that for each one unit increase in the quality points earned the odds of graduation are 1.042 times better. Statistically significant differences were found in the efficacy of the different placement methods; however these differences were overshadowed by the effect of the introduction of a new mathematics course. The average grade in the initial collegiate math class for the groups in this study has risen from a low of 1.87 to 2.37 after the introduction of Math Modeling to the curriculum.

COMPARISON OF THREE METHODS OF PLACEMENT AND ADVISEMENT INTO FRESHMEN MATHEMATICS COURSES AND THE EFFECT ON EVENTUAL DEGREE COMPLETION

by
John Walter Cotter

A Dissertation

Presented in Partial Fulfillment of Requirements for the
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Doctor of Philosophy
in
Mathematics Education
in
the Department of Middle-Secondary Education and Instructional Technology
in
the College of Education
Georgia State University

Atlanta Georgia
2007

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TABLE OF CONTENTS

List of Tables iv
List of Figures vi
Chapter 1 Statement of the Problem 1
Overview 2
Degree Completion 2
Tinto's Longitudinal Model of Institutional Departure 10
Research Questions 21
Importance of the Study 22
Summary 24
Chapter 2 Review of the Literature 25
Purpose 25
Research Questions 26
Pre-Entry Characteristics 27
Institutional Experiences and Integration 47
Intervening Variables 54
Outcomes 56
Summary 58
Chapter 3 Method 59
Design 59
Data Collection 61
Data Analysis 62
Threats to Validity 64
CHAPTER 4: RESULTS 67
Introduction 67
Context of the Study 67
Subjects and Descriptive Statistics 69
COMPASS Test as a Predictor of Course Success 71
Performance in the First Two Terms and Eventual Degree Completion 80
Mathematics Course Grade as a Predictor of Success in the First Year 84
Treatment and Odds of Degree Completion 85
Intervening Variables 89
Summary 93
CHAPTER 5 DISCUSSION 95
Conclusions 95
Implications and Recommendations 99
Suggestions for Further Research 100
Summary 102
References 103

LIST OF TABLES

Table		Page
1	Distribution of Undergraduate Letter Grades	29
2	SAT Verbal and SAT Mathematics Means and Standard Deviations for 1998 – 2002	70
3	2001 COMPASS Score Advising and Placement Options	72
4	Math 1101 Odds of Course Success (D or higher) by Algebra Cut-Score = 30	73
5	Math 1101 Odds of Course Success (C or higher) by Algebra Cut-Score = 30	73
6	Math 1111 Odds of Course Success (D or higher) by Algebra Cut-Score = 40	74
7	Math 1111 Odds of Course Success (C or higher) by Algebra Cut-Score = 40	75
8	Math 1113 Odds of Course Success (D or higher) by College Algebra Cut-Score = 41	75
9	Math 1113 Odds of Course Success (C or higher) by College Algebra Cut-Score = 41	76
10	Classification Table: Success D or Better 2001Entry Level Math Courses	77
11	Logistic Regression Results: Success D or Better 2001 Entry Level Math Courses	78
12	Classification Table: Success C or Better 2001Entry Level Math Courses	79
13	Logistic Regression Results: Success C or Better 2001Entry Level Math Courses	80
14	Classification Table: 1998 Cohort Graduation by Quality Points Earned in the First Two Semesters	81
15	Logistic Regression Results for Graduation of the 1998 Cohort by Quality Points	82
16	Classification Table: 1999 Cohort Graduation by Quality Points Earned in the First Two Semesters	83
17	Logistic Regression Results for Graduation of the 1999 Cohort by Quality Points	83
18	Classification Table: 60% Chance of Graduation after Two Semesters by Grade in First Math Class	84
19	Logistic Regression Results for Success in First Year by Grade in first Math Class	84

20 1ST MATH GRADE AND QUALITY POINTS FOR CONTROL AND EXPERIMENTAL GROUPS 85
21 ODDS OF FIRST YEAR SUCCESS (QP 66.5 OR HIGHER) BY TREATMENT 1(2001) VS. CONTROL 86
22 ODDS OF FIRST YEAR SUCCESS (QP 76.5 OR HIGHER) BY TREATMENT 1(2001) VS. CONTROL 87
23 ODDS OF FIRST YEAR SUCCESS (QP 66.5 OR HIGHER) BY TREATMENT 1(2002) VS. CONTROL 87
24 ODDS OF FIRST YEAR SUCCESS (QP 76.5 OR HIGHER) BY TREATMENT 2(2002) VS. CONTROL 88
25 CLASSIFICATION TABLE: TREATMENT MODEL 2000, 2001, AND 2002 COHORTS SUCCESS = 66.5 QUALITY POINTS 89
26 LOGISTIC REGRESSION RESULTS TREATMENT MODEL 2000, 2001, AND 2002 COHORTS SUCCESS = 66.5 QUALITY POINTS 89
27 CLASSIFICATION TABLE: COMPLETE MODEL 2000, 2001, AND 2002 COHORTS SUCCESS = 66.5 QUALITY POINTS 90
28 LOGISTIC REGRESSION RESULTS: COMPLETE MODEL 2000, 2001, AND 2002 COHORTS SUCCESS = 66.5 QUALITY POINTS 90
29 ODDS OF FIRST YEAR SUCCESS (QP 66.5 OR HIGHER) BY LEARNING COMMUNITY PARTICIPATION 93

LIST OF FIGURES

Figure Page

1 Tinto's Longitudinal Model of Institutional Departure 15

2 The Simplified Model 20

3 The Study Design..... 60

CHAPTER 1

STATEMENT OF THE PROBLEM

Less than half of the freshmen admitted to college graduate within five years (ACT, 2005). This alarming yet consistent feature of higher education has led to the creation of researchers like Bean (Bean, 1980), Tinto (Tinto, 1975, 1993), Astin (Astin, 1993), Adelman (Adelman, 1999), Braxton (Braxton, 2000) and DesJardins (DesJardins, Ahlburg, & McCall, 2002) to create a body of research which attempts to explain the causes of student attrition and suggest possible interventions. This research has led to many attempts at reforms with a focus on retention. Retention efforts typically focus on students in the first year of their college career with the aim of having this group return for a second year. Learning Communities and Freshman Experience courses are two high visibility efforts at retention that can be found across the country. Despite these efforts the graduation rate at four year public institutions has been in a gradual decline over the past 20 years(ACT, 2002).

The purpose of this study is to examine alternate placement testing and advising procedures and the effects these procedures may have on eventual degree completion. The study pertains to incoming freshman students at a large urban research university in the southeastern United States.

Overview

This chapter is organized into four sections. The first section begins with a description of degree completion across the United States and the related concept of student retention. This section eventually narrows to a discussion of the similarities and differences in degree completion across the nation and those found at the university. The second section introduces Tinto's (1993) longitudinal model of institutional departure, and proposes, of a simplified adaptation of Tinto's model applicable to the study at hand. The third section describes the model as the basis for the research questions to be used in this study. The fourth and final section discusses the importance of the study.

Degree Completion

Bachelor's degree completion is a significant milestone for students, the public, and the degree granting institution. Putting aside the esoteric benefits of an education for the moment, students benefit economically from a college degree. Current estimates by the United States Census Bureau for the average annual income of full time workers aged 25 to 64 with a bachelor's degree is $52,200 (Day & Newburger, 2002). The estimates for a high school dropout and a high school graduate in the same age range are $23,400 and $30,400 respectively. The gap between the earning power of high school graduates and college graduates has been slowly growing over the last three decades. In the seventies college graduates earnings were about 1.5 times that of the high school graduate. Currently those holding a bachelor's degree can expect to earn almost twice what the high school degree holder earns and as the gap continues to widen the relative worth of the college degree will continue to rise.

The disparity in earnings is even more pronounced when calculated over a working lifetime. A person who holds a bachelor's degree can expect to earn nearly $2.1 million over his/her working lifetime compared to the $1.2 million an individual with only a high school degree will earn. These different levels of income are also accompanied by other differences related to the amount of income an individual earns, such as the likelihood of accumulating savings and owning a home.

Along with the economic benefits that degree holders enjoy, college graduates also benefit from a longer life-span. The longer life span may be accounted for in part by to the fact that only about 14 percent of those with a bachelor's degree or higher smoke tobacco, compared to 23 percent of those with some college, 30 percent of high school graduates, and 37 percent of those with less than a high school degree that smoke (The Institute for Higher Education Policy, 1998).

The families of college graduates also enjoy an improved quality of life. Studies have shown that the children of college graduates are more likely to attend college after high school. Also the daughters of college educated mothers are less likely to become single teen mothers.

In the report, *Reaping the benefits: Defining the public and private value of going to college*, the Institute for Higher Education Policy (1998) enumerated several ways that society benefits economically from having an educated populace. Included in this list were increased tax revenues, greater productivity, increased consumption, and decreased reliance on government financial support. Besides the economic benefits society also benefits from reduced crime, and increases in charitable giving, as well as volunteer work. College graduates are also more likely to vote in elections.

In addition to the individual and society benefits, our institutions of higher education clearly benefit from higher graduation rates. The business of a degree granting institution may be open to many interpretations; however, for the constituencies of the school, which include the students, the public, and the funding legislatures, the bottom line has to be degree completion. The accountability trend of recent years has not allowed the institutions of higher education to escape unscathed. Since the Federal Student Right-to-Know and Campus Security Act of 1991 colleges have had to publish data about completion and graduation rates. The perennial publication of these reports leads to newspaper articles and television news items that invariably report the "shocking and disappointing" job that our colleges and universities are doing (Simmons, 2005). The state legislature of Virginia now ties funding to graduation rates.

Given the rewards of obtaining a college degree for the individual, the public, and the degree granting institution it might be reasonable to expect near universal completion of college degrees for those admitted to institutions of higher education. Indeed, England enjoys a graduation rate that exceeds 80 percent (Bennett, 2003). However graduation rates in the United States only approach these numbers in our most selective institutions; i.e. six year graduation rate for 2003: Yale 96%, Princeton 96.5% Harvard 97.8% (The Education Trust, 2005).

The actual graduation rates for four year public institutions in the United States falls far short of the ideal represented by the best and the brightest. The United States Department of Education 2004 report *The Condition of Education* records that only 47% of all undergraduates who entered a public, four-year institution in the 1995-96 academic year had obtained a bachelors degree within five years (Wirt et al., 2004). This is the

same percentage that was found for the cohort that entered school in the 1989-90 academic year.

Similar outcomes are reported by ACT for graduation rates in 2003 (ACT, 2005). The data reported by ACT are compiled from the ACT Institutional Data Questionnaire, which is completed annually by more than 1,500 baccalaureate institutions across the United States (ACT, 2002). ACT relies on the questionnaire to collect graduation outcome information from schools that choose to participate and share their information. ACT sorts the data and reports on eight different categories of institutions based on whether the school is public or private as well as the highest degree conferred by the institution. In 2003, the sample questionnaire had the following participation counts from the eight different categories of institutions throughout the nation: 793 two year public, 28 two year private, 63 bachelor's public, 388 bachelor's private, 200 master's public, 464 master's private, 203 PhD public, and 180 PhD private. For the present discussion we will limit the reported results to public schools that also grant doctoral degrees. In the year 2000 the five year graduation rate for a bachelor's degree at 194 schools in this group was 45.6%. In 2001 and 2002 this percentage was 45% with 195 schools participating. In 2003 the five year graduation rate for a bachelor's degree at the 203 schools participating in the survey was 46.7%.

It is natural for institutions of higher education to be the focus and the unit of measure when considering retention and graduation rates. The hierarchy of higher education forces this organization on the data that describe the phenomena of the educational experience. This organization of the data, and the perspective it implies, colors the picture of graduation rates bleaker than in fact it is. The assumption of

institutional graduation rates is that each individual school is its own academic ecosystem that exists in an independent vacuum. The traditional notion that a student will enter as a freshman at one school and persist until graduation is becoming outdated. This notion of one-student, one-school while still dominant describes a lower percentage of degree completers than ever. In the future it will become increasingly rare to find students who enroll as freshmen and continue throughout their college career until degree completion at only one school. Today many students move from school to school building a portfolio of credits that eventually cumulates in a degree. From the school's perspective and the institutional graduation rates reported by ACT, the student that does not earn a degree from the institution of origin disappears from the radar and is eventually tallied as another dropout, a failure for the school even though the student may very well complete a degree at another institution.

In *Answers in the Toolbox*, Clifford Adelman, a senior research analyst with the U. S. Department of Education (DoE), advocates a different view of retention and degree completion. "Institutions may 'retain' students, but it is students who complete degrees, no matter how many institutions they attend. So follow the student, not the institution" (Adelman, 1999).

Adelman's 1999 study is based on a National Center for Educational Statistics longitudinal study that began with a national census of 3.8 million 10th graders in 1980. A sample of 28,000 was then drawn from the census and over time this group was observed by examination of transcripts and asking students to complete questionnaires. By 1992, the number of respondents with post secondary transcripts being studied had shrunk to 8,873 cases.

The information from this sample is relatively unique in the study of college persistence in that it does not come from any one institution of higher education; rather the data represent a true sampling of the college going population that transcends any one institution. When the graduation rate is considered from this student perspective rather than through the lens of the institutions the portrait of degree completion appears noticeably different. If we look at completion of the bachelor's degree by age thirty then the rate jumps to 63 percent. It is important to note two things when comparing this rate with other rates reported in this study. First, this rate allows up to 12 years for completion of a degree started at 18 years of age. Second, the unit of measure is the student and not the institution.

The National Center for Educational Statistics, *Descriptive Summary of 1995–96 beginning Postsecondary Students: Six Years Later*, found similar graduation rate results allowing only six years for degree completion (Berkner, He, & Cataldi, 2002). The data for this report are from a longitudinal study that collected data from a national sample and not from individual institutions. This study purports to describe the experiences of the 3 million undergraduates that entered college for the first time in the 1995-96 academic year. Three interviews of a sample of the three million students were conducted in 1996 at the end of the first year, then again in 1998 three years after the start of their post secondary academic career and finally in 2001. This sample came from 2-year and 4-year colleges and universities as well as some institutions that offer vocational training.

The distinction between the institutional graduation rate of 50.7 percent and the student graduation rate of 58.2 percent shows the value of following the student as

opposed to the institution when trying to get an accurate picture of graduation completion. The study also reports that 40 percent of the students involved in the study were enrolled in at least two different schools during the six year period (Berkner et al., 2002).

The purpose of Adelman's (1999) *Toolbox* study was not to just report college dropout rates, but to identify and examine characteristics of successful students. Some of his analysis has led Adelman to the discard traditional "sacred cow" variables often used in retention studies. In particular, Adelman found parents' highest level of education as reported by the student to be an inaccurate measure. For example, after comparing student responses to the actual level of educational attainment, he found that students were only 72 percent accurate when they selected the category, "father had some college." This was the highest level of agreement of any of the categories in educational achievement of the parents. One student in six would not even guess at the level of parents' academic attainment. Many of Adelman's choices for data sources are predicated on the empirical underpinnings of the variable. Throughout his analysis, Adelman demonstrates a preference for objective rather than subjective sources of information.

Another variable Adelman would have us deemphasize is part-time versus full-time status. Adelman points out that full time status will change from term to term and even within the term as students drop, withdraw, and leave incomplete segments of their class load. The "DWI index" which is the ratio of drops, withdrawals and incomplete credits to the actual number of credits attempted is much more important than full-time/part-time status. For example Adelman found that once a student has more than

seven withdrawals on his/her transcript the odds of completing a degree are reduced by half.

Adelman also found that chronological persistence is not a particularly meaningful variable. Thirty percent of those who arrived at their second year did so with less than 20 hours of credit towards their degree. The odds for this group to complete a degree were severely reduced. Rather than just watching the calendar, Adelman (1999) argues that we must pay attention to the quality of work that the student is achieving. For example, students who earn more than 30 hours in their first year have a graduation rate that exceeds 70 percent.

Even though Adelman's and the NCES approach of following students in a longitudinal study is superior for developing a true understanding of degree completion behaviors of students, it is not the perspective that will be used in this study. In fact, students who transfer and choose to persist at other institutions are considered "lost" by their initial institution. Also since the topic of interest is how the institution can affect degree completion, it is appropriate that we focus on the institution rather than the individual behaviors.

On January 19, 2005 the Education Trust, a nonprofit organization founded by the American Association for Higher Education in 1990, went online with http://www.collegeresults.org/ . This website complies all of the graduation data reported on the annual graduation survey conducted by the Unites States Department of Education. With minimal input from the user the site can produce a comprehensive report about the graduation rate of any higher education institution in the United States. This data is broken down by gender and ethnic make-up of the students at a particular

school. It also provides other information that a potential applicant may want to consider. For example, information is included about the percentages of applicants that are admitted, college setting, and the estimated cost of attending. The site also presents a cohort of 15 similar institutions in a table that includes median SAT, size of the institution, and percentage of the student body receiving federal aid in the form of Pell grants.

