EXAMINATION OF PERSISTENCE FACTORS AND THEIR RELATIONSHIP TO SUCCESS IN COLLEGIATE MATHEMATICS FOR REMEDIAL AND NON-REMEDIAL COLLEGE STUDENTS AT A FOUR-YEAR INSTITUTION

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Submitted to the Faculty of the
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in partial fulfillment of
the requirements for
the Degree of
DOCTOR OF EDUCATION
July, 1999

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ACKNOWLEDGMENTS

No work would be complete without acknowledgment of the participants in its formation. I wish to thank my committee, Dr. Laura Barnes, Dr. Ronald Beer, Dr. Dennis Bertholf, Dr. Martin Burlingame, and Dr. David Webster. Special thanks goes to Dr. Burlingame and Dr. Bertholf for shepherding me through the process of creating a scholarly composition. I wish to express my sincere gratitude to the East Central University Assessment Office and in particular Dr. Kurt Jackson for providing me with assistance in data collection. Thanks go to the many who provided encouragement, incentive, and inspiration. You know who you are, and I will not forget your kind words.

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CHAPTER I

INTRODUCTION, BACKGROUND, AND PROBLEM STATEMENT

Introduction

The alarming number of students who are unsuccessful at College Algebra in post-secondary institutions is a distressing problem for colleges and universities. These high failure rates may contribute to early student withdrawal and place undue burdens on students who now must repeat courses. Usual techniques employed to reduce the number of unsuccessful students include placement testing for students to provide appropriate educational opportunities in the form of developmental or remedial courses. Lewis and Farris (1995) report that 29% of first year students take at least one remedial course and remedial mathematics courses were offered by 75% of the colleges and universities which responded to the survey. Colleges and Universities traditionally assess and admit students based on nationally recognized exams such as the Scholastic Aptitude Test (SAT) or the American College Test (ACT). Some schools also recognize the importance of high school grade point average (HSGPA) and/or class rank in admissions and placement. Initial assessment may also include other academic performance variables such as institutionally prepared exams, computerized placement exams, or field-based exams. While these academic variables are important, they do not by themselves determine the

ability of the student to persist to a college degree nor do they adequately predict individual class performance. Tinto (1987) found less than 15% of all student departures result from academic dismissal. A study by Kanoy, Webster, and Latta (1989) found none of the traditional measurements function as accurate indicators of overall college success. Other research indicates that for lower-performing students and minority students other factors including psychological and cognitive variables may perform better as indicators of persistence than traditional measures (see for example Astin, 1975; Chapman, Cullen, Boersma, & Maguire, 1981; Gose, Wooden, & Muller, 1980; Nelson, Scott & Bryan, 1984).

Use of student scores on these academic variables and other assessment data for course placement is prevalent in higher education. Wood (1985) in a survey of 683 community and junior colleges found 90% of these institutions used course placement tests and indicated that placement in mathematics and language arts courses was likely to increase. A Southern Regional Education Board survey indicated more than 80% of the institutions surveyed have written policies concerning course placement (Abraham, 1992). These placement techniques have resulted in a considerable number of remedial courses. Colleges and universities offer these courses in 64% of all four-year colleges, 90% of all community colleges, and 91% of all public colleges (Mansfield, Farris, & Black, 1991). Increased emphasis on planning for student success and wise use of tax dollars resulted in the Oklahoma State Regents for Higher Education mandating assessment for course placement of all entry year students in all institutions under their governance.

Selection of appropriate academic variables which institutions use as placement criteria in mathematics courses have mixed results. Some studies favor high school grades

as better predictors than the ACT or SAT (Crouse & Trusheim, 1988; Thornell & Jones, 1986), while others have shown ACT and SAT scores are good single predictor variables (Dwinell, 1985; Nobel & Sawyer, 1987). However, using academic performance variables in the form of mathematics exam scores or high school grades to measure readiness for college algebra is an imperfect science at best. While acceptable correlations may exist between academic variables and course grades, the number of students identified as ready for college algebra who still fail the course evidences their unreliability as placement tests. This is particularly true at four-year institutions where admissions policies may allow less qualified (and less goal-oriented) students to attend.

A more comprehensive examination of other factors which may provide insight into the reasons students fail at collegiate mathematics should be explored. A rich source of literature exists on factors related to student persistence and these factors may provide insight into reasons why students fail at collegiate mathematics. Several theorists have advanced models to explain student attrition (Bean, 1980; Kamens, 1971; Rootman, 1972; Spady, 1980; Tinto 1975). These studies have identified several factors associated with students' decisions to depart. Very few studies relating these student persistence factors to success in college algebra exist.

I hypothesize these persistence variables to be related to success in collegiate mathematics for three reasons. One, there are a striking number of students (22% in this study) who withdraw from the class voluntarily and/or simply stop attending. This departure is done before the final grade is assigned. Although it is certain many of these departures are due to academic difficulties, it is unknown what affects other factors which account for overall student departure play. Second, even if the departure of the student

from collegiate mathematics is made primarily due to academic reasons, no effort has been made to observe the indirect effects of variables associated with student departure which may contribute to these academic difficulties.

A third and final reason is anecdotal. Having worked with developmental mathematics students over the years I am still surprised by the number of students who blame their lack of understanding on external factors such as former techniques of classroom instruction, health problems, real or imagined disabilities, and uncaring or unmotivated instructors. As the average age of students has increased, student characteristics have changed. Increasingly students now have multiple demands on their time. Many work or have demands placed on them by their families. I propose to examine factors which research has linked to college success as measured by persistence and their relationship to overall success in college algebra.

Background and Statement of the Problem

East Central University, a small regional university located in Oklahoma with total enrollment of approximately 4,300, provided the site for the study. While considered a four-year liberal arts university (comprehensive university type I by Carnegie classification), it does offer masters degrees in education and human resources. In 1994, with the assistance of a Title III grant, East Central University embarked on an ambitious program to examine and develop assessment programs, college placement guidelines, and enrollment procedures. East Central University Assessment Office collected the data on students. Examining scores on the ACT and College BASE's Computerized Placement Test (CPT) determined decisions regarding student placement in developmental courses

in mathematics, reading, and science. The state governing board, the Oklahoma State Regents for Higher Education, set scores on the ACT resulting in initial standards regarding the need for remediation or further assessment. Students scoring lower than 19 in any core area on the ACT required additional assessment of the student which consisted of the CPT. To provide a base line to compare non-remediated and remediated students, East Central University Assessment Officials decided to assess all entering students with the CPT. Students who scored low in any core area and additionally had an ACT score below 19 in any core area were required to take developmental courses.

In addition to this assessment of academic performance variables, assessment officials asked students voluntarily to fill out a survey with thirty-eight responses (see Appendix A). An independent researcher designed this survey to elicit responses from entering students in areas correlated with overall student success. The survey required responses to demographic variables including age, gender, number of planned hours of work, previous academic preparation (high school or college transfer), nearness of college residence, and parents level of education. In addition the survey included 31 statements designed to measure the student's beliefs and concerns about college and high school experiences with respect to degree of academic readiness, social integration, financial concerns, institutional commitment, maturity (locus of control), family support, commuting concerns, and indications of joining a fraternity or sorority. These statements referenced areas such as previous study habits, expected involvement with the faculty, expectation of the college experience, goals and commitment, involvement in extra curricular activities, peer group interactions, socialization, locus of control and self-efficacy, and ability to pay (financial needs). The demographic variables, social and

academic integration indicators as well as academic performance variables, ACT composite score, math CPT score, and high school grade point average form the independent variables in this study. Dependent variables included persistence indicators and success at college algebra. I made further groupings according the classification of the student as remediated-successful (took a developmental mathematics course and earned a passing grade in college algebra), remediated-unsuccessful (took a developmental mathematics course and did not earn a passing grade in college algebra), non-remediated-successful (was not required to take a developmental mathematics course and earned a passing grade in college algebra), and non-remediated-unsuccessful (was not required to take a developmental mathematics course and did not earn a passing grade in college algebra).

In particular this study addresses the following questions.

1. Does the student survey yield a set of underlying factors that the research literature has identified as factors linked to student persistence or models of student persistence?
2. Do differences exist between successful and unsuccessful students in college algebra on these emerging factors as well as academic performance indicators and demographic variables?
3. Using discriminant analysis on academic performance indicators, demographic variables, and the factors high school academic experiences, high school social experiences, college academic expectations, college social expectations, institutional commitment, finances, and locus of control, can a classification system be developed as an aid in identifying

class membership in remediated-successful, remediated-unsuccessful, nonremediated-successful, and nonremediated-unsuccessful groups?

4. Using academic performance indicators, demographic variables, and the factors high school academic experiences, high school social experiences, college academic expectations, college social expectations, institutional commitment, finances, and locus of control, can a path model be determined which shows factors and variables important to a student's final grade in MATH 1513 College Algebra?

CHAPTER II

LITERATURE REVIEW

Introduction

The literature presented here is limited to the variables under study; academic performance, demographics, and the factors high school academic experiences, high school social experiences, college academic expectations, college social expectations, institutional commitment, finances, and locus of control. Although significant research exists with respect to other academic performance indicators such as the Scholastic Aptitude Test, the Mathematical Association of America's mathematics placement exam, and locally developed exams, the only academic performance indicators under study are high school grade point average (HSGPA), American College Testing Program score (ACT), and College Board's Basic Academic Skills Examination Computerized Placement Exam (CPT).

I divided the literature search into two sections. The first is a review of the academic performance variables listed above and other factors as they relate to success in mathematics. The second is a brief review of literature involving student persistence.

Factors of Success in Post Secondary Mathematics

Several studies have linked academic performance indicators to eventual success in college mathematics. Most of the studies in this area have resulted from colleges and universities developing placement schemes. The need for proper placement in developmental courses to moderate the effects of underpreparedness has resulted in a rich source literature on use of the American College Test (ACT) and Scholastic Aptitude Test (SAT) as indicators of eventual success in college mathematics. The American College Testing Program (1991) reported a significant positive correlation between ACT mathematics subscore and grades in college algebra in state universities. Correlations ranged between .34 and .56. The College Entrance Examination Board (1984) in a survey of 29 colleges reported a correlation of .35. At East Central University all new, non-transfer admissions require ACT scores. No sufficiently large subgroup exists at East Central University to provide additional analysis between grades in MATH 1513 College Algebra and SAT scores.

Other studies exist which investigate relationships between ACT scores and college algebra. Most of these studies also use additional academic predictors as well. Many studies compare which academic performance indicators are better predictors. Although we have mixed results on which predictors may be "best," all studies suggested significant predictive ability of the ACT composite or mathematics subscores. Studies which reported positive correlations between grades in college algebra and ACT composite scores and/or ACT math subscore were performed by Gibson (1989), Lovel

and Fletcher (1989), Hudson (1989), Thornell and Jones (1986), Sawyer (1989), and Myers and Pyles (1992).

Indications by several studies, including some of the above have suggested significant correlation between high school grade point average (HSGPA) and college grades. Myers and Pyles (1992) found a positive correlation between HSGPA and success in college mathematics as did Sawyer (1989). Thornhill and Jones (1986) found that secondary school performance was a better predictor of college performance. Newman (1994) in a study at a technical college found that HSGPA was the best predictor of grades in basic algebra followed other predictors with the ACT subscore in natural science ranking fourth behind high school rank and college grade point average. Ang and Noble (1993) examined the use of HSGPA and ACT assessment subject area scores and found while HSGPA was effective in making course placement decisions, the ACT scores were most effective. In a study on developmental students, Dwinell (1985) found both SAT scores and HSGPA to be good predictors of academic performance.

Three separate studies examined the use of the College Board's Computerized Placement Tests (CPTs). Roberts (1994) found high correlation between the CPT and a locally developed placement test. Osterlind and Schmitz (1993) found the CPT to be a better predictor of scores on the National Teacher Examinations than the ACT. Anderson (1996) analyzed the correlation between CPT's and subsequent academic performance and found a low correlation.

Although useful as predictors of success in mathematics, other non-academic factors may also be important. In a study between affective variables and academic success, Dwinell and Higbee (1989) found that stress and other variables may account for

a greater proportion of the variance than either HSGPA or SAT mathematics subscores. Smittle's 1995 study, suggested comprehensive measures which include student characteristics are helpful in predicting future success.

A study performed by House (1996) investigated the relationship between overall grade point average and non-cognitive variables and found significant positive correlations existed between academic self-concept, academic expectations and parental education as well as academic performance indicators and overall grade point average. Negative correlations existed for financial and social goals.

Kanoy, Webster, and Latta (1989) considered traditional (academic performance), cognitive, and psychological measures as predictors of first-year college grade point average between female students expected to do well in college and those who were not. Results from this study indicated that for students expected to do well, HSGPA and academic self-concept were the best predictors. For students not expected to do as well, none of the traditional variables were effective predictors. Instead, an internal locus of control and amount of effort put into their work were better indicators.

Limited studies do exist linking factors other than academic performance variables to success in post-secondary mathematics. Dumont and Jones (1983) used discriminant analysis in an attempt to differentiate between successfully remediated students in developmental programs. When considering successful remediation as passing the developmental course they identified the factors math pretest score, perceived usefulness of course, and race as important. When they defined successful remediation as passing the next mathematics course, ACT composite score and number of hours carried emerged as factors, but the significance level was low ($p=.1101$). In addition this study suffered from

a limited sample size (n=48, n=24). Other variables included in this study were gender, age, ACT math subtest score, and confidence in ability to master mathematics.