The stated motivation of the Education Trust for the publication of this data in such a consumer friendly format is to improve the quality of education for all students. The rationale is that market forces will compel schools to provide a better product when potential students make educated decisions about which schools best meet their needs. Students can easily research a variety of schools and make an educated decision about their chances of admission and more importantly of completing a degree once they matriculate.

Tinto's Longitudinal Model of Institutional Departure

The problem of student dropout has been around for a long time. In 1910, in *The College Laggard*, an article for the *Journal of Educational Psychology*, James Minor concluded that the principal reason for freshmen at the University of Minnesota to leave college early was not due to intellectual incapacity; rather the failure was more often due to personal or moral shortcomings (Beck & Davidson, 2001).

Many theories to explain dropout behavior have propagated over the years including varieties of economic, psychological, and sociological theories. Due to our unit of measure, a sociological theory is most appropriate for the study at hand.

In 1987, Vincent Tinto's *Leaving College: Rethinking the Causes and Cures of Student Attrition* was published. In this seminal work Tinto adapted the Emile Durkheim's classic work *Suicide* to the problem of student attrition. In *Suicide*, Durkheim sought to explain the reasons different societies experienced differential rates of suicides, and why the rates in some societies varied over time. His analysis of the underlying causes of suicide led him to create a four-category classification system: altruistic, anomic, fatalistic, and egotistical (Durkheim, 1967; Tinto, 1993).

An altruistic suicide is one that society would consider appropriate morally. An example from literature would be Sydney Carton, the unlikely hero of Charles Dickens' *A Tale of Two Cities*. As Carton is led to the guillotine after exchanging places with a condemned man, he is finally at peace with himself with the realization: "It is a far, far better thing that I do, than I have ever done; it is a far, far better rest that I go to than I have ever known (Dickens, 1948)."

Anomic suicide refers to a situation in which the norms of society have broken down and society no longer controls behavior. Extreme conditions of plague and war could lead to the type of normlessness that would force individuals to make their own rules in the absence of societal forces that normally govern behaviors. Riots and looting are examples of behaviors that seem amoral when viewed through the lens of polite society. But these behaviors become acceptable to the individuals who find themselves temporarily disconnected from society and thus compelled to create their own morality. Anomic suicide is most likely to befall individuals who cannot adapt to the loss of the societal norms.

Fatalistic suicide is at the other end of the spectrum of normative control. Whereas an anomic suicide occurs in situations having too little normative and societal control, the fatalistic suicide is characterized by too much control. A fatalistic suicide may appear to be the only solution to individuals who find their future and passions hopelessly blocked by oppressive regulation. A less extreme response by an individual than suicide would be self-destructive behaviors, such as alcoholism or drug abuse. This model of suicide provides insight into understanding prison suicide attempts.

The fourth form of suicide in Durkheim's theory is egotistical suicide. This form of suicide is characterized be the individual's failure to become integrated within the communities of society. Failure to integrate may be the result of the individual holding deviate values which are not commensurate with the dominant values of society. Or the failure to integrate may simply be the lack of affiliation that leads to or is caused by social isolation.

Tinto (Tinto, 1993) illustrates the efficacy of Durkheim's theory with analogies between historical trends and the different forms of suicide. For example, Tinto sees parallels between the "drop out and drop in" movement of the 1960s and 1970s and altruistic suicide. The counter culture of the period provided many with adequate rationales for leaving college and "tuning in" to an alternate lifestyle that did not value a college degree.

Continuing his analogies, Tinto found that the disruptive student riots in the 1970s and other societal forces of the time clearly lead to anomic conditions. It is not surprising that these sometimes cataclysmic events were also accompanied by heightened levels of

student departure. In some countries the entire education system has been temporarily suspended due to widespread unrest.

While the ideas of altruistic, anomic, and fatalistic suicide are useful in explaining dramatic and extraordinary historical influences that have led to fluctuations in student departure rates, they fall short when explaining continuing differences in patterns of departure during ordinary times. To broaden our understanding of the differential rates of student departure between institutions and over time, we need the perspective of egotistical suicide. In particular, the mechanisms of social and intellectual integration can be used to explain differential departure rates from different institutions or the same institution over time. In other words, the theory asserts that institutions that do a better job of integrating their students intellectually and socially have lower departure rates.

Durkheim identified two separate types of integration: intellectual and social (Tinto, 1993). When individuals hold membership in a social group they are said to be somewhat integrated. Tinto makes a distinction between membership and integration. Integration of an individual means adoption of the group values. Membership, while still implying conformity to the norms of the group, does not require a total subjugation of the individual's values and beliefs to the values and beliefs held by the group. The difference between Durkheim's integration and Tinto's membership may be as subtle as the difference between indoctrination and inculcation. Tinto's less stringent requirements of membership make sense when considered in the transitory context of an undergraduate academic career.

For Tinto, social and intellectual integration are the two vehicles for achieving membership into the campus community. When insufficient integration has occurred, the

individual can become vulnerable to departure that is analogous to Durkheim's egotistical suicide. Whether the non-integrated individual opts for departure depends on the interaction of the individual and his/her beliefs and the society that provides the contexts of the individual's behaviors.

Considering the social and intellectual components of Durkheim's theory, it is easy to see why Tinto was able to adapt the theory to describe the bipolar nature of the social and academic life found on the modern college campus. The social and intellectual arenas both provide opportunities for the individual to become integrated within the college community. Academic integration is much more formal than social integration with rules that are well defined and documented. Students must maintain prescribed levels of academic performance and follow specific programs of study found in published catalogs. Each course a student takes is governed by the contract of the syllabus which communicates expectations and consequences. In contrast, social integration has few formal rules other than those that are necessarily included in the student code of behavior to prevent chaos. Within the larger culture of the school are subcultures that may have more stringent and explicit social rules but membership is these subgroups is a choice of the individual. The success or failure of the integration depends on how the individual reacts to different integration mechanisms.

Durkheim's concept of egotistical suicide adopted for Tinto's longitudinal model of institutional departure is represented in Figure 1 (Tinto, 1993). The temporal model is divided into six stages across the top, Pre-Entry Attributes, Goals and Commitments, Institutional Experiences, Integration, Goals and Commitments (again) and Outcome.

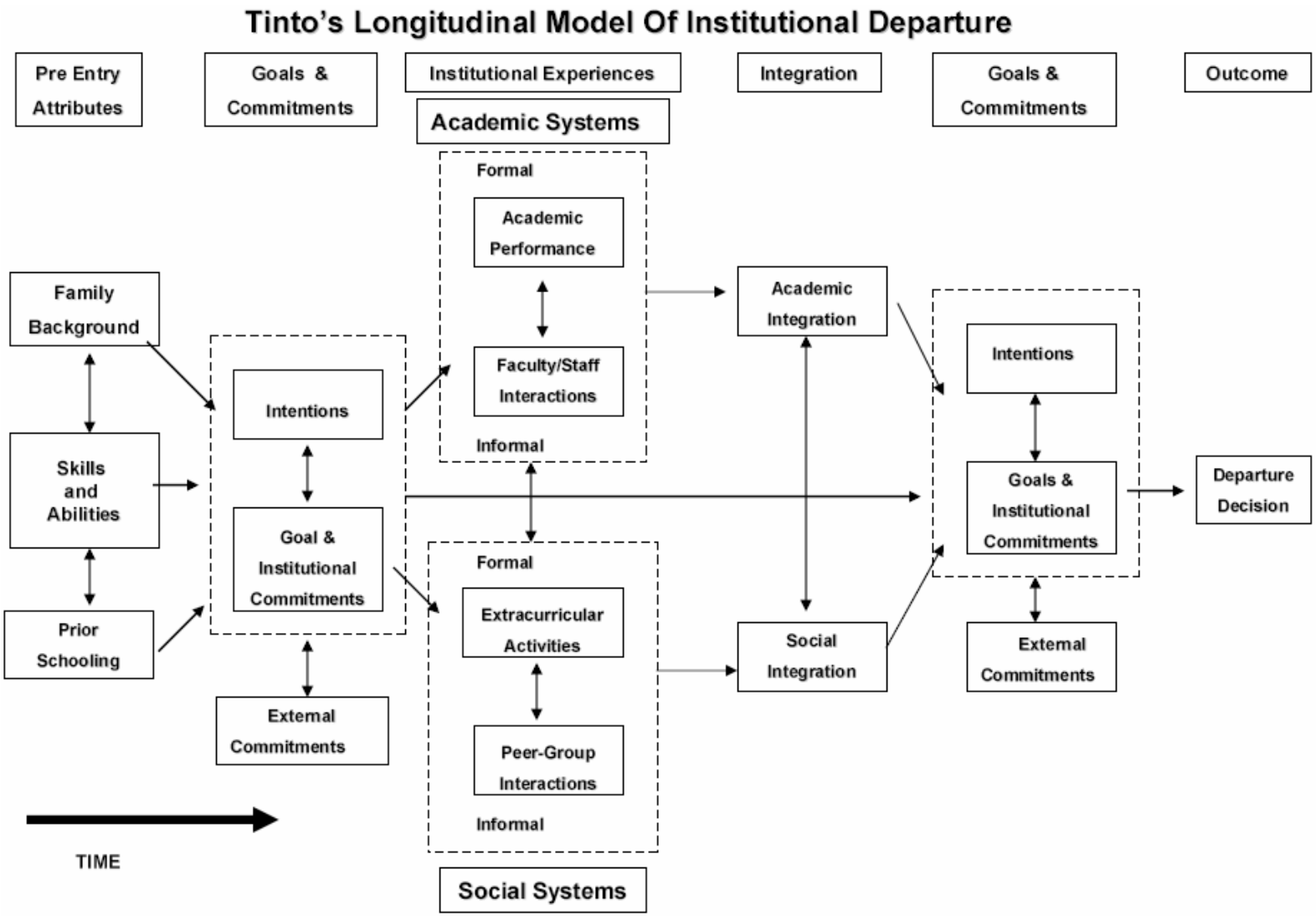

Figure 1. Tinto's model of institutional departure.

Pre-Entry Attributes include family background, skills and abilities and prior schooling. These three components describe characteristics that are for the most part objectively observable phenomena. Family background could be quantified as to income levels and educational attainment of family members. Skills and abilities are measured with the SAT, ACT, and other entrance tests. Prior schooling is recorded on transcripts. These three components interact with each other and provide us with a description of the individual prior to any attempt at integration within the community.

The Goals and Commitments stage is included twice in the model to stress the reiterative nature of this stage which is actually not a discrete stage but a pervasive ether that forms the context in which the individual acts. Tinto includes this stage twice to force the consideration of before- and after-interaction with the academic and social systems. The components of this stage include intentions, goal and institutional commitments and external commitments. Intentions and goals are much more challenging to measure than the quantifiable components of the pre-entry attributes. Commitments can manifest into observable behaviors. For example, the number of hours per week spent on studies or at work can be counted. External commitments also include marital status and parental obligations.

The institutional stage is broken down into academic systems and social systems. Components within each system are in turn broken down into formal and informal behaviors. Academic performance is the formal component of the academic system. The informal component refers to the faculty/staff interactions that comprise the more humane side of the academic system. The social systems of the institutional experience also have formal and informal components. Extracurricular activities are considered the

formal part of the social system, while the informal component pertains to peer-group interactions.

The integration stage includes academic and social integration. These two components are derived from the interaction of the goals and commitments stage and the institutional experience stage. Interaction is also possible between the two integration components.

Tinto reiterates the goals and commitments stage and illustrates how this stage is the product of the interaction of the integration stage and prior goals and commitments. The goals and commitments form the context and background for the last stage in the model, the outcome stage which only has one component – the departure decision.

When considering this model Tinto stresses three key characteristics(Tinto, 1987). First, the model is only concerned with what happens within the system; it does not address what happens to individuals after they leave the institution. In other words, once lost to the institution the individual is considered lost from the entire process of higher education even though the individual may persist elsewhere. Second, this model does not address academic dismissal. Departure from the system described in this model is considered to be a voluntary action of the individual. Finally, this is a longitudinal model that seeks to explain how interactions between the institution and individuals with differing characteristics result in differing departure rates.

Tinto also emphasizes that this is a sociological model, the focus of the theory is on the institution rather than the individual. This is not to say that the individual does not play a part in the departure decision. The theory describes the departure decision as

being made as a result of the interaction between the institution's ability to integrate the individual and the individual's independently held commitments, goals, and intentions.

Because the design of the model is particularly suited to studying departure decisions at the institutional level, Tinto argues that the model is relevant for institutional officials and planners to use when trying to identify the elements of the institution that hinder degree completion. Tinto asserts that the model will enable institutional officials to "…ask and answer the question, how can the institution be altered to enhance retention on campus?" (Tinto, 1987).

Tinto's theory of student departure with its intellectual and social integration has become the dominant theory in the field of student retention in the United States. Freshman Learning Communities (FLCs) and freshman experience courses are just two examples of how this theory has manifested itself in the retention efforts of schools across the nation. In the fall of 2002, the university offered a selection of over 30 different FLCs. These programs attempt to integrate students both academically and socially by building learning communities around unified curricular themes. The University of Syracuse in New York offers over 25 different varieties of FLCs. Appalachian State University's FLC in General Studies enjoys a national reputation. The national database referred to as The Learning Community Commons has over 200 different learning communities programs listed in its online database.

Almost every unit in the University System of Georgia offers some type of freshman experience course. Georgia State University offers GSU 1010: New student Orientation. Floyd College's offering is FCST 1100 while the University of West Georgia recommends University 101 as an elective for entering freshmen. University

101 is the same course title that is used by the University of South Carolina for its nationally recognized freshman experience course. Smaller in scope than a FLC the efforts of a freshman orientation course typically address topics such as study habits, time management, and library research skills.

The many features of Tinto's model help to convey the complexity of understanding the problem of student departure. His model is rich enough to describe a great range of human behavior and offers a variety of options to attack the problem of early departure; however, testing the theory is difficult. The model presented in figure 2, which is a subset of Tinto's full model, will serve to operationalize the theory and help to address the question at hand: how can orientation and advisement of incoming freshmen at the university with respect to initial mathematics course selection affect eventual degree completion? This simplified model, a model of placement and advisement for degree completion, highlights particular instances where we can extract concrete measures from Tinto's model.

The first component, skills and abilities, is taken from the Pre-Entry stage of Tinto's model. The box beneath this component indicates that this characteristic can be measured with the COMPASS mathematics test administered during the freshman orientation before school begins. The next measurement addresses the Institutional Experience stage of the student and takes place at the end of the first semester when we observe the actual course grade in the first mathematics course. The next observation takes place at the end of the first year and looks at the quality points generated by the student. This is an attempt to measure the Academic Integration stage by looking at how productive the student's relationship is with the University. In the final Outcome stage

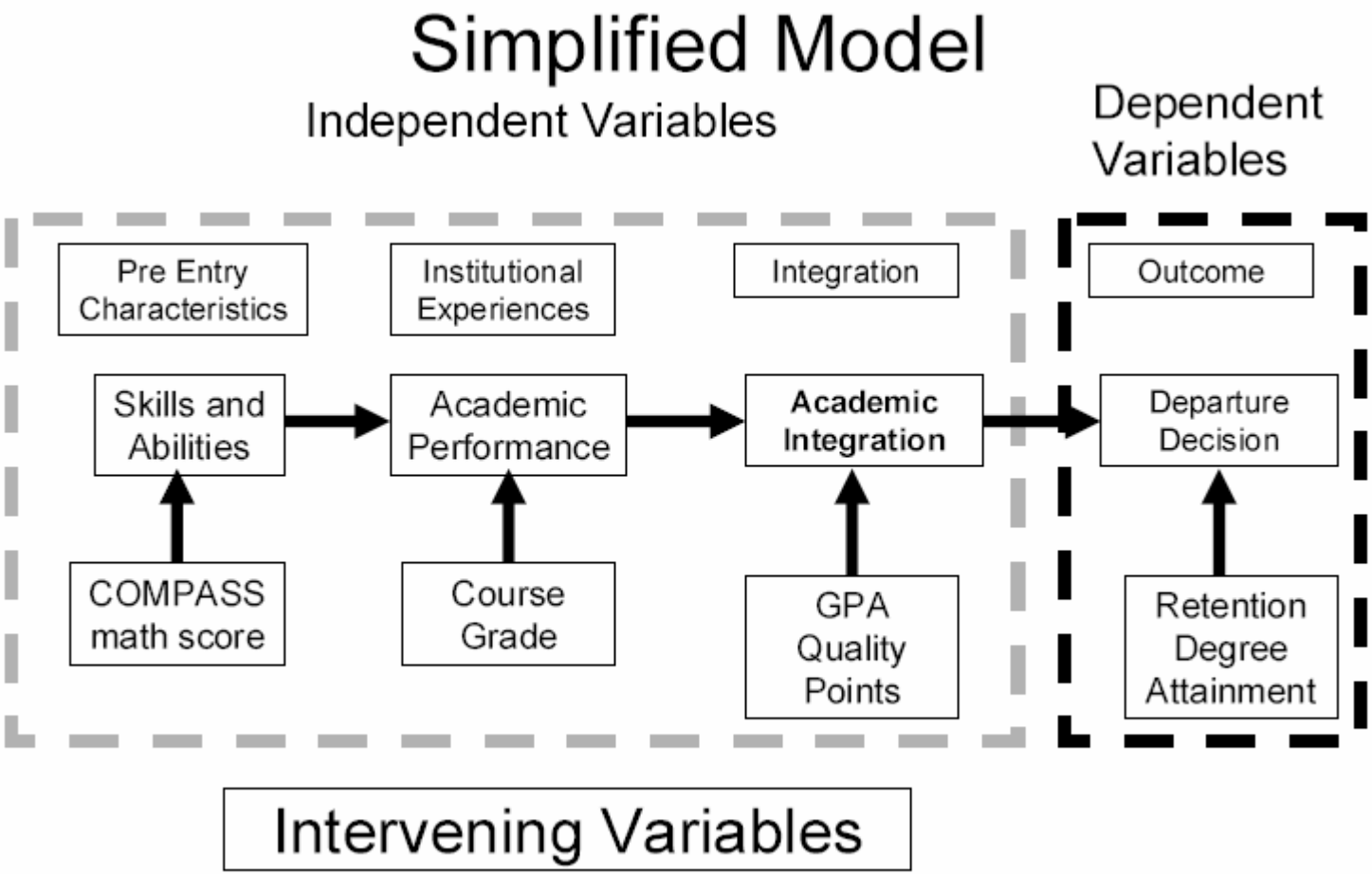

Figure 2. The simplified model.

the actual graduation rates are observed; this is the most important measurement of any attempt to improve student retention. As Adelman (1999) put it, “Degree completion is the true bottom line for college administrators, state legislators, parents, and most importantly students—not retention to the second year, not persistence without a degree, but completion”(p. v).