In a study of retention in a two-year developmental mathematics program at a community college Umoh, Eddy, and Spaulding (1994) studied 41 students and compared persisters and non-persisters. They found no significant difference in any of the variables studied. The variables under consideration were age, gender, parent's education, grade point average (GPA), academic goal commitment, academic integration, institutional experience, and academic performance.

Although use of gender as a placement variable would be unlawful, I have included it as a variable of interest for prediction. Studies on the effects of gender as related to mathematics have produced mixed results. When considering mathematics achievement by area, Dossey (1988) reports that males out-perform females in geometry and measurement, while females out-perform males in numbers and operations. Bridgemand and Wendler (1991) found that gender differences favored women in grades and men in SAT mathematics subscores. Rech (1996) found women had better course grades than men in intermediate algebra and similar grades in college algebra. Women's pass rate in a basic mathematics course was higher than men's in a study by Goldston (1983). Frerichs and Eldersveld (1981) found however, percentages of males and females succeeding in a developmental mathematics course to be the same. McConeghy (1987) and Cooper and Robinson (1989) found no significant differences. Duke and Duke (1990) in a study of the Pre-Professional Skill's Test mathematics portion found no significant differences between women and men. Other researchers (Becker, 1990; Raymond & Benbow, 1986) have also found little difference.

Factors Related to Student Persistence

The reasons why students leave colleges and universities are complex. Although academic difficulties continue to be a reason for departure, these difficulties do not explain why students with grades higher than persisters leave. Students who leave because of academic difficulties may in fact account for only a small percentage of nonpersisters. Tinto (1987) in Leaving College: Rethinking the Causes of and Cures of Student Attrition found only 15% of students departures result from academic dismissal. Kalsner (1991) reports

> A review of the current literature on college attrition . . . , reveals four recurring themes: 1) uncertainty both about what to expect from college and its rewards; 2) transition/adjustment problems; 3) financial difficulties; and 4) academic underpreparation.

Other studies echo this theme. Variables identified by these studies include academic aptitude and performance, motivation, sense of belonging, level of aspiration, and student involvement (Beal & Noel, 1980; Lenning, Beal, & Sauer, 1980).

Considering the "goodness of fit" between the student and institution and the student's goals may provide an understanding of the uncertainty about college. Astin and Panos (1967) suggested students who plan to obtain an advanced degree are more likely to persist. Commitment to college was found to be important in retention in a study by Bers (1986). Janes (1997) reported that individual commitment to degree completion was a major factor in persistence. Institutional commitment, the degree of loyalty to the higher education institution, was the most important indicator of student dropout for both sexes in a study by Bean (1980). Pascarella and Terenzini (1980) in a study of factors affecting

voluntary dropouts of first-year students, also found institutional and goal commitment important to student persistence.

We cannot underestimate the importance of integrating into college socially. This integration can take place in at least three ways, student-faculty interaction, involvement in college activities, and peer relationships. Tinto (1975) posited that students who maintain strong social support separate from the collegiate experience and fail to develop social associations within the college or university have a stronger chance of departure. Pascarella and Terenzini (1977) indicated that positive faculty interactions have a positive effect on retention as does student perception of faculty and peer-group interactions. In a more recent work Nordquist (1993) found that lack of faculty-student interaction in the form of mentoring appeared to have a significant negative impact on student retention. In 1967, Astin and Panos reported that students who participate in college activities were more likely to persist. In this same study positive peer relations were correlated with retention. Astin (1979) later developed measurements along an "intensity of involvement" theory which explores the relationship of the student and institution along multiple scales including living on or off campus, amount of time spent on academic activities, amount of time spent on campus and whether the student was concerned with persons and events on campus or off campus. These factors were significant with respect to student departure.

Tinto (1987) plays down the importance of financial need while Astin (1975) suggests it has a definite effect. More recent research clearly indicates its importance (see for example Gerardi, 1996; Janes, 1997; Ogletree 1992; Von Wald, 1992). Students who receive grants are more likely to persist according to a study by Porter (1990). Cabrera, Nora, Castaneda, and Hengstler (1990) included ability to pay in a model of student

persistence and found that ability to pay for college can moderate effects of other variables in the Tinto model of student persistence.

Institutions which have higher academic admissions were found to have higher retention rates in a study by Noel (1985). Pascarella and Terenzini (1980) found high academic and intellectual development positively influences persistence. Astin (1975) found significant correlations in student persistence and academic performance variables including HSGPA, high school class rank, and college admission's tests (ACT and SAT). In addition Astin reported significant differences between persisters and non-persisters with respect to gender and religious background. Significant positive correlations were also found between parental education and income. Other variables associated with dropping out reported by Astin were poor study habits, low aspirations, and age.

Research has also linked other factors to student persistence. Locus of control was found significant in studies by Gail and Behuniak (1981) and Bers (1986). Both studies suggested that students more internally controlled are more likely to persist. Students who work full time are less likely to persist according to a study by Brooks-Leonard (1991). Astin (1975) reports however that working off campus as long as it is less than 25 hours per week may increase a student's chance of persisting.

The age of a student may directly influence persistence. Brooks-Leonard (1991) reported that being more than 40 years old is correlated with low persistence. Steltenpohl and Shipton (1986) reported that older students find it more difficult to adjust to college. Older students also face multiple challenges as they typically have considerable external demands including family and work.

Summary

As the literature suggests, several factors have been linked to student retention. Among these are academic underpreparation and associated academic problems, difficulty in adjusting to the demands of college both socially and academically, maturity, lack of coping skills, absence of goals, uncertainty about college in general, lack of commitment to degree completion, finances, locus of control, and quality of interaction between students and other students as well as faculty.

The interaction between these factors and student success in collegiate mathematics is, however, poorly understood. Instead researchers have concentrated their efforts on relating success in mathematics to academic performance variables. In particular these studies have linked success in collegiate mathematics to ACT scores, SAT scores, high school grade point averages, and exams with a mathematics orientation. Other non-academic factors studied included level of stress, academic self-concept, parental education, finances, social goals, internal locus of control, age, and gender. Studies of these non-academic factors are few however. This interplay between non-academic factors and success in collegiate mathematics is important, especially for those less academically prepared students, and deserves further study.

CHAPTER III

METHODS AND MATERIALS

Introduction

A major portion of this study lies in data collected by the East Central University Assessment Office using a survey instrument. The survey instrument was designed to assess student beliefs and attitudes about factors important to overall student success as well as demographic information. A review of the construction and content validity along with a copy of the survey can be found in Appendix A. Additional information gathered included academic performance indicators. This chapter discusses the survey instrument and associated validity and reliability measures, subjects used in the study, and the overall design used to answer the research questions.