Research Questions

In order to better understand degree completion and its relationship to credit hour productivity in the first year, the grade earned in the initial freshman math class, and placement or advice that determines placement in that first math class this study will answer the following research questions:

1. What is the relationship between COMPASS score and grade in the initial, freshman math class?

2. Is there a link between performance in the first two terms as measured by quality points and eventual degree completion?

3. Does placement treatment into the initial mathematics class have an effect on the odds of degree completion?

4. What effect do other intervening variables have that may contribute to our understanding of this problem? In particular does participation in a Learning Community affect the accumulation of quality points at the end of the first two semesters?

Importance of the Study

The importance of this study lies in the fact that if the study can find a relationship between placement, advising, and degree completion and point to a "best" practice that would produce improvement in graduation rates, the benefits would literally last the lifetime of the students that would graduate. For example, if an entering freshman class of 3000 had a graduation rate of 30% without testing and advisement during freshman orientation and a comparable group of 3000 had a graduation rate of 35% with testing and advisement during freshman orientation, the gain in the number of graduates of these two classes is 150. These 150 hypothetical graduates will enjoy the benefits derived from their college degrees for the rest of their lives, benefits which include longer more productive lives as described above.

To the state and the nation these 150 graduates represent millions of dollars in tax revenues over their lifetime as well as a more educated and productive populace. The benefits of an increased graduation rate are not just a one cycle occurrence. Once the graduation rate improves, then the 150 extra graduates per year becomes a continuous dividend for the students, the state, and the university.

For the University, higher graduation rates represent fulfillment of the University's responsibility to serve its students, provide the state with an educated workforce, and show a return on the investment made by the state legislature on behalf of the people of the state of Georgia.

If placement testing and advising can reduce failure rates in freshman mathematics courses, then the university will function more efficiently. For example, if there were a 5 percent reduction in failures and withdrawals in a freshman mathematics

class that serves 3000 students then the 150 that would have failed do not need to repeat the course. If the number of attempts at a course can be reduced so dramatically, then the number of sections that the school needs to offer can also be reduced. The resources that would have been dedicated to these courses can be redirected to other needs.

An area where the university can also realize rewards with an increased graduation rate is in the area of admissions. One of the most expensive tasks in terms of enrollment management is recruitment and admission of new students. If graduation yields and retention can be improved, then the university will not need to replace dropouts with new freshmen. While the school will still have to replace graduates this will be after four productive years of consuming services and credit hours rather than after just one or two years of low yield production and then a premature departure from the university by those who fail to earn their degree.

An additional potential benefit from this study will be an understanding of the relationship between success in the freshman year and eventual degree completion. If a strong relationship is found between the two it may warrant the redirection of resources to encourage success by undergraduates during their freshman year.

One important aspect of this study is the longitudinal nature of the inquiry. Often experiments and programs are evaluated on the basis of relatively short cycles of one year. This study will take a long view of the questions related to degree completion and examine how small differences at the beginning of an undergraduate degree can manifest themselves across the years leading up to degree completion.

Summary

This chapter described college degree completion rates across United States and the difference between institutional graduation rates and student graduation rates. The chapter also introduced Tinto's Longitudinal Model of Institutional Departure and the sociological theories that form the foundation of the model. The section concluded with a description of a simplification of Tinto's model that will be used in this study. Finally the chapter presented the research questions to be used in the study and discussed the importance of the study as well as potential benefits that can be derived from the study.

CHAPTER 2

REVIEW OF THE LITERATURE

Prior to the summer of 2001 the decision of which math course that an incoming freshman at the university would take was based on SAT scores and the best guess of the incoming students as to which course would fit their intended major the best. During the summer of 2001 the university gave all of its incoming freshmen the COMPASS mathematics test as a placement test. Based on the results of this test students were given advice about which math course was the best placement for them to start in the fall. Students could choose to follow the recommendation, take a less advanced course, or take a more advanced course. The next summer students were again given the COMPASS mathematics test and placed into a prescribed course based upon their scores. Students could choose to take a less advanced course but they were not allowed to take a more advanced course than they were qualified for based on their test score. This implementation of the COMPASS testing program provided a unique opportunity to compare the three methods (no COMPASS; COMPASS with advice, and COMPASS prescriptive) of initial placement into a math course.

Purpose

The purpose of this study was to test portions of Tinto's (1993) longitudinal model of institutional departure that relates academic fit to persistence and degree

completion. The three different methods of initial placement into a mathematics course can be understood as three different approaches to integrating freshmen into the academic community.

Research Questions

Four research questions were developed to examine this topic and each question had its own set of independent variables that are related to dependent variables that measure some portion of the simplified model introduced in the last chapter.

1. What is the relationship between COMPASS score and grade in the initial, freshman math class? This first question addressed how pre-entry characteristics as measured by the COMPASS test and subsequent placement influence grades in the initial mathematics class at the university. In addition to the skills and abilities measured by the COMPASS instrument other measurements of pre-entry characteristics were considered. For example, high school grades and scores on standardized instruments like the SAT and the ACT were considered as well as the COMPASS score. The focus of this question was the transition from high school mathematics to college level mathematics. The COMPASS mathematics score serves as a standardized, real time measure of the pre-entry mathematics skills that the students bring with them from high school. It is important to know how well this instrument estimates the abilities students need in order to succeed in their first college level mathematics course. Ideally the instrument should recognize any disjuncture between where the student is (mathematically speaking) and where the student intends to go (initial mathematics placement).

2. Is there a link between performance in the first two terms as measured by quality points and eventual degree completion? This question explored the relationship between academic integration at the end of the first year, as measured by quality points and eventual degree completion. Production of quality points is an indication of temporal persistence as well as productive persistence. Degree completion can be thought of as accumulating enough credits and then obtaining a degree. Quality points capture production of credits as well as the involvement necessary by the student to produce a particular grade. High quality point production should indicate that a student is on track for timely degree completion.

3. Does placement treatment into the first mathematics course have an effect on the odds of degree completion? This question spanned the simplified model as well as the undergraduate academic career of the subjects and motivated the entire inquiry.

4. What effect do other intervening variables have that may contribute to our understanding of this problem? It is naive to believe that a placement test administered before the first class is taken can entirely explain a departure decision made by an undergraduate sometime in the academic career. This question was an opportunity to highlight other influences on the departure decision that may obscure the role of testing, advising and placement. In particular this question looked at participation in learning communities and the freshman orientation course.

Pre-Entry Characteristics

In 2004 Adelman authored *Principal Indicators of Student Academic Histories in Postsecondary Education, 1972-2000*, a comprehensive report combining data from three

investigations: (a) *The National Longitudinal Study of the High School Class of 1972 (NLS:72)*, (b) *The High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B/So:80-92)*, and (c) *The National Education Longitudinal Study of 1988 (NELS:88/2000)*. These three studies employed questionnaires that were administered to over 70,000 secondary students nationally and then followed up by sampling the post secondary transcripts of nearly 30,000 of the subjects. The final product purports to be "… a descriptive account of the major features of the post secondary academic experience and attainment of traditional-age students during the period 1972–2000, with an emphasis on the period 1992–2000" (Adelman, 2004). Much of this study matches some level of attainment to the pre-entry characteristics of the cohort; for example, eighty-eight percent of the class of 1992 enrolled in some form of post secondary education and persisted at least one year. Two thirds of the 12 percent that did not persist had enrolled in a community college. Seventy percent of those who did not persist accumulated less than 10 credits in the first year. Adelman characterizes students who earn fewer than 10 credit hours as "incidental". Once this portion of the cohort is defined by their level of attainment, Adelman proceeds to reveal facts about their pre-entry characteristics. The transcripts show that incidental students are more likely to delay entry into post secondary institutions after high school and start in a community college. Forty-two percent of the incidental students never got beyond Algebra 1 in high school. This fact is part of a consistent theme Adelman uses to show that the higher the level of mathematics course taken in high school the less likely the student is to become incidental (2004, p. 59).

Grade Distribution

Adelman's (2004) report, *Principle Indicators* also presents interesting information about the college grade distributions across the three cohorts presented here in Table 1 (Adelman, 2004). At first glance the distributions seem similar across the years and resistant to the forces of grade inflation that have dramatically altered the distributions of high school grades to be discussed later in this chapter.

Table 1

Distribution of Undergraduate Letter Grades

Grade	Class of 1972	Class of 1982	Class of 1992
A	27.3	26.1	28.1
B	31.2	32.8	29.9
C	21.9	22.2	18.2
D	5.4	5.8	4.6
F/penalty grades	3.8	4.8	4.5
Pass/credit, etc.	6.4	2.6	6.4
Withdrawal, no-credit repeat	4.0	6.7	8.3

Of particular interest is the last row that shows a growing percentage of grades of withdrawal (W) and no-credit repeat (NCR) courses. From the first study to the last the percent of the grades falling into this category has more than doubled. This trend is particularly troubling when the impact of the W and NCR is appreciated. Of those students who have three to six grades of W or NCR on their transcript, 43.1 percent do not earn even a certificate, much less an associates or bachelors degree. Less than 25 percent of the students that have 7 or more grades of W or NCR completed a bachelor's degree in the time frame of the study.

Multi-Institutional Attendance Patterns

Adelman (Adelman, 2004) also found evidence of the propensity to move from school to school when pursing a post secondary degree. Twenty percent of those who earned a bachelor's degree did so at an institution other than the one where they started their post secondary academic career. This finding about multi-institutional attendance is consistent with Adelman's (1999) earlier work *Answers in the tool box: Academic intensity, attendance patterns, and bachelor's degree attainment*, which found multi-institutionalism to be a growing trend. In fact, Adelman projected this trend to exceed 60 percent around the year 2000 (1999). This study was based *The High School and Beyond Longitudinal Study of 1980 Sophomores (HS&B/So:80-92)* one of three reports used in Adelman's 2004 *Principle Indicators* report. Transcripts of the national cohort of students were followed from 1980 when they were in the tenth grade until 12 years later when most were 30 years old.

Financial Aid

Among the interesting findings in *Answers in the tool box* was the result that after the first year of school, financial aid, outside of on campus employment, is irrelevant to degree completion. However other researchers disagree with Adelman's analysis of the impact of financial aid reporting that if the financial aid package is disaggregated into merit based awards and loans then the two types of aid had opposing effects over time that canceled each other out and obscured the influence of both (DesJardins, Ahlburg et al., 2002). These researchers found that impact of financial aid is further masked by the fact that aid operates on degree completion indirectly through stop out behavior. Stop out behavior describes non-enrollment during a term other than a summer semester. The

authors view stop out behavior and continuous enrollment as competing economic events. The extent to which aid can lower the cost of enrollment improves the likelihood of continuous enrollment which in turn leads to progress towards the degree. That is why merit based aid that does not have to be repaid continues to have a positive effect on degree completion over time. On the other hand, loans postpone the cost of enrollment and in fact add to the cost of enrollment in the long term. For this reason the researchers feel that loans after an initial beneficial influence on continuous enrollment eventually have a negative cumulative effect on enrollment and thus degree completion.

Strength of High School Curriculum

Even though Adelman (2002) did not find financial aid to be a significant factor in retention, he was able to demonstrate the importance of adequate preparation in high school for success at the college level. Adelman's analysis was based on the development of a regression equation derived to predict academic success in college. As his model evolved he was able to construct a variable from three parts, class rank combined with academic grade point average, test scores, and high school curriculum. He called this constructed variable ACRES, for academic resources. Of the three components of ACRES the rigor of the high school curriculum accounted for 41 percent of the weight of the variable compared to 29 percent for class rank and academic GPA and 31 percent for test scores like the SAT. Mathematics courses taken receive much of the attention here because, "Of all the components of curriculum intensity and quality, none has such an obvious and powerful relationship to the ultimate completion of degrees as the highest level of mathematics one studies in high school" (Adelman, 1999).

Adelman explains the importance of mathematics attainment with the observation that mathematics is much more sequential in nature than the other high school subjects and achievement in mathematics represents a cumulative effort. The characteristics that allow a student to achieve at high levels in high school math courses are also characteristics that predict success in college. Adelman argues that one way to increase college degree attainment is to encourage achievement in high school mathematics. Achievement in the mathematics curriculum is clearly marked by reaching advanced courses.

In a 2001 DoE report, *Bridging the Gap: Academic Preparation and Postsecondary Success of First-Generation Students* researchers found differences between first-generation college students and college students whose parents held bachelor's degrees. The disadvantages that affected the first-generation students were more than compensated for by a rigorous high school curriculum. In fact, first-generation college students from the most rigorous curriculum outperformed second-generation college students who were exposed to the same curriculum (Warburton, Bugarin, & Nuñez, 2001).

In order to get exposure to advanced mathematics courses students must not only perform, they must plan. Indeed for a student to navigate the traditional mathematics courses from Algebra I, Geometry, Algebra II, Trigonometry, and then Calculus requires planning and commitment that can begin no later than the eighth grade. Those who do are much more likely to attend college. "For any student who aspires to obtain a post secondary degree, it is useful for the planning process to commence as early as eighth grade or even before." (Atanda, 1999).

The Disconnect Between Secondary and Post Secondary Education

A disconnect exists between the minimum requirements of a high school diploma and what is needed to ensure academic success in college. This disconnect is not surprising when we consider the origins of the two systems. The public high school is a relatively recent invention with diverse and evolving missions. High schools also have to answer to many different constituencies represented by elected superintendents and school boards that hold real power over the day to day operations of the school. In contrast colleges in the United States have long histories that predate the founding of the country. Public colleges and universities are still institutions of the people but with much more insulation from the day to day interference from the public. The disconnect between these two systems is has been a concern for well over a century.

In 1893, the Committee of Ten, a subcommittee of the National Education Association (NEA) issued recommendations for four courses of study appropriate for the high school curriculum. The differences in the four courses of study were in the number of foreign languages and whether the languages were Latin and Greek or modern. Any of the four courses of study was considered appropriate for both the college bound and the non-college bound student (Urban & Wagoner, 2000).

The Committee of Ten prescription for a classical education was not well received by students and employers who were immersed in the industrial revolution at the turn of the century. School systems responded to the needs of their communities by providing vocational education. Chicago came close to establishing an entirely separate board of education for the vocational curriculum that would be composed of employers (Urban & Wagoner, 2000). This movement, which was not confined to Chicago, was opposed by

labor and educators and has led to combining all of secondary education into one system. When all of the vocational education, general education, and college preparation functions of the secondary system are confined to one building or campus the entity is known as the comprehensive high school. The modern comprehensive high school has become all things to all people who fall between primary school and adulthood. The client list for the comprehensive high school extends beyond its students to include parents, business, government, and higher education.

During the last century colleges and universities have experienced remarkable growth and change. In 1940 there were about 1,400 institutions of higher education in the United States; today there are over 3,400 (Isaacs, 2001). The college curriculum has also undergone growth and change during the same period. Most university catalogs contain entire constellations of majors that did not exist fifty years ago.

Given the disparity between these two systems it is not surprising to find that high school graduation requirements and post secondary standards are rarely consistent with one another (Venezia, Kirst, & Antonio, 2004). The disconnect between the two systems was not as critical in the past when a smaller proportion of high school students pursued college educations. In 1980, about 35 percent of high school seniors stated that they intended to get a bachelor's degree. By 1997 over half of the high school seniors indicated that they intended to earn four year degrees (Isaacs, 2001).