Subjects

Data was collected on students entering East Central University from semester year Fall 1995, Spring 1996, Fall 1996 and Spring 1997. Assessment officials asked all students in this group to complete the survey during their enrollment. They did not require students to complete the survey and they offered no inducement for completion. Approximately 941 surveys were collected. I deleted students with missing academic

performance indicators (high school grade point averages, ACT scores, or Computerized Placement Test scores) from consideration leaving 878 students.

Of the 878 surveys 198 had missing responses on at least one item and were removed from the study. Besides problems resulting from missing responses, several students filled out the survey with irregular or unusual responses resulting in abnormal factor scores. The method used to calculate factor scores produced standard normal scores, thus any score greater than 3 or less than -3 can be considered an outlier and is likely the result of a student improperly filling out the survey. I use these more liberal values rather than conservative estimates of -2.5 to 2.5 to allow for a few large standard normal scores which can occur with a sample size this large. An analysis of factor scores indicated 26 surveys had scores on at least one factor suggesting the presence of an outlier. I removed these 26 surveys from further analysis. This resulted in a sample size of 654 students with complete records. Borg and Gall (1989) recommend 15 observations per variable for this type of study. Based on this estimate and the 41 possible variables in the study we need at least 615 students. Thus, the sample available is sufficient for further analysis.

The sample of 654 students consisted of 358 (54.7%) females and 296 (45.3%) males. More than 95% of the students indicated the last school attended was high school. The East Central University Assessment Office classified most of the students in the sample (486 or 74.3%) as not needing remediation. Most of the students (531 or 81.2%) were in the age group 18 years old or less. Usually students entered the university in the fall term with 240 (36.7%) entering in fall 1995 and 345 (52.8%) entering in fall of 1996. The remaining 69 (10.5%) students entered in Spring 1995 or Spring 1996.

Approximately half (307 or 46.9%) of the students elected to take MATH 1513 College Algebra.

I defined success in MATH 1513 College Algebra as making an "A," "B," "C," or "D" in the course. Any other assignment of a grade which included administrative withdrawals, "AW," and voluntary student withdrawal, "W," was considered unsuccessful. Assessment officials have initially identified students as in need of remediation in mathematics if they scored below 19 on the mathematics subscore of the ACT and scored below 75 on the mathematics portion of the College Base Computerized Placement Test (CPT). From these definitions I divided the students into four groups. Group one represented those students placed in developmental courses who took MATH 1513 College Algebra and were unsuccessful (remediated-unsuccessful). Group two represented those students who were placed in developmental courses and were successful in MATH 1513 College Algebra (remediated-successful). Group three represented those students who were not placed in a developmental course and were unsuccessful in MATH 1513 College Algebra (nonremediated-unsuccessful). Group four represented those students who were not placed in a developmental course and were successful in MATH 1513 Collage Algebra (nonremediated-successful).

Of the 307 students who elected to take MATH 1513 College Algebra, 185 were successful and 122 were unsuccessful. The classification of these 307 students by need of remediation resulted in 56 classified as remediated or "at risk" and 251 classified as nonremediated or "not at risk." There were 30 students classified as remediated-unsuccessful, 26 students who were classified as remediated-successful, 92 students who

were classified as nonremediated-unsuccessful, and 159 students who were classified as nonremediated-successful.

Survey Background Analysis

An independent educational researcher designed the Enrollment Survey used by the East Central University Assessment Office to measure variables which according to previous research impact student persistence. She grouped the variables into three areas, demographics, attitude constructs, and other selected items. The demographic variables included age, gender, type of school attended prior to entering East Central University, and parents level of education. Other selected items (nondemographic) included a measure of the importance of reliable transportation and whether the student believed they had reliable transportation, the number of hours the student planed to work, and the student's intent to join a fraternity or sorority.

Assessment officials based the decision to use a site-constructed instrument primarily on financial reasons. However, other factors such as "goodness of fit" to East Central University and concerns for a simple, brief instrument were also considerations. Using a site-based instrument however raises questions regarding validity and reliability. I examine these issues below and further in the next chapter as the survey is explored using factor analysis.

Factor Analysis of the Survey

Before using the data I used an initial factor analysis to screen for unusable data and problems with variables. As I agreed with the content validity analysis regarding item

36, "If people shout suggestions when I'm playing a game, it doesn't upset me.," and regarding item 24, "I have reliable transportation.," I did not use either of these items in this factor analysis

Since the content validity analysis suggested several factors within the survey, principle components analysis is used to account for all the variation in the model, rather than a common factor analysis which uses commonalities (covariance) to determine factors. Since factor naming cannot be done without an orthogonal rotation. I selected the method of Varimax rotation with a Kaiser normalization.

Kim and Mueller (1982) suggest a rule of thumb for estimating the number of initial factors. This method is referred to as the Kaiser or eigenvalue criterion and involves selecting those eigenvalues greater than one. Johnson (1998) echos this idea and supports this decision based on the reasoning a factor with an eigenvalue less than one explains no more variation than a single variable. Thus, for the initial factor analysis I included any factor with an eigenvalue greater than one.

Using the content validity (see Appendix A) as a guide, I considered the following options regarding the first analysis. Once decisions were made with regards to these options, I performed a new factor analysis. The first option is with regards to item 17, "I plan to join a fraternity or sorority.," denoted by the variable FRATSO. If the variable FRATSO loads on a single factor with no other variables loading high on the same factor, I will remove the variable from further analysis and treat it as a single variable. The content analysis would support this decision. The second option is with regards to the variables FAMFIN and CWASTE. If the variables FAMFIN and the variable CWASTE load on the respective two hypothesized factors, I will remove them from further analysis.

The decision to do this is based on the reasoning that differences in factors may be due to the large influence of a single variable rather than the factor. If for example, groups differ on both a emerging finance factor as well as a family support factor and the variable FAMFIN loads evenly on both factors, it would be difficult to determine if differences on the factors were due to finance concerns or family concerns. Although it is tempting to delete all variables which load on different factors, we do not want to reduce the number of variables indiscriminately as this may reduce the reliability gained by using multiple measures. Since the content validity analysis did not suggest problems with other variables, I will delete no other variables from the study unless additional information provides sufficient reasoning. The final option is the determination of potentially useless data. I used the standard normal computed factor scores to remove outliers from the data. I defined an outlier as any factor score greater than 3 or less than a -3. Surveys with outlier scores on any factor were removed from consideration.

The initial factor analysis revealed the following. The variable FRATSO loaded on a single factor with a loading of .768. Only one other variable loaded significantly on this factor, GRD4YR. The loading for this variable was .393. No reason for the relationship between these two variables is forthcoming. Based on this loading pattern and the options discussed above, I removed the variable FRATSO from the factor analysis and used it as a single variable in further analysis.