One consequence of the disconnect is the wasted senior year, when high school students with enough credits coast to graduation and essentially mark time academically for half a year or more. Many of these students assume that a high school diploma is all the preparation needed to succeed at the next level. Sadly, this is not the case; a poor

score on a college placement test might mean a year of remedial work before the student is allowed to begin earning credits towards a college degree.

This disconnect has been seized upon by ACT and Educational Testing Service (ETS) the two dominant testing organizations in the field of education in the United States. Both have recently fielded efforts aimed at addressing concerns related to high school graduates not being well prepared for the next stage of their life whether it is post secondary education or direct entry into the workforce.

ACT and the Disconnect

In its 2004 report *Crisis at the Core: Preparing all Students for College Work,* the ACT reported on the preparedness of entering college students across the nation (ACT, 2004). Every year the ACT collects data on how students perform in college and compares this data with their performance on the ACT assessment. The information that they have collected has allowed them to set benchmarks that represent the level of achievement a student needs to score on the ACT assessment in order to have a high probability of success in college courses. In particular, the ACT targets college level algebra, biology and English. A high probability of success is defined to be a 75 percent chance of making a C or better and a 50 percent chance of making a B or better.

Last year 40 percent of those tested met or exceeded the benchmark of 22 on the ACT for college level algebra. Only 26 percent were able to score 24 or higher to achieve the benchmark on the science subtest of the ACT. The English composition benchmark was 18 and 68 percent were able to reach that mark. Even though the English achievement is better by comparison than the other two benchmarks, the result still

indicates that about one third of high school graduates are not ready to succeed in a college composition class.

To improve these percentages ACT recommends a minimum high school core of four years of English, three years of mathematics, three years of science, and three years of social studies. For the year 2004, ACT test takers who had less than this core had an average score of 19.4, however, those who had taken the core curriculum recommended by ACT had an average of 21.9 on the assessment. Students who had only taken Algebra I, Algebra II, and geometry scored an average of 17.7, with only 13% achieving the benchmark of 22. When trigonometry is added to the transcript the average score increases to 20.3 with 37 percent achieving the benchmark. An additional advanced mathematics course brings the average score to 22.1 with 55 percent achieving the benchmark. Finally if the student reaches calculus, the score averages 24.6 with 74 percent at or above the benchmark. Clearly, there is a relationship between scores and course taking that suggests the ACT assessment is closely tied to the curriculum.

The point the ACT is making with this information echoes Adelman's position. The more mathematics students have the better prepared they are for college. The problem is that 60 percent of high school students do not reach trigonometry and less than one quarter take the first calculus course.

Along with encouraging high school students to take more mathematics, the ACT report also has recommendations for educational leaders and policy makers. Chief among these recommendations is to make sure there is a common understanding among K-12 and post secondary education about what is needed to be ready for college. Also leaders should raise expectations and provide every student the opportunity to take

"Courses for Success" which include: Biology, Chemistry, Physics, and mathematics courses beyond Algebra II (ACT, 2004).

ETS, The College Board, and the Disconnect

Traditionally the SAT I has not been perceived as being as linked to the curriculum as the ACT. However ETS can show that exposure to more advanced curriculum does correlate to higher test scores. For example the *2004 College-Bound Seniors: A profile of SAT Program Test-takers* report provides average SAT mathematics scores for students who have completed certain portions of the high school mathematics curriculum. The average score on the mathematics portion of the SAT for students who completed an algebra course was 512 and geometry was 515. Those who had taken trigonometry averaged 550. Precalculus completers had scores of 568 and the calculus students scored 606 (ETS, 2004). While the trend seems clear it should be pointed out that the verbal scores of these groups were also higher with the more advanced courses. Perhaps the gains could be attributed to maturity of the students who had been around long enough take the later classes. In fact ETS does not make the strong claims that ACT does in regard to high school curriculum and the score on the SAT I.

In its more than 50 year history the SAT has had many critics. One of the most vocal and important critics is the president of the 174,000 student University of California system, Richard Atkinson. Atkinson took the test himself in the fall of 1999 and the next day is purported to have said, "What the hell are these analogies?"(J. E. Barnes, 2002).

In response to Atkinson and other critics the SAT has undergone a major and some would say a long overdue overhaul. The newest version of the SAT was

administered for the first time on March 12, 2005 and is quite a departure from earlier iterations. Analogies and quantitative comparison questions have been discarded in favor of a 25 minute written essay and mathematics questions that go beyond clever algebra questions to items that come from deeper in the curriculum. Undoubtedly this new test will influence curriculum and the way business is done in the nation's high schools, but this is not the only way that the ETS/College Board is seeking to reform secondary education.

SpringBoard is a comprehensive performance based curriculum/testing/instructional program published by the College Board designed to augment or replace curriculum from sixth grade through high school. The following description is from the SpringBoard website (http://www.collegeboard.com/springboard/):

> SpringBoard is a unique program designed around the rigorous College Board Standards for College Success. These Standards identify the skills and competencies students need to be prepared for college. SpringBoard has backward-mapped these competencies from grade 12 down to grade 6. This enables you to provide a systematic, seamless and rigorous curriculum throughout middle and high school to better prepare students for college success. The result is that students will be better prepared for participation in the Advanced Placement (AP) Program and for college success. (College Board, 2005)

If the College Board can successfully dovetail SpringBoard into the AP program they will have connected into what some have called the de facto national honors curriculum in the United States (Isaacs, 2001). After modest beginnings in 1951 that linked freshman classes at Harvard, Yale, and Princeton to three private prep schools (Isaacs, 2001), the AP program has grown from less than 15,000 tests given in 1960 to over 1.8 million tests given in 2004 (College Board, 2004). The *AP Fact Sheet* (2004)

boasts that students who take just one AP course have a 45 percent chance of graduating in 4 years or less. Those who take two or more AP courses increase their chances to 61 percent. On the other hand those who do not take an AP course only have a 29 percent chance of graduating in four years. The College Board attempts to insure that AP courses are closely aligned with the college curriculum through a formalized program of regular consultation with higher education to carefully monitor the content of the college courses that the AP courses are linked to.

When SpringBoard is compared to the ACT attempts to map curriculum to the existing ACT test, the SpringBoard program is clearly more comprehensive as well as more expensive. Both efforts are aimed at bridging the gap between high school and college work. It will be interesting to see which, if either will prevail over the next ten years. At this point it is difficult to imagine how ACT can overcome the lead SpringBoard has inherited from the AP program, but the ACT approach is the least radical of the two and requires fewer resources to deploy. In the end the answer as to which system will dominate may be settled as much by marketing as it is by pedagogy and curriculum.

Placement Testing

Hopefully both the ACT and ETS/College Board systems can work towards the common goal of reconciling K-12 systems with post secondary education systems. However, the nationwide reform of our educational system from K-12 and post secondary to a true K-16 system is years away and may never happen. In the meantime, colleges and universities have to deal with the very real problem of matching incoming students with widely disparate abilities and experiences to college level classes. Both the

ACT and the ETS/College Board try to address this need with computerized adaptive tests (CATs) to give real time estimates of students' abilities.

Computerized Adaptive Testing

Both ACT and ETS publish CATs. The ACT product is called COMPASS, (COMputer-adaptive Placement Assessment and Support System). The ETS product CPT, (Computer Placement Test), is one component of their ACCUPLACER system that also offers advisement, data management, placement validation, and retention studies (ETS, 1995a). These programs are of particular interest because they are intended to be used with incoming college freshman to determine the most appropriate placement in reading, English, and mathematics courses, or if remedial prescription is necessary. Currently the University System of Georgia uses COMPASS as an exit test for developmental studies courses.

The foundation of CAT is item response theory (IRT). IRT is a group of mathematical models that allows for the analysis of items in order to make generalizations about tests and people who take tests. The responses a person makes on a subset of items in an item pool can be used to generate an estimated score for that person over the entire item pool. A larger number of items yields a more accurate score. However, surprisingly few questions are needed to achieve very accurate estimates of the true score for all of the items in the item pool. This is the chief benefit of a CAT. Up to 50 percent or greater reduction in the length of a test can be achieved while maintaining or improving the accuracy of a conventional test (Ward, 1988). The reduction in the number of questions required for accuracy is even more evident when the purpose of the test is only to classify students into broad placement groups rather than to place the

examinee precisely on a number correct scale. Another benefit of a CAT is that as it searches for the performance level of the examinee it does not administer questions that are too easy or too hard. "It is possible to determine achievement levels while allowing students to work with items that are challenging but not frustrating" (Smittle, 1993).

CAT uses IRT in four ways: calibration of item pool, item selection, estimation of ability level, and as a stopping mechanism. As a candidate answers each question during a CAT, IRT is used to generate an estimate of the ability level of that candidate. This estimate of ability level is called θ (*theta*). At the end of the test this estimate, θ, is converted into an estimate of the true score and reported as either a content domain score or as a percentage of the proportion of the domain that has been mastered (Bock, Thissen, & Zimowski, 1997). During the test θ is used to calculate which item remaining in the item pool will provide the best information for the test. This item will either provide the most information about the candidate or it is the item that will contribute the most to the stability of the estimate. When the stability of the estimate of θ has stabilized, the CAT will stop the test. This estimate of stability depends on the test information function another IRT statistic.

IRT differs from classical test theory in that the focus is the item rather than on the entire test. To obtain information about individual items an analysis of the responses of a large number of examinees is executed with a computer program like LOGIST or BILOG. These programs will find values for parameters that describe the functioning of the item in terms of *b* (difficulty), *a* (discrimination), and *c* (guessing). Once these parameters are determined, the item characteristic curve (ICC) can be computed using the $P(\theta)$ function defined in equation 1.

$$P(\theta) = c + \frac{1-c}{1+e^{-1.702a(\theta-b)}} \tag{1}$$

An ICC is a monotonically increasing function of theta, θ, the variable used to measure ability. Theta has a theoretical range from $(-\infty, \infty)$ but in practice the range is (-3, 3). The ICC is also a probability function that is asymptotically confined by the number one above and *c*, the pseudo-chance parameter, below. The parameter *b* is the item difficulty. This is the level of difficulty where an examinee of random ability has a 50% chance of answering correctly. Parameter *a* describes the discrimination of a particular item. This discrimination is seen graphically in the slope of the ICC at θ = *b*. The last parameter *c* is the probability that an examinee with no ability will answer a question correctly. For example if a question had four possible answers the expected value of the *c* parameter would be about 25%.

The item pool is the foundation of the test. "The quality of the item pool is paramount to CAT performance. Two factors that determine the item pool's quality are the locations of the items and their discrimination indices" (De Ayala, 1992). The ideal test pool will have items that have *b* parameters that cover the range of interest with an even and equal distribution (De Ayala, 1992). The higher the *a* parameter the more discrimination power an item has. Items with low discrimination values do not distinguish very well between high and low θ values. The *c* parameter is the lower asymptote of the ICC. The lower the *c* value the better, because high *c* values compress the information available from the curve.

An interesting difference between COMPASS and the CPT product is the number of choices in the multiple-choice test. The CPT is a four-option test (ETS, 1995b), which would place the *c* parameter at approximately 25%. The COMPASS test is constructed with five option questions (Callahan, Commander, & Cotter, 2005), which would make for a *c* parameter value of about 20%.

The development of an item pool requires a tremendous amount of resources. For the first iteration of CPT items were selected from the New Jersey College Basic Skills Placement Test (NJCBSPT) that met certain statistical requirements. Analysis of this pool revealed gaps that could not be filled with existing items. About 500 new questions were written that targeted these gaps. These questions were presented to about 50,000 students from 199 high schools and 59 colleges along with additional items from the NJCBSPT for equating purposes. Analysis of these results was performed using LOGIST and the three-parameter model. Finally 120 items for each content pool were selected (Ward, 1988).

A criticism of both programs is the size of their item pools. Both currently claim to have item pools of about 200 for each of the mathematical content domains. After exhaustive empirical examination of the ETS product, only about 60% of the claimed items have been exhibited in the algebra content domain (Chang, 1998).

Both COMPASS and CPT use IRT to customize a test administered to an individual by selecting the most appropriate items for the test based on the responses of the individual. But item selection is not the only adaptation that these two programs exercise. If the score of a test taker is high enough then the programs can pass the examinee into another test or content domain without telling the examinee what is

happening. So if the test taker scores high enough on the algebra portion of the test then the test can move into a college algebra domain and then on to trigonometry if needed. This ability to shift content domains is an advantage over paper and pencil tests that would have to be graded before the high scorers could be identified and then brought back to the testing center for more testing.

On the other hand if the examinee's scores are low enough and indicate that some diagnostic information needs to be gathered the program can route the examinee into diagnostic test (ETS, 1995a). The test taker receives no indication that he/she is being moved from one domain to the next, however it is possible to start with a pre-algebra test and pass through algebra, college algebra, geometry, to trigonometry (ACT, 1993).

Another important feature of the CATs discussed here is that they are both power tests; meaning that the tests are not timed. Test takers usually find that this advantage more than makes up for the fact that they cannot revisit a previous item on the test.

CPT Placement Test

Karen Borglum and Thomas Kubala used the CPT instrument in a study that tested Tinto's model of retention in a community college setting (Borglum & Kubala, 2000). The CPT was used to measure pre-entry characteristics of the study's participants. Social and academic integration were measured with a modified version of an enrollment satisfaction survey. While this study failed to show any correlation between integration as measured by the survey instrument and retention, it did find a correlation between CPT mathematics scores and grades of W in mathematics classes (Borglum & Kubala, 2000).

High School Grade Inflation

One of the primary reasons real time estimates of ability are important to colleges and universities has to do with the reliability and validity of high school grades. Grade inflation is a nation-wide phenomenon that will lead anyone to doubt the veracity of high school transcripts. In a 2004 study, David Woodruff and Robert Ziomek found that high school grades had increased 0.20 to 0.26 on a four point scale in the period from 1991 to 2003. This change happened while actual attainment on the ACT did not change (Woodruff & Ziomek, 2004).

Since 1968 the Higher Education Research Institute (HERI) has conducted surveys of incoming freshmen across the nation. The *Higher Education Research Institute 2004 annual report on entering undergraduate class* (HERI, 2005) is based on a sample of 289,542 students. The data is statically adjusted to reflect the responses of the 1.2 million first-time, full-time, freshmen entering four year colleges in fall 2004. The portion of students who reported earning an A average in high school in this group rose to an all time high of 47.5 percent. This number is up from 46.4 percent in 2003, 34.1 percent in 1999, and 17.6 percent in 1968 the all time low from the first year of the survey. At the other end of the scale, only 5.1 percent had an average of C+ or below compared to 23.1 percent in 1968 (HERI, 2005).

Along with the inflated credentials bestowed by the high schools comes a heightened confidence. In 1999, 58.5 percent of entering freshmen ranked themselves in the top 10 percent of their class. In 2003 this portion climbed to 69.7 percent (HERI, 2005).

Nontraditional Students

In *Descriptive Summary of 1995–96 Beginning Postsecondary Students: Six Years Later,* a study for the DoE by Berkner, He, and Cataldi (Berkner et al., 2002), the researchers found that nontraditional status is another pre-entry characteristic that is associated with higher instances of dropping out of higher education. Students who were nontraditional in status received much of the attention in this study. The Georgia State University Undergraduate Catalog 2004-2005 specifies that to be considered for a nontraditional admission an applicant must meet these four criteria: 1) has been out of high school at least five years, 2) holds a high school diploma or a GED, 3) has not attended college in the last five years, and 4) has earned fewer than 30 transferable credit hours (Georgia State University, 2004). The definition for the DoE study approached the definition of nontraditional student less rigidly. Rather than defining what nontraditional status is, Berkner et al. started with the traditional student and then listed characteristics that moved the individual away from a traditional student's profile. The more of these characteristics that an individual possesses; the more he or she is a nontraditional student, a designation which carries with it a higher risk of dropping out.

The two most important characteristics associated with being a nontraditional student identified in this study were part-time enrollment and a delay of entry into higher education after high school. Other nontraditional characteristics include not having a regular high school diploma, having children, being a single parent, being financially independent from parents, and working full time (Berkner et al., 2002). On the other hand the complement of this set makes up the set of traditional students. Characteristics

of the traditional group include enrolling immediately after high school, full-time attendance, financial dependence on their parents and only working part-time if at all.

Institutional Experiences and Integration

Tinto's theory of college student departure, which was first published in 1975, is the dominant theory for understanding student departure from institutions of higher learning. There are more than 170 dissertations and 400 citations that reference Tinto's work (Braxton, Milem, & Sullivan, 2000). Over the last quarter century a student retention industry has grown up around Tinto's theory. The intent of the industry is to improve student retention on campus through various means that are suggested by the theory.

Recommendations from the Theory

Recently Linda Lau (Lau, 2003) reported on ways that institutional administrators, faculty, and students can implement measures suggested by the theory that have demonstrated effectiveness in regards to increasing student retention.

Lau's recommendation for administrators are numerous and expensive. Scholarship programs are at the top of the list and Lau cites the success of the Hope Scholarship in Georgia as a way to improve retention. Advisors, both academic and career, are essential components of a successful retention program. Another way for administrators to have a positive impact on retention is by establishing and maintaining Learning Centers. Learning Centers can meet many needs not addressed within the traditional boundaries of the classroom. Lau suggests faculty involvement for hiring decisions and development of programs which target disadvantaged students.