The variable FAMFIN did load on two separate factors. One of the factors included variables identified by the content reviewers as related to finance (loading was -.340) and the other factor had variables identified by the content reviewers as related to parental/family involvement (loading was .535). Since this variable does not appear to

load high on any single factor and loaded on the two hypothesized factors, it may not provide the hoped for differentiability. Since I now have multiple indications of problems with this variable, I removed it from the study. The variable CWASTE loaded on three separate factors. Since this variable did not perform according to the content review, it may yet provide some type of content validity. As such, I left this variable in the study.

After the removal of the variables FRATSO and FAMFIN and the surveys with unusual scores, I performed a new factor analysis. This analysis produced 8 factors with eigenvalues greater than one, explaining approximately 51% of the variation. One factor in particular had high loading on a single variable HSSTUD with no other significant loadings. The smallest associated eigenvalue was 1.070. This indicates a solution with fewer factors. Based on this analysis, I reran the factor analysis limiting myself to a seven factor solution.

The seven factor solution explains only 47% of the variation. Although this seven factor solution did not explain as much variation as hoped, with several factors hypothesized, we would expect more noise than usual. Some evidence points to a six factor solution. The the sixth largest eigenvalue is 1.204 suggesting multiple measures are more useful, while the seventh has a value of 1.071, suggesting a single variable measure. I opt for the seven factor solution for two reasons. One, the content validity hypothesized a seven factor solution, and two, the reduction to a six factor solution would explain only 42% of the variation.

Although the content validity analysis provided the initial guide should the new factor analysis yield other useful constructs, I did not discard these additional constructs. Rather I attempted to identify these additional constructs and determine if they might have

construct validity. If so, I attempted to identify these factors and additionally I made a deliberate search to determine if existing evidence would not support the emerging factor.

Analysis of this model suggested empirical consistency with the theoretical structure on several factors. Chapter IV details the results of the final factor analysis. The emerging factors which agreed with the hypothesized model are Academic Integration - High School Experiences, Academic Integration - College Expectations, Institutional Commitment - Institutional Fit, Financial - Ability to Pay, Locus of Control - Maturity.

Two of the factors hypothesized by the content analysis, Social Integration - Ability to Establish Social Support System and Family Support - Encouragement of Significant Others did not emerge as clearly as predicted. Two factors which merged parts of each emerged. I renamed these factors as Social Integration - High School Experiences, and Social Integration - College Expectations.

Validity, Reliability, and Persistence Relationships

Borg and Gall (1989) note that some in some cases considering construct validity may not be important. They state

> This is the case when the primary purpose of the research is to find predictors of a criterion on an empirical basis without resort to theory. Here the concern is to identify tests that have predictive validity for a particular purpose. The construct validity of the tests is not necessarily relevant.(p. 256)

However, as construct validity is considered the most essential consideration in test evaluation (Messick, 1989) I should establish some evidence of construct validity.

Mertens (1998) suggests a general method for establishing construct validity. She suggests finding two groups who theoretically should perform differently based on a pre-

identified trait. The literature suggests that persisters and non-persisters should perform differently on the 7 identified factors. Statistically significant differences in mean response for persisters and non-persisters on the factors above should establish construct validity for that construct. This study defines a persister as a student who completes four or more semesters. The data is analyzed by performing a student's t test using independent samples for each of the above factors using factor scores. Factor scores for each respondent are computed using Principal Components Analysis.

In this analysis three of the factors did not show difference between persisters and non-persisters as hoped. One possible explanation is the method used to compute factor scores. The PCA computed scores use all variables, even those with low loadings, to compute a score. These low loading may introduce enough variation into the scores and reduce the possibility of finding significant differences. Alternative methods exist which can also be used to determine factor scores. Johnson (1998) suggests alternatives to statistical methods used to compute factor scores. These "ad hoc" methods can be used if an orthogonal rotation has been obtained. One suggestion is to compute a weighted average of the scores which load high on a factor. Here a simple average can be used as the data are all on the same scale. Those factors which load negatively must be reversed coded. I coded the data so persisters would be expected to do better than nonpersisters along each of the constructs. I analyzed the data by performing a student's t test using independent samples for each of the above factors using the averaged variables.

Definition of Variables

As with any study employing multivariate analysis, care must be taken to define variables carefully. Variables used in this study representing single responses from the Likert scales are defined in Appendix A. In addition to these variables I have created eight new variables which are actually factor scores (weighted combinations of the variables listed in table 1) from the analysis. Academic Integration - High School Experiences is represented by the variable AIHSCH, Academic Integration - College Expectations is represented by the variable AICOLL. I named the social integration factors similarly, SIHSCH for Social Integration - High School Experiences and SICOLL for Social Integration - College Expectations.

The variable name LCCNTL denoted the Locus of Control - Maturity factor. Financial - Ability to pay factor is denoted by the variable name FINANC. The variable name COMMIT is denoted by Institutional Commitment - Institutional Loyalty.

This study also has several demographic variables. I denoted the respondent's age group by the variable name AGE. I coded the variable AGE (item 1) as "5" if the respondent indicated "18 or less," "4" if the respondent indicated "19 - 21," "3" if the respondent indicated "22 - 30," "2" if the respondent indicated "31 - 40," and "1" if the respondent indicated "over 40." A high score on this variable indicates a younger student. The variable name GENDER denoted the sex of the respondent. I coded GENDER as "5" if the respondent indicated male and "4" if the respondent indicated female. Type of school attended just prior to entering this university (item 4) is denoted by the variable name SCHOOL. This variable was coded as "5" if the respondent

indicated "highschool," "4" if the respondent indicated "vocational technical school," "3" if the respondent indicated "2-year college," "2" if the respondent indicated "4-year college or university." High scores on this variable would indicate a student who was fresh out of high school. Item 3 is a measure of the number of hours per week the respondent plans on working. The variable WORK was coded as "5" if the respondent indicated "over 40 hours," "4" if the respondent indicated "31 - 40 hours," "3" if the respondent indicated "21 - 30 hours," "2" if the respondent indicated "11 - 20 hours," and "1" if the respondent indicated "1 - 10 hours." High scores on this variable indicate the respondent is planning to work more hours.

The content reviewers suggested the importance of reliable transportation only if the student lived off campus. I agreed with their assessment and have combined the two responses to give a new variable which measures the relative importance of this response in light of college residence. To measure this variable the responses for item 24, "I have reliable transportation." were reverse coded. A high score on this item would suggest responders do not have reliable transportation. This variable was added to the response for item 5, "Indicate your current college residence." I coded the responses for item 5 as "3" if the responded indicated an on campus residence (either residence, fraternity, or sorority hall), "4" if the respondent indicated an off-campus residence within 20 miles of campus, and "5" if the respondent indicated an off-campus residence greater than 20 miles away from campus. To give a variable with the same scale as most of the other variables, I divided the sum by 2 to give a response between 2 and 5. I name this variable TRNRES. High scores on this variable would indicate either off campus address and/or lack of reliable transportation.