Freshman Year Programs are a highly visible way that institutions can reach out to new freshmen and help them make the transition from home to campus life. Lau cites studies that show that programs of this type produce higher academic achievement and student satisfaction as well as increased student retention. Other recommendations for administrators include dormitories, study rooms, career centers, and social and professional organizations to promote extracurricular activities. All of these recommendations fall under the umbrella of fostering community and therefore academic and social integration.

Lau's recommendations for faculty to improve retention include classroom practices such as cooperative learning and collaborative learning. In cooperative learning importance is placed on group activities. Group discussions, group projects and group presentations are all cooperative learning activities that encourage development of the classroom community. Lau describes the dynamic practice of collaborative learning as, "a dynamic student-centered, task-oriented learning process involving both faculty and students" (p. 133). Lau also emphasizes the faculty role in academic advising. Lau states that advising is more important to freshmen than to seniors because freshmen need more guidance and support. Faculty involvement with students outside of the normal classroom is a one way to build the academic and social integration which increases the commitment between the student and the institution.

Effort and responsibility are two themes that permeate Lau's last set of recommendations for students. In particular there is a social and academic responsibility for students to take part in and acclimatize themselves to their new learning community.

All of the factors and recommendations of Lau's article are designed to produce a meaningful and healthy learning community that is built by the administration, faculty, and students. If all of the suggestions were implemented then we would have an idealized product of the retention industry that manifests many of the ideas that have grown up around Tinto's theory of student departure from higher education. This finished product would be designed to maximize the type of institutional experiences that would increase integration. The desired byproduct of this integration is increased student retention.

Learning Communities

One of the more appealing features of Tinto's theory is that it seems pragmatic and grounded in common sense. In other words, it is easy to explain and sell intervention plans based on Tinto's theory. A case in point is a study Tinto published in 1997 that concerns implementation of a learning community at a two-year commuter school.

The Coordinated Studies Program (CSP) at Seattle Central Community College is a multidisciplinary approach that clusters several courses into one offering. Students are enrolled as a cohort into a group of courses that are tied together with a theme; for example "Ways of Knowing" or "Of Body and Mind". Classes meet in four to six hour blocks for a total of 11-18 hours a week. Typically all instructors are present and active at each class meeting (Tinto, 1997). The CSP incorporates cooperative activities that encourage students to experience interdisciplinary learning which requires active involvement with their peers. The activities and the classes are designed so that the group learning is dependent on the learning of each member (Tinto, 1997).

Tinto's study of the CSP was a mixed method study (1997). The purpose of the study was twofold: (a) first to ascertain if the CSP had any effect on retention and (b) if it did have an effect to determine how was it accomplished? Tinto's first question was the focus of a quantitative methods approach (logistic regression) and the second question was addressed qualitatively (case study). The quantitative portion of the study revealed significant gains for the CSP group over a control group. These gains included higher rates of participation in a variety of activities, for example, time spent studying, library use, time with instructors, and time spent on coursework. The CSP group also achieved a higher GPA than the control group. The retention rate to the next fall of the CSP group was 66.7 percent compared to only 52.0 percent for the control group.

After an analysis of the case study data Tinto attributed the success of the program to three key features of the program. First, students were able to build supportive peer groups. These peer groups also served to aid in the development of an extended community outside of the CSP group and thus increase integration into the college as a whole. The second feature Tinto highlighted was shared learning. This type of active learning uses social aspects to realize academic gains. The final feature was at once individual as well as group-oriented. When students put their voice into a group setting they take ownership of the construction of knowledge. The ownership of the knowledge is ratified by the group as well as shared by the group. The interaction of individuals with the group in the sharing and construction of knowledge has the power to integrate both academically and socially.

Tinto makes some observations about the results. First these results show that the reasoning behind learning communities and collaborative teaching is sound. Second

participation in a learning community that practices collaborative learning helps students develop ties to the community that becomes a network of support. Finally this initial small network can facilitate connections to the larger network that represents the social and academic communities of the college (Tinto, 1997).

Elaboration on Tinto's Theory

Tinto concludes his article about CSP with a closing comment about the implications for existing models of student retention. He augments his classic model (figure 1) with one that uses the classroom to bridge social and academic systems of the college communities. This bridge leads to a new component called "Quality of Student Effort" which in addition to the classroom has social and academic integration as direct antecedents.

Even with the introduction of the modified classroom model of retention, Tinto (1997) still seems dissatisfied with the model's ability to describe the phenomena. "The likelihood that persistence is marked overtime by a changing balance of academic and social involvements leads us to consider the parallels between the longitudinal process of persistence we have just described and those that describe moral and intellectual development" (p. 618). He then proposes recreating the model by building it around two nested spheres. The larger sphere represents social systems and the inner sphere would represent the academic system. The implication is that the dynamic of institutional experiences and integration is much more complex than depicted by the original model.

Revising Tinto's theory to incorporate the importance of active learning was the emphasis of a study published in 2000 (Braxton et al., 2000). Braxton et al. noted that the mechanism of the integration function of Tinto's original theory had yet to be

satisfactorily explained. Several attempts have been made to elaborate on the original theory which considered among other things institutional type, organizational attributes, motivations for attending college, financial aid, expectations, sense of community in residence halls, student involvement, and self-efficacy. To this list of elaborations the authors added their own. Braxton et al. proposed that active learning is the mechanism of integration. The argument was that active learning encourages student involvement which leads to academic and social integration. The authors also felt that student advisement is of critical importance, and suggested that advisors should be informed about the teaching styles of professors to help them match the learning styles of their advisees.

Grades in College

Many researchers (Astin, 1997; Beck & Davidson, 2001; Borglum & Kubala, 2000; Braxton et al., 2000; DesJardins, McCall, Ahlburg, & Moye, 2002; Kern, Fagley, & Miller, 1998; St. John, Hu, Simmons, Carter, & Weber, 2004; Tinto, 1997) use GPA and grades in general as measures of academic integration. It is important to acknowledge that grades are subjective measures that are not without validity and reliability concerns.

Armstrong (2000) found grading differences between part-time and full-time English professors contributed as much as 20 percent to the variability of the grades in the course. Among the results that Armstrong found most important in his study of nearly 4000 English students and 3700 mathematics students in California was the assertion that educational standards are not determined by the entering ability of its students, they are owned and maintained by the college. Armstrong feels that the college

should somehow assert ownership of the standards and determine how much variability in grading between different professors was tolerable. Interestingly, he did not find any grading variability between full-time and part-time mathematics instructors.

On the other hand, Burgess and Samuels (1999) found that differences between grading practices of part-time and full-time mathematics instructors led to unexpected results in failure rates in the second course of two course mathematics sequences. Of the combinations of part-time and full time instructors a student could have in a two course sequence those students who had a part-time instructor for the first course and subsequently had a full time instructor for the second course were at a much higher risk of failing the course than students in the other three possible sequences; full-time, full-time; part-time, part-time; full-time, part-time(Burgess & Samuels, 1999). The researchers attributed the high failure rate in the second course to lenient grading practices by part-time instructors in the first course that allowed weak students to get to the second course unprepared.

Differences in grading practices across disciplines has received the attention of researchers at Oklahoma State University (L. L. B. Barnes, Bull, Campbell, & Perry, 2001). Adaptation-level theory suggested that differences in grading across disciplines results from the isolation between the fields and an evolution that is accelerated by mimicry within the discipline. Disciplines that have a reputation for being rigorous attract those who can compete on those terms while fields with reputation for lenient grading attract the less competitive. Barnes et al. applied a much more sophisticated model to this problem and differentiated disciplines on three characteristics: paradigmatic (hard science) or pre-paradigmatic (soft), pure or applied, and life or non-

life. The researchers found differences in grading behaviors by discipline classification as well as personal beliefs of the grader about using norm referenced tests to sort and classify students.

Intervening Variables

Intervening variables are factors that are outside the scope of the simplified model. It is likely that these variables play a role in degree completion that is unaccounted for by the simplified model.

Temporal Economics

DesJardins, Ahlburg and McCall (DesJardins, Ahlburg et al., 2002) also used grades as a measure of integration in their study of temporal factors relating to degree completion. Their analysis describes GPA as an extrinsic reward for academic achievement and notes a higher GPA lowers the risk of early departure. DesJardins et al.'s economic arguments are even more compelling when he uses a temporal analysis to describe how the market forces change over time. So while grades have a strong influence on persistence at first, this effect diminishes over time. Viewing grades as a reward is consistent with DesJardins et al.'s economic approach that places departure and persistence decisions into the familiar frame of costs and benefits. The decision to persist or not is a matter of optimization of the benefit for each individual. So students are constantly weighing the options and deciding what action is best for them with the information that they have available at the time. For example, in the field of nursing the difference in the rate of pay for a two year degree and a four year degree is negligible. Combine the small difference in pay rate and the lost opportunity cost when completing a four year degree, then the decision not to persist can be interpreted as a sound economic

decision. On the other hand students in a high demand field that commands relatively larger rewards for individuals with completed degrees have an economic motivation to persist. The difference in the rewards for careers in social science awaiting social science majors compared to business majors has been used to explain differences in persistence between the two groups (St. John et al., 2004).

Student Ratings of Instructors

In the first ever publication of a study that examined course evaluations and student persistence Langbein and Snider (Langbein & Snider, 1999) found both predictable and surprising results. The question of what course evaluations actually measure is the source of much debate. There is evidence that information about the quality of instruction, time spent on the class by the student, and anticipated grade can be captured with a student evaluation. However, student evaluations can also be related to other information that has little bearing on the quality of instruction, for example, gender of the student (Langbein & Snider, 1999).

If course evaluations are interpreted as being in some measure an instrument of customer satisfaction with instruction, then it is not surprising to find that students who experienced particularly poor classroom experiences as indicated by class ratings were less likely to persist than other students. The surprising result of Langbein and Snider's study was that persistence and quality of instruction is not a linear relationship. Students who were consistently enrolled in top-ranked courses were just as likely to leave as those who were consistently enrolled in courses with low rankings. To explain this occurrence Langbein and Snider posit that the students who experience high quality instruction develop a higher sense of expectation and are not satisfied with an average class

experience. The result is that overall satisfaction with the school drops and early departure is the consequence of superior classroom experience.

The implications of this finding argue against providing high quality instruction in first year freshman learning communities unless it is followed by equally high quality instruction in subsequent years. If students see quality instruction once then they will know what they are missing when they return to a normal classroom and go elsewhere in search of satisfaction. As interesting and provocative as this study is we must keep in mind that it is the first of its kind and needs to be replicated in other settings.

Outcomes

The simplified model of placement and advisement for degree completion is ultimately concerned with degree completion. However, there are several intermediate stages in the model with their own outcomes.

COMPASS Math Score

The COMPASS math score is the estimate of the mathematical abilities that the incoming freshmen possess. If the COMPASS instrument is a reliable and valid measure of mathematical abilities then it is reasonable to expect this test to provide benchmarks for success in the variety of courses in which freshmen may enroll.

Grade in the Initial Mathematics Course

The grade in the initial mathematics course is the first measure of Academic Performance and should correlate with the COMPASS score for ability as well as high school grades which indicate study habits. As Armstrong (Armstrong, 2000) said, “Past behavior is often the best predictor of future behavior.” (p. 689). The grade in the initial

mathematics course will provide the information we need to evaluate the effectiveness of the COMPASS test as a placement instrument. It will be interesting to see if the hard truncation rules of the 2002 COMPASS/prescriptive placement produce different correlations than the 2001 COMPASS/advising placement. Also if the correlations drop is there any change in the value of the COMPASS as a placement tool?

Quality Point Production at the End of the First Year

Naturally since the grade in the initial mathematics class is a component of the quality point production in the first year there should be some degree of correlation. The strength of the correlation may indicate if success in the initial mathematics class carries over to other subjects and also serves as an early indicator of success in the entire first year. High quality point production should also indicate progress towards degree completion. Cumulative hours earned and GPA will also be considered even though they are related measures of the same construct. It may be that raw hours towards a degree are more important than the quality of work indicated by grades.

Degree Completion

Degree attainment is the bottom line measure of a successful undergraduate program. Since the scope of this study will terminate before the freshmen of 2000, 2001 and 2002 will have had six years to work complete their degrees we will project the graduation rates for these cohorts. We can make this projection by looking at the quality point production of earlier cohorts, 1998 and 1999 freshmen that have had six years to complete a degree. It will simplify the study not to go back any further to avoid complications that would arise from the system wide conversion from the quarter system to the semester system.

The benefits of degree completion have already been discussed in the statement of the problem in chapter 1. But it bears repeating that the rewards of degree attainment are a resource that the degree holder, the family of the degree holder, the community, the institution that granted the degree, and society as whole benefit from. These rewards are persistent even beyond the life of the graduate.

Summary

This chapter has reviewed literature that relates to both independent and dependent variables under consideration in this study. Pre-entry characteristics and the disconnect between secondary and post secondary education systems dominate the literature. Institutional Experiences and Integration were deliberately considered together because the literature does not discuss one without the other. Some possible intervening variables that fall out side the purview of the simplified model were also mentioned. These factors have much to contribute to the understanding of the college retention problem. Finally the outcomes of the different stages of the study were discussed.

CHAPTER 3

METHOD

This chapter describes the research design and methodology used for this study. It begins with a restatement of the problem, a description of the general design of the study, followed by an overview of the population being studied; next data collection procedures are explained and finally the methods of data analysis are introduced.

The setting for this study is a research university located in the southeastern part of the United States. The undergraduate student population is just under 16,000 but when combined with graduate students the head count is close to 27,000. Each summer the university conducts a freshman orientation program for incoming freshmen called Incept. The Incept orientations are one day events attended by groups of incoming freshmen that range in size from 20 to 200. Typically an Incept day consists of two hours of COMPASS testing during the morning followed by a walking tour of the campus and lunch. In the afternoon academic advisors help students select their initial classes for the fall semester. The implementation of the COMPASS testing during Incept in 2001 and subsequent revisions to the program in 2002 presents a unique opportunity to evaluate the effects of placement testing on retention.

Design

The design of this study is illustrated in figure 3. The general design is an ex post facto, quasi-experimental design with two experimental treatments. There is no

randomization of the approximately 4,845 participants that are divided into three nonequivalent groups by the year they began their undergraduate studies.

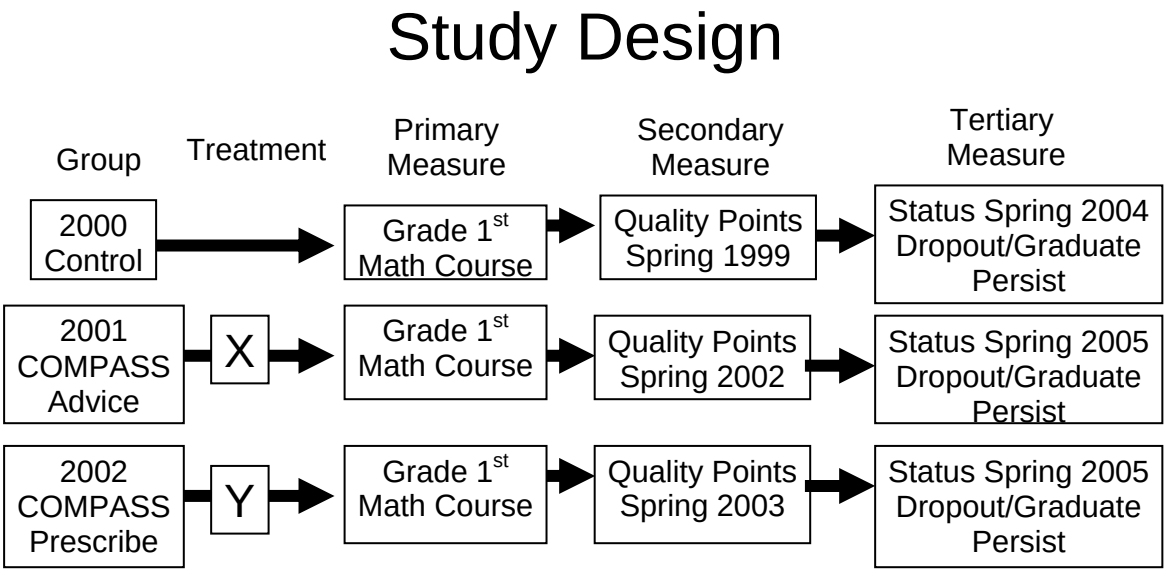

Figure 3. Study design.

First-time entering freshmen who enroll in a math course in the fall of 2000 will serve as the control. This group, designated "2000 control" had 1,654 subjects. The first treatment group, designated "2001 COMPASS Advice", is defined to be all freshmen from the fall of 2001 who took the COMPASS test and received advice about which course mathematics course to take and subsequently enrolled in a mathematics course during the fall semester. There were 1,688 subjects in the 2001 COMPASS Advice group. The second treatment group, "2002 COMPASS Prescribe", consisted of all first time freshmen who took the COMPASS test prior to enrolling in a mathematics class in the fall of 2002 and were told which mathematics class to take. There were 1,503 subjects in the 2002 COMPASS Prescribe group.