To measure parent's level of education responses on item 6, "Mother's level of education." and item 7, "Father's level of education." were coded as "5" if the respondent indicated "below high school," "4" if the respondent indicated "high school or GED," "3" if the respondent indicated "Bachelor's degree," "2" if the respondent indicated "Masters degree," and "1" if the respondent indicated "Doctorate or higher." The responses for each item were averaged to give a variable representing parental level of education, PAREDU. Low scores on this variable would indicate higher levels of parental education.

On the variables described above we would, according to the existing literature, expect for persisters to score higher on AGE, SCHOOL, and WORK and lower on PAREDU and TRNRES. Conversely we would expect nonpersisters to score higher on PAREDU and TRNRES and lower on AGE, SCHOOL, and WORK

Also included in this study are three academic performance variables. The student's high school grade point average as reported by the transferring school was recorded on a 4 point scale. I will denote this score by the variable name HSGPA. The variable CACT will denote student's composite American College Testing score. A final academic performance score is the student's score on the mathematics portion of the College BASE Computerized Placement test. The variable MCPT will denote this score. I used the math score on the computerized placement test for two reasons. One, no composite score is calculated for the placement test, and two, the math score is used for placement. The composite ACT score is used rather than subscores as it is used as a criterion for admission. We would expect persisters to score higher than nonpersisters on all the academic performance variables.

Research Design

In this section I outline the methods used to answer the research questions. Question 1 asks the following. Does the student survey yield a set of underlying factors that the research literature has identified as factors linked to student persistence or models of student persistence? To ascertain an answer to this question, I used the seven factor solution obtained as described earlier. I demonstrated that this factor solution to agreed with current literature on student persistence and the hypothesized model. To demonstrate the statistical viability of the factor solution, I performed independent t-tests on each factor using persistence data. Significant differences between persisters and nonpersisters on each factor confirmed the factor solution. Additionally, I also preformed t-tests with respect to the variables FRATSO (intent to join a social organization), TRNRES (transportation and college residence), AGE (age group of the respondent), PAREDU (parent's education), WORK (number of planned hours of work), HSGPA (high school grade point average), CACT (composite ACT score), and MCPT (math computerized placement score).

In addition to the confirmatory analysis above, I considered internal reliability as well. Traditional methods of establishing internal reliability using the method of rational equivalence may not be useful for this instrument as the instrument does not measure a single construct. However since I have hypothesized the variables to distinguish between persisters and nonpersisters, I would be remiss not to evaluate the survey on this criterion. Using Cronbach's alpha, I computed reliability estimates each factor as well as an overall estimate.

To answer research question 2, "Do differences exist between successful and unsuccessful students in college algebra on these emerging factors as well as academic performance indicators and demographic variables?," I performed independent t-tests on these variables. Significant differences between students successful in college algebra and unsuccessful in college algebra suggested differences in performance between the groups. In addition to examining differences between successful and unsuccessful students, I also preformed a one way analysis of variance on the groups remediated-unsuccessful, remediated successful, non-remediated-unsuccessful, and non-remediated-successful on these same variables. For those variables that show differences between groups, I used a post ad-hoc test (Bonferroni's method) to examine where those differences exist.

I answered research question 3, "Using discriminant analysis on academic performance indicators, demographic variables, and the factors high school academic experiences, high school social experiences, college academic expectations, college social expectations, institutional commitment, finances, and locus of control, can a classification system be developed as an aid in identifying class membership in remediated-successful, remediated-unsuccessful, non-remediated-successful, and non-remediated-unsuccessful groups?," by using a stepwise discriminant analysis on all available variables. This included demographics, academic performance variables, derived factors, and single responses from the original survey. I preformed a cross validation study to determine the reliability of the indicators.

I answered the final research question, "Using academic performance indicators, demographic variables, and the factors high school academic experiences, high school social experiences, college academic expectations, college social expectations, institutional

commitment, finances, and locus of control, can a path model be determined which shows factors and variables important to a student's final grade in MATH 1513 College Algebra?," by constructing a path model based on a temporal model. Path analysis is a method to estimate the magnitude of the various relationships predicted by a causal model (Asher, 1976). An a priori model is hypothesized and regression analysis is used to determine if the data support the hypothesized causal effects. Wolfe (1985, as cited in Braxton, Duster, & Pascarella, 1988) suggests two advantages to causal modeling or path analysis. One, the theoretical model is hypothesized determining not only cause and effect but also the ordering and patterns. The second advantage is that indirect effects along a path can also be measured. Exogenous variables are those which the student has little if any control over. I arranged endogenous variables in a temporal model with interaction between theses variables established either by the literature or the time in which one would expect them to occur. I tested the reliability of the model by testing the significance of the path coefficients derived by using linear regression. I calculated twelve separate regression equations regressing each of the twelve endogenous variables on the exogenous variables. Standardized beta weights are used as path coefficients. I tested standardized beta weights for significance levels.

CHAPTER IV

DATA ANALYSIS

Introduction

This chapter begins with an examination of the attitude responses from the survey and leads into the factor analysis used to answer the first research question. I have performed reliability analysis as well. I refer the reader to Appendix A for a discussion of the content validity. I address the remaining research questions in order following this discussion.

Initial Factor Analysis

The first research question was "Does the student survey yield a set of underlying factors that the research literature has identified as factors linked to student persistence or models of student persistence?". To answer this question I used both the content validity as well as a factor analysis to examine the structure of the survey. Although there were 38 original items on the survey, item 36, "If people shout suggestions when I'm playing a game, it doesn't upset me." and item 38, "I like myself and am proud of who I am." were not used in the analysis. I deleted item 38 based on the content reviewers' suggestion that the item was too contextual. Item 36, although posing no apparent contextual problem,

caused considerable concern among the reviewers. Many of them objected to the item outright. Since this item might be controversial, I removed it from the survey as well.

An initial factor analysis of the variables gave 10 factors with eigenvalues greater than 1, explaining approximately 57% of the variation. I did not attempt to identify any factors at this time, instead concentrating on the loadings on the factors. As hypothesized by the content reviewers, the variable FRATSO, suggesting the desire to join a social organization may be a single factor variable. The loading on this factor was .768 and the eigenvalue was near 1. The only other loading of merit was the variable GRD4YR, representing the desire to graduate in 4 yours, with a loading of .393. No reason for the relationship of these two variables is forthcoming. This analysis suggested this variable is most likely a single variable. I therefore used the variable FRATSO as a single variable in further analysis.