A six year time period is the typical basis of comparison when considering graduation rates (Adelman, 2004; Berkner et al., 2002). So in addition to the three

cohorts discussed so far data was also collected on subjects from the entering freshmen class in 1998 and 1999. These subjects were selected because they were first time freshmen who enrolled in a mathematics course their first semester of college. The 1998 cohort consisted of 1,355 subjects and the 1999 cohort had 1,425 subjects.

Data Collection

The majority of COMPASS scores used in this study were collected during Incept orientations held during the summer of 2001 and 2002. Each incoming freshman is encouraged to attend one of about 20 Incept session held during the summer June till August. Inevitably some miss the orientation and must be tested on an individual basis by appointment or during a make-up session near the end of the summer.

Scores for the COMPASS test as well as high school GPA, SAT, demographic data, grades, and enrollment status are incorporated in the Banner student data base at the university. The data for this study will come from this data source. Access to this system will require the permission of the University Registrar and approval of a Research Project Involving Human Subjects by the Institutional Review Board.

Data collection was executed on January 5, 2006. All personal information (names, addresses, phone numbers, social security numbers) that might be used to identify individual subjects was "scrubbed" from the files before the information was available for analysis. The initial database contained basic demographic information from 113,447 individuals who had attended the university from the fall of 1998 until the fall of 2005. During this time period these individuals generated 1,710,724 grades and 51,347 degrees that ranged from Ph.D. and J.D. to undergraduate. In addition to grades, degrees and the basic demographic information the database contained all available test

scores and high school grade point average. The database is a compilation of all of the academic information that is available to the university. When the database is looked at on a subject by subject basis it looks like a transcript that can be sorted by semester to recreate the academic history of the individual.

The subjects for this study were identified by sorting the database by course and date. If a subject had any course work before the initial mathematics course then they were eliminated from the study. Using this selection method cohorts from 1998 and 1999 were also identified for comparison purposes and to establish benchmarks used for defining successful completion of the first year. The 1998 cohort contained 1,355 subjects and the 1999 cohort had 1,425 subjects.

Data Analysis

Many of the questions in this study involve dividing students based on performance on a test, performance in a class, and quality point production into either successful of non-successful categories. Logistic regression is a statistical technique appropriate for analyzing data with binary dependent variables and continuous as well as categorical independent variables (Agresti, 1996; Pedhazur, 1997; Wright, 1995).

The APA recommends four components to be included when presenting logistic regression results: (1) overall goodness-of-fit measure; (2) model coefficients with test statistics, probabilities, and confidence intervals; (3) odds ratios; and (4) a classification table with a summary of classification accuracy.

In addition to logistic regression analysis descriptive statistics were calculated for all five groups including demographics and SAT scores. The groups were then compared for pre-entry differences that would preclude later comparisons. While some statistical

differences were found between the groups the differences were not large enough to preclude comparisons between the groups and the use of the data to address the four research questions:

1) What is the relationship between COMPASS score and grade in the initial, freshman mathematics class? Specifically, given a COMPASS score what are the odds of an individual being successful in a particular class? Logistic regression is an appropriate tool to address this question that pertains to the relationship between COMPASS math score, a continuous variable, and the grade in the first math course, a categorical variable. This analyses should identify the appropriate cut scores at which students would have a 50 percent chance of making a "B" or higher in the course and 75 percent chance of passing the course.

2) Is there a link between performance in the first two terms as measured by quality points and eventual degree completion? This question again pairs a continuous variable, quality points at the end of the first semester, with a categorical variable, degree completion. Logistic regression will be used to examine this question. This analysis can only be executed with the control group because the two experimental groups will not have the six years that is customary to evaluate graduation rates.

3) Does placement treatment into the initial mathematics course have an effect on the odds of degree completion? Since the two treatment groups and the control group have not had the six years customary in graduation studies at the time that the data was collected the answers to this question will depend upon comparisons of the control group and the treatment groups to the 1998 and 1999 groups. These inferences will make it is possible to suggest the graduation rates for the experimental groups by comparing the

intermediate stage of first year quality point production of all groups. The 1998 group has demonstrated that there is a strong relationship between quality point production in the first year and graduation rates. Given the fact that quality point production is an early indicator for graduation establishes benchmarks for success that can be used for comparison amongst the control and treatment groups. Logistic regression will be used to examine the relationship between placement treatment and quality point production at the end of the first year. If placement treatment is related to increased quality point production of the two treatment groups then we will be justified in an expectation of higher graduation rates for the treatment groups. A definitive evaluation of this inference will have to wait until the summer of 2007 for the advising group and summer of 2008 for the prescriptive group.

4) What effect did other intervening variables have that may contribute to our understanding of this problem? In particular did participation in a Learning Community effect the accumulation of quality points at the end of the first two semesters? Logistic regression is also an appropriate tool to address this question since the independent variable (participation in a learning community) is categorical and the dependent variable (quality points) is continuous.

Threats to Validity

An important assumption of the study is that the three comparison groups were equivalent. The equivalency of the groups was tested using SAT scores. By using the SAT as a pretest the veracity of this assumption was examined. Some minor differences were found in the mean SAT math score between the groups under consideration. The differences between these groups are similar to a national trend in the scores on the SAT

and are not thought threaten the study. Even if these differences in the SAT scores are not important there is still the possibility that the groups differ on a parameter that is not measured by the SAT.

The fact that the design of the study is quasi-experimental and depends on a sample of convenience precludes any randomization of the subjects. This lack of randomization is a regrettable but necessary compromise that comes with this data set. The results that emerge from this study should be verified through replication.

Any attempt to generalize this study to all college students is threatened by the self-selection process of the participants. All of the participants in the study are students who decided to take a mathematics course their first semester of college. It is not difficult to imagine a math phobic student postponing their college math requirement for a semester if not until their senior year. As a result of this predisposition the mathematically fearful are likely to be underrepresented in the study.

Another threat to the validity of the study has to do with the considerable size of the samples. Because the sample sizes are relatively large, minute differences between the groups are likely to be found statistically significant. Therefore the power of a statistic should be considered whenever a test for significance is made to guard against exaggerating the importance of the results (Huck & Cormier, 1996).

The most important threat to any results that are found will be the possibility of an alternate hypothesis. Math 1101 was introduced into the curriculum for the first time in the fall semester of 2001. This course can be described as a less traditional math course than Math 1111 and has different grade distribution characteristics than other math

courses. It is quite possible that this new course offering will have a large effect on the overall grade distribution of the participants in this study.

Another interesting rival hypothesis is addressed by the fourth research question involves participation in the Freshman Learning Communities (FLC) program that has become an important feature of the freshman experience at the university. Considerable effort and resources have been devoted to retaining students at the university through the FLC program which began fall semester 2000. Some portion of the two treatment groups will also be participants in the FLC.

Overall the design of the study has many drawbacks: no randomization, samples are separated by years, rival hypothesis abound, and time constraints. But it is the design necessary to ask and answer the questions of interest within the timeframe available.

CHAPTER 4

RESULTS

Introduction

The primary goal of this study is to examine the differences in the odds of graduation for students at the university who were placed into their initial college math course with one of three different methods. Treatment #1 (freshmen who first enrolled in the fall of 2000, the control group) placed the majority of students into Math 1111, freshman algebra, by default. Those students with outstanding scores on AP exams or the SAT were allowed more latitude in their placement. In 2000 of about 33% (547) of the 1652 entering freshmen enrolled in a course more advanced than 1111. Treatment #2 (freshmen who first enrolled in the fall of 2001, n = 1542) students were given the COMPASS mathematics test during their freshman orientation experience and based on those results they were given advice about which course to take. Treatment #3 was similar to treatment #2 with the exception that students were not allowed to take more advanced courses than they qualified for by COMPASS test score.

Context of the Study

Consideration of the context of the study is important for understanding limitations of and motivations for the procedures employed to address the research questions.

In the fall of 1998 the University System of Georgia converted from a quarter system calendar to a semester calendar. During this transition, enrollment and credit hour generation suffered a decline at the university as well as across the entire University System as students adjusted to the new calendar. One casualty of the transition to the semester system at the university was the loss of a freshman mathematics course for the liberal arts major. Therefore in order to complete degree requirements at the university a student had to successfully complete at least Math 1111.

In the fall of 1998 and 1999, 49% of the students taking Math 1111 earned grades of D, F or W (Statware, 2006). Fall of 2000 produced 43% DFWs for Math 1111. Clearly, Math 1111 had become a high risk course that had a devastating effect on retention at the University.

In 2001, a two prong strategy was implemented to address the difficulties with Math 1111. First the university would begin to offer Math 1101, Math Modeling, as an alternative for non-science majors. The prerequisites and objectives for this course are quite different than Math 1111, College Algebra. In general the course experience for the Math 1101 student might be described as less rigorous than that of the Math 1111 student. The DFW rate for students enrolled in this course is about 30%.

Secondly, every incoming freshman would be given a mathematics placement test to help to match them with the most appropriate course. The instrument selected for the placement test is called COMPASS. The COMPASS test is part of a computerized adaptive test (CAT) that is published by ACT. This implementation of comprehensive placement testing and advising of incoming freshman provides a unique opportunity to

study the effects of CAT placement test on performance in the first collegiate math class, subsequent performance during the freshman year, and eventual degree completion.

Subjects and Descriptive Statistics

The data for this study was obtained with the assistance of the Office of the Dean of the College of Education. Using several databases an extraction was performed that collected basic demographic information, all testing data, and every grade of every individual who was actively enrolled at the university from fall of 1998 until fall of 2005. The Office of the Dean then "scrubbed" the data of any personally identifying information, i.e. name, social security numbers, addresses, phone numbers etc. At this point the database was turned over to the researcher and the analysis began. This initial database contained approximately 1.7 million grades and the records of over 100,000 students.

The subjects of this study were first time freshmen at the university who enrolled for their first classes during the fall of 1998, 1999, 2000, 2001, and 2002. Additionally this group was limited to those students who enrolled in a mathematics course in their first semester. After making the appropriate selections the pool of subjects was limited to 7,625 who fit the criteria for the study.

The average age for the subjects showed a declined from 19.6 years old to 19.3 years old. The oldest subject was 67.3 years old in 1999 and the youngest was 15.1 years old in 2002.

The ethnicity of the groups was mostly stable with about 13% Asian, 30% black, a little less than 4% Hispanic, and a combination of different ethnic groups makes up

about 7% of the population throughout all five years of the study. The exception was whites who made up 51.3% of the sample in 1998 and lost share to only make up 38.6% of the sample in 2001. The segment to gain share off of this decline was the portion of subjects identified as multiracial. This group rose from 2.3% in 1998 to 9.1% of the subjects in 2001, but then declined to 4.7% in 2002. Also on the rise from a low of 0.9% in 1998 to a high of 9.1% in 2002 is the portion of subjects identified as "other". These numbers seem to indicate confusion between the "multiracial" and the "other" category.

Table 2 presents the average SAT Verbal and SAT Math scores for each year in the study. Note that the total from the table 6,076 differs from the total number of subjects for this study due to the fact that many subjects lacked SAT scores.

Table 2

SAT Verbal and SAT Mathematics Means and Standard Deviations for 1998 – 2002

		SAT Verbal		SAT Math	
Year	N	M	SD	M	SD
1998	1100	519.02	69.025	518.06	68.837
1999	1005	519.00	75.155	519.67	72.971
2000	1151	511.16	71.369	521.69	73.819
2001	1475	522.30	72.865	532.97	71.159
2002	1345	516.33	65.456	531.07	70.432
Total	6076	517.73	70.781	525.52	71.649

The largest difference between the SAT Verbal scores is 3.30 points. While this difference is statistically significant ($F = 4.325$, $p = .002$) the practical difference between SAT Verbal means of 519.00 and 522.30 is negligible and illustrates a danger of misinterpreting large sample size statistical significance. On the other hand the 14.91 point difference ($F = 11.559$, $p < .000$) SAT Math scores between the high year 2001 and low year 1998 is less easily dismissed. During this same time period (1998-2001) ETS

reported a nine point increase from 482 to 491 in the mean score for the state of Georgia on the mathematics portion of the SAT. Taken in this context the differences in the SAT Math scores of our study groups does not seem as threatening to the validity of the study.

COMPASS Test as a Predictor of Course Success

This section presents results that pertain to the relationship between the COMPASS test and results in various entry level mathematics classes. The data set used for these results comes from the 2001 cohort (N = 1542). This cohort was selected because the placement information derived from the test was used for advice in course selection rather than a rule. So students could choose to take a more difficult course than what their test score suggested. Including these risk takers in the dataset avoids the problem of hard truncation and allows us to see how the test performs over a broader range of course taking behaviors.

The COMPASS test is a sophisticated adaptive test that tailors the item pool of the test according to the responses of the individual taking the test. This allows the test to accomplish one of its primary functions, which is to gather as much information about the test taker using as few test items as possible. This economy of items allows for testing over a broad range of abilities in a limited amount of time. So during the same testing period some test takers answer questions about trigonometry while others are only exposed to questions pertaining to basic algebra. During the administration of the test the test taker is not informed when the test shifts from one domain to the next and the only clue that this has happened is in the content of the questions or the final score.

Just as the test is sophisticated and multi-tiered the results produced by the test have several levels that require interpretation. During the placement testing in 2001 three domains were used: Algebra, College Algebra, and Trigonometry. Cut-scores from each domain were identified and employed for placement and advising. Table 3 summarizes the placement and advising options based on COMPASS scores used during the summer of 2001.

Table 3

2001 COMPASS Score Advising and Placement Options

Domain and Score	Advising Options
Algebra Subtest 0 – 19	Recommended: Math 0098; Allowed: Math 1101
Algebra Subtest 20 – 30	Recommended: Math 0099; Allowed: Math 1101
Algebra Subtest 31 – 40	Math 1101
Algebra Subtest > 40	Math 1101 or Math 1111 depending on major
College Algebra > 41	Math 1101, Math 1111, Math 1113 depending on major
Trigonometry > 45	Math 1101, Math 1111, Math 1113, Math 1220 or Math 2211

Odds of Success for Different Cut Scores in Different Courses

This section presents six tables (tables 4 – 9) that describe the effectiveness of using cut scores from the COMPASS test to predict success in the three classes, Math 1101, Math 1111, and Math 1113, with the largest cohorts. Success is alternately defined as passing the class with a D or higher or passing with a C or higher. The conclusions about the effectiveness of COMPASS as a predictor depends on the course is under consideration and the definition of success.

Ideally, cut scores should provide a clear demarcation between those who will succeed and those who will fail in a particular class. Table 4 presents the odds of course success (D or higher) outcomes in Math 1101 using the Algebra Subtest score of 30 as a cut score. The results indicate that the odds of success for students who met or exceeded

the cut score were 2.08 times higher than for students who scored below the cut score. The differences in proportions of success was statistically significant (X^2 = 5.292 (df = 1, N = 545), p = .021).

Table 4

Math 1101 Odds of Course Success (D or higher) by Algebra Cut-Score = 30

	Success (ABCD)	Non-Success (FW)	Conditional Odds, Success
Score 30 or higher	420	54	7.78
Score less than 30	56	15	3.73
Conditional Odds, 30 or higher	7.5	3.60	
Odds Ratio Success	2.08		
Log Odds Ratio	0.32		

Table 5 also addresses the odds of success in Math 1101 for students who scored above and below the Algebra Subtest cut-score of 30. This time success is defined more stringently as earning a grade of C or better. These results show that the odds of success for students who met or exceeded the cut score were 2.13 times higher than for students who scored below the cut score. The differences in proportions of success was statistically significant (X^2 = 7.636 (df = 1, N = 545), p = .006).

Table 5

Math 1101 Odds of Course Success (C or higher) by Algebra Cut-Score = 30

	Success (ABC)	Non-Success (DFW)	Conditional Odds, Success
Score 30 or higher	382	94	4.17
Score less than 30	47	24	1.95
Conditional Odds, 30 or higher	8.13	3.83	
Odds Ratio Success	2.13		
Log Odds Ratio	0.39		

Table 6 presents the odds of course success (D or higher) outcomes in Math 1111 using the Algebra Subtest score of 40 as a cut score. The results indicate that the odds of success for students who met or exceeded the cut score were 3.62 times higher than for students who scored below the cut score. The differences in proportions of success was statistically significant (X^2 = 18.576 (df = 1, N = 535), $p < .001$).

Table 6

Math 1111 Odds of Course Success (D or higher) by Algebra Cut-Score = 40

	Success (ABCD)	Non-Success (FW)	Conditional Odds, Success
Score 40 or higher	420	58	7.24
Score less than 40	38	19	2.00
Conditional Odds, 40 or higher	11.05	3.05	
Odds Ratio Success	3.62		
Log Odds Ratio	0.56		

Table 7 also addresses the odds of success in Math 1111 for students who scored above and below the Algebra Subtest cut-score of 40. Only this time success is defined to be earning a grade of C or better. These results show that the odds of success for students who met or exceeded the cut score were 3.15 times higher than for students who scored below the cut score. The differences in proportions of success was statistically significant (X^2 = 7.636 (df = 1, N = 545), $p = .006$).