In addition I also examined the two variables hypothesized by the reviewers to load across factors. Item 29, "I will have financial support form my family." loaded evenly on two constructs. The first appeared to represent financial concerns as other variables loading high represented beliefs that the respondent would have difficulty paying expenses and needed student loans, scholarships, and grants. The second appeared to represent family encouragement as other variables loading high on the constructs represented beliefs that the respondent's family encouraged their educational goals and parents expected them to get a college degree. Although loading across two constructs is not in itself problematic, in this situation, it does present cause for concern for two reasons. One, including this variable may make the naming of these factors difficult since we can be uncertain if a factor is a financial one or a family support factor. Two, our present

concern is to find out if differences exist between groups along each factor. If two groups differ in responses to a factor which includes this variable we would not know if the difference was due to financial concerns or family expectations. I believed this particular item was too problematic to use. I therefore deleted it from further analysis.

The content reviewers also expressed concern with item 37, "I believe taking courses not directly related to my career choice is a complete waste of time." This variable did not load on the two constructs as hypothesized. I therefore kept this variable CWASTE in the analysis.

At this point I also examined the data for possible outliers. Principal Component Analysis as performed by SPSS produces factor scores that are approximately standard normal. Individuals with factor scores more than 3 or less than -3 were deleted from the survey. An analysis of factor scores suggested 26 surveys had scores on at least one factor showing the presence of an outlier. I removed these 26 surveys from the analysis.

I ran a new factor analysis and I examined the results of the new factor analysis to determine an appropriate model for the survey. The new factor analysis gave 8 factors with eigenvalues greater than 1. Two of the eigenvalues were close to 1 (1.070 and 1.037). The solution explained approximately 51% of the variation in the model. On factor 7 a single variable, HSSTUD, an indication of whether the student believed they studied in high school, had a factor loading of .811. The next largest factor loading on this factor was -.333. The small eigenvalue coupled with the disparity in loading values suggests perhaps another single variable should be used. However the content reviewers did not suggest this variable should load as a single variable. Rather than use this variable as a single value and since the content reviewers hypothesized a 7 factor solution, I reran

the factor analysis requiring a 7 factor solution to see if this would force the variable to load on a different factor.

I would be remiss in not considering other methods of determining the number of factors for this data. However, some traditional methods of determining an appropriate number of factors may not be useful for this model. If the hypothesized model is true and only a few items load on certain factors, each factor will not explain much of the variation. A scree plot therefore did not supply any useful information on number of factors. I instead relied on the amount of variation explained. A reduction to a 6 factor solution would explain only 42% of the variation. The 47% explained variation is already low. This level of explained variation coupled with the content reviewers' hypothesized model favors a 7 factor solution provided no other problems arise. The 7 factor solution on the remaining 26 variables presented has no evident problems except perhaps the last factor. This factor has some indications of single variable loadings. However, based on the discussion above I found this factor model acceptable and I used it to generate final factor scores for the survey. Factor loadings for this model are given in Table I.

Factor Structure

The reader is referred to Appendix A for the definition of the variables and the exact statements representing single item variables drawn from the survey discussed in this section. Following each list of variables loading on a particular factor is an explanation of the variables loading on that factor.

TABLE I

FACTOR LOADINGS FOR ATTITUDINAL VARIABLES

Variable	Factor Loadings						
	1	2	3	4	5	6	7
GRD4YR	.580						
COLGGR	.571						
GRDSCH	.522					.462	
SURMAJ	.473						
DIFCRS	.397						
KNWFAC	.394	.382					
HSSTUD		-.720					
TESTQN		.544					
ASKHEP		.465					
STDY20	.351	.455					
SUCEFF		.442					-.362
NFREND			-.657				
HNDLST			.639				
LECTRE			-.631				
HEALPB			-.396				
FAMENC				.639			
HSXACT				.590			
PAREXD	.346			.559			
FRIEND			.314	.434			
DIFPYX					.713		
NSTULN					.700		
SCHGRT					.619		
PTRANS						.761	
ECURGT	.319					-.608	
CRBYCL		.311					.704
CWASTE							.474
	(3.96)	(1.75)	(1.55)	(1.41)	(1.30)	(1.20)	(1.07)

Note: Factor loadings less than .300 are not reported. Only factors with eigenvalues greater than one are reported. Numbers in parenthesis are eigenvalues.

Factor 1 loads high on GRD4YR, COLGGR, GRDSCH, SURMAJ, and DIFCRS. Additional variables which load on this factor, but also load higher on other factors include KNWFAC, STUD20, PAREXP, and ECURGT. A respondent scoring high on this factor would suggest the presence of a desire to graduate in four years and the expectation of good grades. This respondent is certain of his or her major, expects difficult courses, and may obtain an advanced degree. In addition this respondent plans on getting to know faculty, and studying 20 or more hours per week. The variables PAREXP and ECURGT also load on this factor but load much higher on other factors. These variables are related to college expectations. Although I have the absence of the variable LECTRE and the additional variables listed above loading on this factor, indications hint at alignment with the hypothesized factor Academic Integration - College Expectations. I would hypothesize that persisters would score higher on this factor than nonpersisters.

Factor 2 loads high on HSSTUD, TESTQN, SUCEFF, STDY20, ASKHEP, KNWFAC, and CRBYCL. The negative loading on HSSTUD suggests a respondent with a high score on this factor studied in high school. The high positive loadings of SUCEFF, STDY20, ASKHEP, KNWFAC, and TESTQN suggest a willingness to study for 20 or more hours per week and a desire to get to know faculty. In addition they believe that the amount of effort they applied determined past successes and are unafraid to ask for help. Finally, when the student studied for exams they made out practice questions. The loading of CRBYCL on this factor is unexplained. However, the loading is small and therefore of little concern. Of the six remaining factors which loaded on factor 2, four were hypothesized to load on the Academic Integration - High School Experiences. KNWFAC

also loads on factor 1, which was hypothesized. Thus, I have confirmation of this factor. I would hypothesize that persisters would score higher on this factor than nonpersisters.

Factor 3 loads high on the variables NFREND, HNDLST, and LECTRE. The variable HEALPB loads negatively, and has a low loading on this factor. A respondent scoring high on this factor believes they handle stress well and will not have difficulty in making new friends. They also believe that they will not have difficulty with lecture classes and health problems rarely interfere with intended goals. This factor was not hypothesized. It may be a factor related to social integration at the collegiate level. I define this factor as Social Integration - College Expectations. I would hypothesize that persisters would score higher on this factor than nonpersisters.

Factor 4 loads high on the variables HSXACT, FRIEND, FAMENC, and PAREXP. This suggests an individual who agrees with the statements attached to the above variables was involved in high school activities, has friends attending East Central University, and will not have trouble making new friends at East Central University. In addition their family encourages their educational pursuits and their parents expect the respondent to get a degree. It appears a respondent who agrees with this statement was involved socially at their high school and had family encouragement. Although this factor is highly related to the hypothesized encouragement of significant others and family, the addition of other unhypothesized factors suggests this factor encompasses more than just family encouragement. As I have split part of the social factor into college expectations and this factor deals with high school beliefs, calling this factor Social Integration - High School Experiences seems appropriate. I would hypothesize that persisters would score higher on this factor than nonpersisters.