Table 7

Math 1111 Odds of Course Success (C or higher) by Algebra Cut-Score = 40

	Success (ABC)	Non-Success (DFW)	Conditional Odds, Success
Score 40 or higher	383	95	4.03
Score less than 40	32	25	1.28
Conditional Odds, 30 or higher	11.05	3.05	
Odds Ratio Success	3.15		
Log Odds Ratio	0.50		

Table 8 address the odds of course success (D or higher) in Math 1113 using the College Algebra Subtest score of 41 as the cut score. The results indicate that the odds of success for students who met or exceeded the cut score were 1.81 times higher than for students who scored below the cut score. The differences in proportions of success was not statistically significant (X^2 = 1.955 (df = 1, N = 275), p = .16).

Table 8

Math 1113 Odds of Course Success (D or higher) by College Algebra Cut-Score = 41

	Success (ABCD)	Non-Success (FW)	Conditional Odds, Success
Score 41 or higher	199	45	4.42
Score less than 41	22	9	2.44
Conditional Odds, 41 or higher	9.05	5.00	
Odds Ratio Success	1.81		
Log Odds Ratio	0.26		

Table 9 also addresses the odds of success in Math 1113 for students who scored above and below the College Algebra Subtest cut-score of 41. This time success is defined more stringently as earning a grade of C or better. These results show that the

odds of success for students who met or exceeded the cut score were 2.04 times higher than for students who scored below the cut score. The differences in proportions of success was not statistically significant (X^2 = 1.567 (df = 1, N = 275), p = .211).

Table 9

Math 1113 Odds of Course Success (C or higher) by College Algebra Cut-Score = 41

	Success (ABC)	Non-Success (DFW)	Conditional Odds, Success
Score 41 or higher	176	68	2.59
Score less than 41	19	12	1.58
Conditional Odds, 41 or higher	9.26	5.67	
Odds Ratio Success	1.63		
Log Odds Ratio	0.21		

Success Results (D or better)

A logistic regression analysis was performed with a course outcome of D or better as the dependent variable. The categorical independent variables were the COMPASS cut scores (A19, A30, A40, C40, and T46) as well as a three category variable that keeps track of whether or not the student followed the placement recommendation or not. Two other non-categorical independent variables were included: high school average and math SAT.

Table 10 presents the classification table for the model. By adjusting the cut score of the mode from 0.5 to 0.6 the PAC (Percentage of accurately classified cases) rose from 84.8% to 85%. Subsequent adjustments to this cut score did not improve the classification rate.

Table 11 presents the regression coefficients, Wald statistics, odds rations and 95% confidence intervals for each of the predictors in the model. Using the Wald statistic

several non-COMPASS variables emerge as significant predictors of course success, high school average, math SAT, and the follow variable. On the other hand all but one of the COMPASS variables was not statistically significant. The COMPASS variable C40 (z = 5.065, *p* = .024) showed statistical significance; however the confidence interval for the odds ratio (1.063, 2.436) was close to 1. These results suggest that odds of success for students who achieved a score of 40 or higher on the College Algebra portion of the COMPASS exam were 1.61 times higher than those who did not.

From these results the largest influence on the odds of success comes from the high school grade point average. The odds of success in the initial collegiate math class are 4.201 times higher for each one point increase in a student's high school average.

While the Math SAT score is statistically significant (z = 9.88, *p* = .002) the odds ratio 1.004 indicates that the practical effect is negligible.

Table 10

Classification Table: Success D or Better 2001Entry Level Math Courses

		Predicted	
		Success	Non-success
Observed	Success	1253	2
	Non-success	220	3
			PAC = 85%

PAC = Percentage of accurately classified cases
Cut score = 0.6

Table 11

Logistic Regression Results: Success D or Better 2001 Entry Level Math Courses

Variable	B	SE	Wald	*p*	e^B	95% CI (odds)
HS_Ave	1.435	.229	39.433	.000	4.201	(2.684, 6.575)
Math_SAT	.004	.001	9.883	.002	1.004	(1.002, 1.007)
Follow			17.679	.000		
Follow(1)	1.126	.270	17.331	.000	3.083	(1.814, 5.237)
Follow(2)	.642	.236	7.430	.006	1.900	(1.198, 3.015)
A19	.582	.884	.433	.511	1.789	(.316, 10.120)
A30	-.054	.359	.023	.881	.948	(.469, 1.914)
A40	.320	.240	1.782	.182	1.377	(.861, 2.203)
C40	.476	.211	5.065	.024	1.610	(1.063, 2.436)
T46	.172	.242	.505	.477	1.118	(.739, 1.909)
Constant	-6.215					

CI = Confidence Interval

Success Results (C or better)

A logistic regression analysis similar to the one just discussed was repeated with course success redefined as C or better as the dependent variable. The categorical independent variables were the same with COMPASS cut scores (A19, A30, A40, C40, and T46) as well as a three category variable (Follow, Follow(1), and Follow(2)) that keeps track of whether or not the student followed the placement recommendation or not. Two other non-categorical independent variables were included: high school average and math SAT.

Table 12 presents the classification table for the model produced by the logistic regression analysis. Again the cut score has been changed from 0.5 to 0.6. The PAC declined from 77% to 76.6%. While this adjustment did not improve the PAC the classification table is made more interesting by shifting 98 cases from the predicted

success column to the predicted failure column. The fact that this shift is accomplished without damaging the overall PAC indicates how arbitrary the cut score is.

Table 12

Classification Table: Success C or Better 2001Entry Level Math Courses

		Predicted	
		Success	Non-success
Observed	Success	1072	64
	Non-success	282	60
			PAC = 85%

PAC = Percentage of accurately classified cases
cut score = 0.6

Table 13 presents the regression coefficients, Wald statistics, odds rations and 95% confidence intervals for each of the predictors in the model for success defined a c or better. These results are consistent with those presented in table 10. In general the non-COMPASS statistics are slightly more important and the COMPASS statistics are not significant. The exception is again the C40 variable (z = 5.451, p = 0.20). Again the confidence interval for the odds ratio (1.072, 2.210) was close to 1. The results suggest that odds of success for students who achieved a score of 40 or higher on the College Algebra portion of the COMPASS exam were 1.539 times higher than those who did not.

From these results the largest influence on the odds of success again comes from the high school grade point average. The odds of success (defined as C or better) in the initial collegiate math class are 5.411 times higher for each one point increase in a student's high school average.

Table 13

Logistic Regression Results: Success C or Better 2001Entry Level Math Courses

Variable	B	SE	Wald	*p*	e^B	95% CI (odds)
HS_Ave	1.688	.203	68.852	.000	5.411	(3.631, 8.062)
Math_SAT	.006	.001	25.144	.000	1.006	(1.004, 1.008)
Follow			27.252	.000		
Follow(1)	1.174	.241	23.686	.000	3.234	(2.016, 5.189)
Follow(2)	.522	.209	6.206	.013	1.685	(1.118, 2.540)
A19	.719	.881	.785	.376	2.052	(.418, 10.120)
A30	-.054	.359	.023	.881	.948	(.469, 10.065)
A40	.288	.200	2.064	.151	1.334	(.900, 1.975)
C40	.431	.185	5.451	.020	1.539	(1.072, 2.210)
T46	.238	.216	1.220	.269	1.269	(.832, 1.936)
Constant	-6.215					

CI = Confidence Interval

Performance in the First Two Terms and Eventual Degree Completion

One of the goals of this study is to establish a link between student performance in the first year and eventual degree completion. It is customary in graduation studies to allow six years evaluate graduation rates. Since there is not enough time between initial enrollment and data collection for this study it was necessary to use a different dataset for this portion of the study. So the data used to examine the relationship between first year productivity and eventual graduation comes from the class that entered the university in the fall of 1998. As was noted earlier the Math SAT scores for the 1998 class differs from the 2001 and 2002 class. While this difference is statistically significant this difference should not present a serious threat to the validity of the study.

To examine the relationship between quality points and eventual degree completion a logistic regression procedure that used the sum of the quality points

produced during the first two semesters as the independent variable and eventual degree completion as the dependent categorical variable.

Table 14 presents the classification table for the model produced by the logistic regression analysis. This classification table divides the 1,355 students that enrolled at the university for their first colligate experience in the fall of 1998 and also took a math course during that first semester into four cases by the predicted success and failure and observed success and failure. Note that the data for this observation was collected after fall semester 2005 so this group data represents a seven year graduation rate rather than the customary six year period observed for comparing graduation rates. The first row classifies the 569 students that earned a degree. The second row sorts the 786 students from this cohort who did not earn a degree from the university within seven years. If we divide the sum of the top row by the sum of the all of the graduates and non-graduates we find that this cohort had a seven year graduation rate of about 42%. There were 42 individuals from this group that graduated in 2005. If we subtract this total from the 569 graduates we find that the six year graduation rate is about 39%.

Table 14

Classification Table: 1998 Cohort Graduation by Quality Points Earned in the First Two Semesters

		Predicted	
		Success	Non-success
Observed	Success	357	212
	Non-success	178	608
			PAC = 71.2%

PAC = Percentage of accurately classified cases

Table 15 presents the regression coefficients, Wald statistic, odds ratio and the 95% confidence interval for the predictor variable Quality Points. The Quality Points

variable is statistically significant (z = 242.578, $p < 0.000$). The results suggest that for each one unit increase in the quality points earned the odds of graduation are 1.042 times better. The confidence interval for the odds ratio (1.036, 1.047) seems close to 1, however it is important to keep the scale in mind when we interpret this odds ratio. If a student were to take five classes each of the first two semesters and earns a C in each class then that student generates 60 quality points. On the other hand if another student carried the same load but earned a B in each class they would generate 90 quality points. The results of this logistic regression implies that the odds graduating for the B student would be (30)(1.042) = 31.26 times greater than the C students odds.

Table 15

Logistic Regression Results for Graduation of the 1998 Cohort by Quality Points

Variable	B	SE	Wald	*p*	e^B	95% CI (odds)
Quality Points	0.041	.003	242.578	.000	1.042	(1.036, 1.047)
Constant	-2.717					

CI = Confidence Interval

Using the predicted probabilities of this logistic regression model we find that 66 quality points has a 49% predicted probability of graduation while 67 quality points produces a 50.2% probability of graduation. Based on these results 66.5 quality points will serve as the threshold for a 50% chance of graduation. In a similar manner 76.5 quality points was determined to be the threshold for a 60% chance of graduation. These thresholds will be used to define categories of success in the next section.

The same analysis was performed on the 1999 cohort with similar results. From the classification table, Table 16, we find that this cohort has a six year graduation rate of

about 38% and that the logistic regression is successful in predicting graduation a little over 70% of the time.

Table 16

Classification Table: 1999 Cohort Graduation by Quality Points Earned in the First Two Semesters

		Predicted	
		Success	Non-success
Observed	Success	259	250
	Non-success	168	748
			PAC = 70.7%

PAC = Percentage of accurately classified cases

Table 17 presents the regression coefficients, Wald statistic, odds ratio and the 95% confidence interval for the predictor variable Quality Points for the 1999 cohort. This model is almost identical to the model produced for the 1998 cohort. The exception is the constant which is -2.717 for the 1998 model and -3.103 for the 1999 model. This difference is consistent with the lower graduation rate for the 1999 group.

Table 17

Logistic Regression Results for Graduation of the 1999 Cohort by Quality Points

Variable	B	SE	Wald	*p*	e^B	95% CI (odds)
Quality Points	0.044	.003	259.854	.000	1.045	(1.039, 1.050)
Constant	-3.103					

CI = Confidence Interval

These two models support the assertion that quality point production in the first year of college is strongly associated with eventual degree completion. In fact these models suggest that for every extra quality point earned the odds of degree completion also increase by a factor of about 1.04.

Mathematics Course Grade as a Predictor of Success in the First Year

If success in the first year of college is defined to be having at least a 60% chance of graduation then the course grade in the initial collegiate mathematics course can serve as the independent variable in logistic regression analysis. Table 18 presents the classification table for a logistic regression analysis that uses 76.5 quality points to determine a categorical variable of success and non-success in the first two terms. This table uses all five years of available data.

Table 18

Classification Table: 60% Chance of Graduation after Two Semesters by Grade in First Math Class

			Predicted	
			Success	Non-success
	Observed	Success	1022	1294
		Non-success	618	4689
				PAC = 74.9%

PAC = Percentage of accurately classified cases

Table 19 presents the regression coefficients, Wald statistic, odds ratio and the 95% confidence interval for the predictor variable grade in initial math class. Course grade is coded using the customary scale with an A = 4, B = 3, C = 2, D = 1, and F = 0. Grades of W are also coded as 0.

Table 19

Logistic Regression Results for Success in First Year by Grade in first Math Class

Variable	B	SE	Wald	*p*	e^B	95% CI (odds)
Math Grade	0.844	.024	1226.821	.000	2.325	(2.218, 2.437)
Constant	-2.885					

CI = Confidence Interval

The Math Grade variable is statistically significant (z = 1226.821, $p < 0.000$). The result suggests that for each letter grade increase in the initial mathematics course grade the odds of obtaining more than 76 quality points by the end of the first year increase by 2.325 times.

Treatment and Odds of Degree Completion

The primary goal of this study to was compare the effect of placement testing and advising on degree completion. Since time constraints did not allow the customary six years to directly measure completion of degrees proxies have been established to measure odds of degree completion indirectly.

Table 20 presents the means and standard deviations for grade in the first math class and the quality points earned at the end of the second semester for the 2000 cohort(control), the 2001 cohort(treatment 1), and the 2002 cohort(treatment 2). Comparing the means of the grade in the first math class of these cohorts reveals statistically significant differences ($F = 26.150$, $df = 2$, $p < .001$). Significant differences ($F = 18.562$, $df = 2$, $p < .001$) are also found when the means of the quality point production by these different groups are compared.

Table 20

1st Math Grade and Quality Points for Control and Experimental Groups

		Grade in first Math Class		Quality Point Production	
Year	N	M	SD	M	SD
Control 2000	1652	2.02	1.492	57.23	29.815
Treatment 1 2001	1688	2.38	1.421	63.04	29.466
Treatment 2 2002	1503	2.18	1.403	62.16	19.152
Total	4843	2.19	1.448	60.79	29.595

Odds of Success Control (2000) vs. Treatment 1 (2001)

Table 21 compares the odds of success for the control group from the year 2000 with treatment 1 from the year 2001. Success is defined by attaining at least 66.5 quality points in the first two terms. The difference in proportions of success was statistically significant (X^2 = 24.780 (df = 1, N = 3340), p < .000).

Table 21

Odds of First Year Success (QP 66.5 or higher) by Treatment 1(2001) vs. Control

	Success > 66.5	Non-Success < 66.5	Conditional Odds, Success
Treatment 1 (2001)	850	838	1.01
Control (2000)	690	962	0.72
Conditional Odds, 66.5 or higher	1.23	0.87	
Odds Ratio Success	1.41		
Log Odds Ratio	0.15		

A similar result was found when the definition of success in the first year of college is changed to 76.5 quality points or better. Table 22 presents a comparison of the odds of success for the Treatment 1 group compared to the Control group. The results suggest that the experimental group has odds of success that are 1.48 times greater than the odds of the control group. The difference in the ratios of the proportions is still statistically significant (X^2 = 24.780 (df = 1, N = 3340), p < .000). From these results we can conclude that the odds of success of the subjects in the Treatment 1 group (2001) were larger than those for the Control group (2000).

Table 22

Odds of First Year Success (QP 76.5 or higher) by Treatment 1(2001) vs. Control

	Success > 76.5	Non-Success < 76.5	Conditional Odds, Success
Treatment 1 (2001)	628	1060	0.59
Control (2000)	472	1180	0.40
Conditional Odds, 76.5 or higher	1.33	0.90	
Odds Ratio Success	1.48		
Log Odds Ratio	0.17		

Odds of Success Control (2000) vs. Treatment 2 (2002)

Table 23 compares the odds of success for the control group from the year 2000 with treatment 1 from the year 2002. Success was again defined by attaining at least 66.5 quality points in the first two terms. The difference in proportions of success was statistically significant (X^2 = 17.087 (df = 1, N = 3155), p < .000) and the odds for success appear to be about 1.34 times larger for the Treatment 2 group.

Table 23

Odds of First Year Success (QP 66.5 or higher) by Treatment 1(2002) vs. Control

	Success > 66.5	Non-Success < 66.5	Conditional Odds, Success
Treatment 2 (2002)	738	765	0.96
Control (2000)	690	962	0.72
Conditional Odds, 66.5 or higher	1.07	0.80	
Odds Ratio Success	1.34		
Log Odds Ratio	0.13		

A similar result was found when the definition of success in the first year of college is changed to 76.5 quality points or better. Table 24 presents a comparison of the

odds of success for the Treatment 1 group compared to the Control group. The results suggest that the experimental group has odds of success that are 1.48 times greater than the odds of the control group. The difference in the ratios of the proportions is still statistically significant (X^2 = 24.780 (df = 1, N = 3340), $p < .000$). From these results we can conclude that the odds of success of the subjects in the Treatment 1 group (2001) were larger than those for the Control group (2000).

Table 24

Odds of First Year Success (QP 76.5 or higher) by Treatment 2(2002) vs. Control

	Success > 76.5	Non-Success < 76.5	Conditional Odds, Success
Treatment 2 (2002)	532	971	0.55
Control (2000)	472	1180	0.40
Conditional Odds, 76.5 or higher	1.12	0.82	
Odds Ratio Success	1.37		
Log Odds Ratio	0.14		

Table 25 presents the classification table for a logistic regression analysis that uses the Control (2000), Treatment 1 (2001), and Treatment 2 (2002) as predictors for success. Success is defined as earning at least 66.5 quality points by the end of the second semester. The percentage of accurately classified cases is only 53.2%. Table 26 presents the regression coefficients, Wald statistic, odds ratio and the 95% confidence interval for the predictor variables Treatment 1 and Treatment 2 for predicting success, defined as earning at least 66.5 quality points at the end of the second semester. Note that the equation coefficients indicate a negative association with the predictor variables which contradicts the trends demonstrated in the odds tables 21 – 24.

Table 25

Classification Table: Treatment Model 2000, 2001, and 2002 Cohorts Success = 66.5 Quality Points

		Predicted	
		Success	Non-success
Observed	Success	850	1428
	Non-success	838	1727
			PAC = 53.2%

PAC = Percentage of accurately classified cases

Table 26

Logistic Regression Results Treatment Model 2000, 2001, and 2002 Cohorts Success = 66.5 Quality Points

Variable	B	SE	Wald	*p*	e^B	95% CI (odds)
Treat 1	-.347	.070	24.717	.000	.707	(.617, .811)
Treat 2	-.296	.072	17.055	.000	.743	(.646, .856)
Constant	.311					

CI = Confidence Interval

The odds tables present clear evidence to support the assertion that individuals in the treatment groups have better odds of success defined by quality point production than those in the control group. However the logistic regression analysis suggests weak, negative associations with the predictor variables and success.

Intervening Variables

A more complete picture of the differences in the odds for success between these groups emerges when we consider other available data. Tables 27 and 28 present the results of a logistic regression analysis that includes Control (2000), Treatment 1(2001), and Treatment 2 (2002); this model also includes intervening variables Math 1101, GSU 1010, Learning Communities, and the letter grade earned in the first math course. The Math 1101 variable is a categorical variable that indicates whether or not the student took

Math 1101. The GSU 1010 variable is another categorical variable that tracks enrollment in the freshman orientation course. GSU 11010 is designed to aid retention by through a series of activities designed to integrate the student into the university. This course also devotes time to study skills and an extensive orientation to the library. The Learning Communities variable is also a categorical variable to track participation in one of the universities learning communities. These learning communities represent an effort by the university to retain freshmen by integrating freshmen both academically and socially into the university. The final variable in this more complete model is the grade earned in the initial collegiate mathematics course. Of the variables in the complete model this is the only one that pertains to student performance.

Table 27

Classification Table: Complete Model 2000, 2001, and 2002 Cohorts Success = 66.5 Quality Points

		Predicted	
		Success	Non-success
Observed	Success	1759	519
	Non-success	836	1729
			PAC = 72.0%

PAC = Percentage of accurately classified cases

Table 28

Logistic Regression Results: Complete Model 2000, 2001, and 2002 Cohorts Success = 66.5 Quality Points

Variable	B	SE	Wald	*p*	e^B	95% CI (odds)
Treat 1	-.180	.085	4.422	.035	.836	(.707, .988)
Treat 2	-.301	.088	11.735	.001	.740	(.623, .879)
GSU 1010	-.915	.084	118.066	.000	.400	(.339, .472)
Math 1101	.243	.087	7.726	.005	1.275	(1.074, 1.513)
Grade Math	.822	.027	923.879	.000	2.275	(2.158, 2.399)
Constant	-1.140					

CI = Confidence Interval

Since this complete model presented in tables 27 and 28 has more variables than the models used thus far a stepwise forward Wald procedure was used to select the predictor variables. The Wald statistic is essentially a z^2 statistic. The computation of the Wald statistic is the square of the quotient of coefficient and the standard error associated with that coefficient. This Wald statistic provides a measure of the statistical significance of a particular coefficient in the logistic regression model. The stepwise forward Wald procedure calculates the Wald statistic and then enters each variable into the model according to the statistical significance associated with that variable. This particular model was completed in five steps. The first variables in (grade in the first math course) are at the bottom of the table and the last variable entered (Treatment 1) is at the top. The classification table obtained the 72% level of accuracy after the second step and did not improve with the addition of the last three variables. The Learning Communities variable failed to enter the model.

From these results we can conclude that Treatment 1 (2001) and Treatment 2 (2002) have a minor effect on the odds of success (earning 66.5 quality points in the first two semesters) when compared to the effect of the grade in the first math course for the individual and the effect of offering Math 1101.

Grade in the First Mathematics Class

Grade in the first mathematics class is the variable with the largest effect in the complete model. The two variables are highly correlated (R = 0.58). There are several reasons that can help to explain this association. First the grade in the first mathematics class is a component of the quality point production. For example an A in a math course will contribute 12 points to the quality point total while a C will only contribute 6 points.

Another reason for the strength of the association is the nature of what the variable measures. Compared to the other variables in the model, mathematics grade is the variable that is most closely tied to the performance of the individual. The other variables represent things that happen to the student; like placement method or course enrollment, but the grade is the product of the student just as quality point production is a product of the student.

Math 1101

The Math 1101 variable is a categorical variable that tracks which of the subjects enrolled in Math 1101. One interpretation of the size of the effect of this variable is that Math 1101 may be an easier class than Math 1111. The mean grade for the year 2000 cohort in Math 1111 was 1.99 with n = 1038. The mean grade for the year 2001 cohort in Math 1111 was 2.38 with 584 enrolled. The reason that only 584 took math 1111 in 2001 is that 533 of this cohort enrolled in Math 1101 and produced a mean grade of 2.56. From these shifts in the population and the means we can infer that the weakest performing segment of what would have been the Math 1111 class of 2001 performed well in Math 1101. In terms of quality point production, the year 2000 Math 1111 class produced (1.99)(3)(1038) = 6196.86 quality points or 5.97 quality points per student. In 2001 Math 1101 and Math 1111 combined to produce (2.56)(3)(533) + (2.38)(3)(584) = 8263.2 quality points or 7.4 quality points per student.

Learning Communities

Learning Communities at the university are an attempt to incorporate Tinto's ideas about retention to integrate students socially and academically. It was surprising that the Learning Communities variable failed to enter the logistic regression model

presented in Table 28. Table 29 presents a comparison of the odds of earning 66.5 quality points for learning community participants compared to the rest of the 2001 and 2002 cohorts. This table shows that Learning Community participants reach the 66.5 quality point threshold about 65% of the time while non-participants succeed about 47% of the time. These comparisons of Learning Communities to the rest of the freshman class are made within years so are not as susceptible to the influences of intervening variables that exaggerated the effects of the different treatments discussed in question 3.

Table 29

Odds of First Year Success (QP 66.5 or higher) by Learning Community Participation

	Success > 66.5	Non-Success < 66.5	Conditional Odds, Success
Learning Community	328	180	1.82
Non Learning Community	1260	1423	0.89
Conditional Odds, 66.5 or higher	0.26	0.13	
Odds Ratio Success	2.06		
Log Odds Ratio	0.31		

Summary

This chapter has presented results which are relevant to the study of the Simplified Model. The first result showed that high school average does a better job than COMPASS measuring pre-entry characteristics. The second result showed the strong relationship between performance as measured by quality point production in the first year of college and eventual degree completion. The third result appeared to show that the placement method had an effect on quality point production in the first year. This result was shown to eclipsed by the effect of intervening variables seen in the fourth result. In particular the addition of Math 1101 and the grade earned in the first

mathematics course far outweigh the effects of placement treatment. The implications of these results will be discussed in the next chapter.

CHAPTER 5

DISCUSSION

The purpose of this chapter is to present the conclusions of the research as well as the implications and recommendations. The conclusions are organized by the original four research questions. The chapter will conclude with suggestions for further research.

Conclusions

The purpose of this study was to test a subset of Tinto's Longitudinal Model of Institutional Departure. This subset was defined by the Simplified Model introduced at the end of chapter 1. This Simplified Model limited the range of Tinto's model to: (1) pre-entry characteristics, skills and abilities as measured by the COMPASS instrument. (2) institutional experiences, academic performance, in particular the grade in the first math course (3) integration, the academic integration of a student as measured by quality point production at the end of the second semester, and (4) outcome, which is ultimately measured by degree attainment. Each portion of the model generated a research question that we use now to organize the conclusions of the study.

Research Question 1

What is the relationship between COMPASS score and grade in the initial, freshman math class?

For the COMPASS instrument to be an effective tool for placement it must provide information that segregates students by their chances of success in a class. Evidence from this study is contradictory and open to interpretation.

From the data collected from the 2001 cohort we have seen that if success is defined to be a grade of D or higher in Math 1101 then students who made at least the cut score of 30 on the Algebra sub-test had odds of success that were 2.08 times larger than those who did not. The difference in odds of success was statistically significant (X^2 = 5.292 (df = 1, N = 545), p = .021). A similar result is found when the definition of success is considered to be a grade of C or higher. Students making at least a 30 on the algebra subtest had odds of success that were 2.13 times more than those who scored below the cut score. Again the differences in the proportions of success for those above and below the cut score were statistically significant (X^2 = 7.636 (df = 1, N = 545), p = .006).

The data from Math 1111 tells a similar story. If a grade of D or better is considered a success then those scoring at or above a cutoff score of 40 on the Algebra sub-test had odds that were 3.62 times larger than those who scored below 40. The proportions of success of the two groups was statistically significant (X^2 = 18.576 (df = 1, N = 535), p < .001). If success is a grade of C or higher, then those who made 40 or above had odds that were 3.15 times larger than those who did not make the cut score. Again the proportions of success were statistically significant (X^2 = 7.636 (df = 1, N = 545), p = .006).

The data from Math 1113 showed higher odds for those who scored at or above the cut score of 41 on the College Algebra subtest. However the differences in the proportions of the likelihood of success were not statistically significant.

Since the odds for succeeding in the initial math class of students who have meet or exceeded the cut score are greater than those who have not we have evidence to

support the idea that COMPASS is a good predictor of success. However a logistic regression analysis of success in the initial math class using available information rather than the just the COMPASS scores reveals how weak the actual association is between success and COMPASS. When the COMPASS cut scores are used in a logistic regression model that incorporates the student's high school average and the SAT math score all of the COMPASS inputs except for the College Algebra sub score ($p = .020$) fail to exhibit statistical significance. From a practical point of view the College Algebra sub score is not a practical measure as a universal placement tool in that only 45% (697/1542) of the cohort performed at a high enough level to generate a score.

While the COMPASS instrument does provide some useful information for placement decisions about some courses, it clearly does not capture nearly as much information as other available measures, in particular, the high school history expressed as the GPA.

Research Question 2

Is there a link between performance in the first two terms as measured by quality points and eventual degree completion?

The logistic regression analysis of the 1998 cohort data found that the Quality Points variable was statistically significant ($z = 242.578$, $p < 0.000$) and the odds ratio for quality points and graduation was 1.042. This result suggests that for each one unit increase in the quality points earned the odds of graduation are 1.042 times better. This information is a tool we can use to explain the incremental difference between the grade of B and the grade of C at the end of the first year of college. Suppose that a student who had earned 60 quality points at the end of their first two terms and then made a C in the

final 3 credit hour course of the second term. This course would contribute 6 quality points to the student's total. The odds of graduation for the student with 66 credit hours as opposed to 60 credit hours are about 6.252 times higher. Now suppose that the student earned a B in the final 3 hour course to contribute 9 hours to the quality point total. The B student has increased their odds of graduation so that the odds are now 9.378 times higher than the student who only has 60 hours. Using the 1998 data these odds translate into a 43% probability of graduation at 60 quality points, 49% probability of graduation at 66 quality points, and a 52% probability of graduation at 69 quality points.

Research Question 3

Does placement treatment have an effect on the odds of degree completion?

The results for this question were mixed. If we ignore intervening variables then it appears that the Treatment 1 group has odds of success that are about 1.5 times larger than the Control group. Also ignoring intervening variables the odds for Treatment 2 appear to be about 1.34 times the size of the odds of success for the Control group. A logistic regression analysis suggested negative association with the treatments and the odds of successfully earning 66.5 quality points be the end of the first year of college. The ambiguity of these findings was resolved with the results of the fourth research question that considered intervening variables.

Research Question 4

What effect do other intervening variables have that may contribute to our understanding of this problem? In particular does participation in a Learning Community effect the accumulation of quality points at the end of the first two semesters?

The investigation of the intervening variables on the chances of a successful first year of college has demonstrated that the effects of the two different placement methods are negligible at best when compared to student performance in the first math class and the addition of Math 1101 to the curriculum. Of the things that the university has done to try to improve the chances of success in the first year the introduction of Math 1101 has had the largest effect. The average grade in the initial collegiate math class for the groups in this study has risen from a low of 1.87 in 1999 to 2.37 in 2001 after the addition of Math 1101.

The effect of the Math 1101 is in turn dwarfed by the effect of the student's performance in the initial math class. For every increase in the letter grade of in the initial collegiate math class the odds of earning 66.5 quality points increases by a factor of 2.27. Simply stated the better the student does in the initial math class the better the student does in their first year.

Implications and Recommendations

The most important implication of this research is the importance of the grade in the first math class. Clearly as decisions are made with regard to resource allocation the importance of success in the initial collegiate mathematics class should be kept in mind. Anything that can improve the performance in this first math class should be considered. Supplemental Instruction, increased support for free tutoring services, and consideration of instructor assignments should be taken into account to maximize the quality of the experience and thus the performance of the freshman mathematics student. Investments made in the freshman year will yield dividends that are counted in degree completion.

Another implication of this research is that the standardized tests (SAT and COMPASSS) that are used to classify and place students bear little relation to the end product as measured by the grade in the class. On the other hand the high school GPA is a better predictor of success in the initial mathematics class. The GPA is a measure of performance as a student rather than an ability or aptitude test. The history of classroom performance that spans years and is represented in the high school GPA is a more pertinent measure of what it will take to succeed in the classroom than an aptitude or ability test that is executed in a few hours. So rather than rely entirely on the standardized test we use now I would encourage greater reliance on the use of high school transcripts for admission and placement decisions. The best predictor of classroom performance should be classroom performance. If the high school classroom is irrelevant to the college classroom then this transition away from standardized tests will be the first step in bridging this disjuncture.

Information about the importance of the first collegiate mathematics class should become a standard component of advising students. When students know what is at stake they will be more likely to allocate their own resources to maximize their success. This information should also be shared with high school students and teachers. If this information can motivate the high school senior to invest in meaningful college preparation in the spring of their senior year then they will reap the rewards in the fall of their freshman year and beyond.

Suggestions for Further Research

While the historical context of this study (in particular the introduction of an entirely new course) would make replication of this study difficult the 2000, 2001, and

2002 cohorts should be followed for six years to evaluate whether the assertions about quality point production and graduation rate are true. This would also be an appropriate time to evaluate the graduation rates of Math 1101 students compared to Math 1111 students.

Another opportunity for research will require integration of the student databases of the University System of Georgia. If the student databases could share information seamlessly across the system we would have a clearer picture of what the individual who leaves one school for another is actually doing. The data structure in place now does not capture transfer student behavior. For example most transfer students do not actually disappear from the face of the earth; it just looks that way when the data is parsed by institution.

This study has shown that COMPASS is a poor measure of the pre-entry characteristics that are needed to succeed in the initial mathematics class. Another research opportunity would be to find and test an alternative to the COMPASS test. This new placement instrument should be criterion referenced to the prerequisite skills and abilities for each of the freshman mathematics course. This instrument should be used in conjunction with the high school GPA to develop a meaningful placement scheme that is tied to content as well as the history of classroom performance. In addition to these data sources the individual student should be part of the placement process and have input about appropriate course selection. Investment in the process of placement and advising will pay off with higher graduation rates.

Summary

The initial motivation for this study was to examine three different methods of placement into the initial collegiate mathematics course. Any meaningful difference in the placement methods was subsumed by the very real difference introduced by the new mathematics course for non-science majors. The study did reveal the importance of the initial math course and the odds for success in the first year and college. The importance of this class has implications for students, instructors, and administrators who all need to seek to maximize the performance in the first mathematics class.

The study also found that standardized instruments are not a good measure of the pre-entry skills and abilities necessary to do well in the first math class. It is not surprising that the advising and placement program built around these measures do not demonstrate a great deal of success. Development of a more accurate measure of pre-entry characteristics is one step towards developing a more effective and meaningful placement method. In addition to accurate assessment of the pre-entry characteristics meaningful advisement and placement should take advantage of available information from the student and the student's high school performance.

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