Factor 5 loads high on the variables DIFPYX, NSTULN, and SCHGRT. This factor suggests a respondent agreeing with these statements expects difficulty in paying college expenses coupled with a desire to apply for student loans and the need for scholarships and grants. I identify this factor as the hypothesized factor Financial Need - Ability to Pay as the three variables above are the three hypothesized variables. I would hypothesize that nonpersisters would score higher than persisters on this factor.

Factor 6 loads high on the factors PTRANS, ECURGT, and GRDSCH. The negative loadings on the variables PTRANS and GRDSCH suggest that a respondent who agreed with the statements associated with the variables did not plan on transferring to another university and did not intend to go to graduate school. This coupled with a high loading on ECURGT suggests the belief that ECU can provide a complete educational experience. The high loadings on PTRANS and ECURGT are indicative of the Institutional Commitment - Institutional Fit factor hypothesized in the model. I would hypothesize that persisters would score higher on this factor than nonpersisters.

Factor 7 loads high on CRBYCL, CWASTE, and SUCEFF. The variables CRBYCL and CWASTE indicate that a respondent who agrees with the statements associated with the variables believes that when they do not do well in class it is because of circumstances beyond their control and that taking courses not directly related to their major is a waste of time. In addition they believe that the past successes are not related to the amount of effort put forth. This shows a strong belief that forces external to the respondent control much of their life. This matches the hypothesized Locus of Control - Maturity factor. I would hypothesize that nonpersisters would score higher on this factor than persisters.

Examination of the factor analysis yielded 7 identified factors Academic Integration - High School Experiences (AIHSCH), Academic Integration - College Expectation (AICOLL), Social Integration - High School Experiences (SIHSCH), Social Integration - College Expectations (SICOLL), Financial - Ability to Pay (FINANC), Institutional Commitment (COMMIT), and Locus of Control (LCCNTL). The analysis of the student survey agrees well with the hypothesized model and with literature associated with student persistence. I find this survey has acceptable content validity to use the information gathered in further research. A list of factor variables and other variables used in further analysis is given in Table II.

Validity, Reliability, and Persistence Relationships

To examine the construct validity of the survey I performed a student's t-test on the seven factors using factor scores calculated directly by the principle component analysis. The results are given in TableIII.

Three of the factors did not show difference between persisters and non-persisters as hoped. As mentioned in Chapter III, one possible explanation is the method used to compute factor scores. The PCA computed scores use all variables, even those with low loadings, to compute a score. As an alternative to the PCA calculated scores, I also computed scores using the averages of the higher loading variables on each factor. For the factor AIHSCH, I averaged the variables HSSTUD, TESTQN, ASKHEP, and SUCEFF; for the factor AICOLL, I averaged the variables GRD4YR, COLGGR, and GRDSCH; for the factor SIHSCH, I averaged the variables FAMENC, HSXACT and PAREXP; for the factor SICOLL, I averaged the variables NFREND, HNDLST, and

TABLE II

LIST OF VARIABLES

Variable	Explanation
Factor Variables*	
AIHSCH	Academic beliefs of student from highschool. Averaged items were HSSTUD, TESTQN, and ASKHEP.
AICOLL	Academic expectations of student about college. Averaged items were GRD4YR, COLGGR, and GRDSCH
SIHSCH	Social interactions in highschool. Averaged items were FAMENC, HSXACT, and PAREXP
SICOLL	Social expectations in college. Averaged items were NFREND, HNDLST, and LECTRE.
FINANC	Need for financial assistance and/or ability to pay for college. Averaged items were DIFPYX, NSTULN, and SCHGRT.
COMMIT	Institutional loyalty and/or degree of fit between student and university. Averaged items were PTRANS and ECURGT.
LCCNTL	A measure of the locus of control and /or maturity of the respondent. Averaged items were CRBYCL and CWASTE.
Academic Performance Variables	
CACT	The student's composite ACT score.
HSGPA	The student's overall high school grade point average.
MCPT	The student's score on the mathematics portion of the College Base Computerized Placement Test.
Demographic Variables	
GENDER	Male or Female.
AGE	Age of student recorded in age groups from 1 to 5.
PAREDU	Average of each parents educational status recorded on a 1 to 5 scale.
TRNRES	Composite of a measure of reliable transportation and whether the student planned on living on campus or off campus.
SCHOOL	School previously attended recorded on a 1 to 5 scale.
WORK	Number of hours the student planned on working recorded on a 1 to 5 scale.

*PCA scores were calculated by multiplying the standardized responses for each item by the factor loadings and summing. Averaged scores were obtained by averaging the listed items.

TABLE III

TEST FOR SIGNIFICANT DIFFERENCES AMONG FACTORS USING PCA SCORES

Factor	Mean	s.d.	t
AIHSCH			
persisters	.0486	1.0454	1.399*
non-persisters	-.0614	1.0454	
AICOLL			
persisters	.0424	.9604	1.218*
non-persisters	-.0604	1.0479	
SIHSCH			
persisters	.0780	.9964	2.248**
non-persisters	-.0985	.9976	
SICOLL			
persisters	.0361	.9966	1.036
non-persisters	-.0455	1.0041	
FINANC			
persisters	-.0566	1.0050	-1.628*
non-persisters	.0715	.9909	
COMMIT			
persisters	-.0255	.9290	-.732
non-persisters	.0322	1.0804	
LCCNTL			
persisters	.0219	.9649	.629
non-persisters	-.0276	1.0437	

Note: n=365 for persisters, n=289 for non-persisters. *p<.05, **p<.01

LECTRE; for the factor FINANC, I averaged the variables DIFPYX, NSTULN, and SCHGRT; for the factor COMMIT, I averaged the variables PTRANS and ECURGT; and for the factor LCCNTL, I averaged the variables CRBYCL and CWASTE. The data is

analyzed by performing a student's t test using independent samples for each of the above factors using the averaged variables. The results are given in Table IV.

TABLE IV

TEST FOR SIGNIFICANT DIFFERENCES AMONG FACTORS USING AVERAGED SCORES

Factor	Mean	s.d.	t
AIHSCH			
persisters	3.7123	.6331	1.672*
non-persisters	3.6332	.5578	
AICOLL			
persisters	4.1525	.5507	1.906*
non-persisters	4.0704	.5449	
SIHSCH			
persisters	4.5872	.4880	3.025**
non-persisters	4.4648	.5547	
SICOLL			
persisters	3.7370	.5983	1.834*
non-persisters	3.6494	.6175	
FINANC			
persisters	2.6164	.7235	1.981*
non-persisters	2.5063	.6827	
COMMIT			
persisters	3.8041	.7182	1.585*
non-persisters	3.7111	.7787	
LCCNTL			
persisters	3.2356	.7314	.914
non-persisters	3.2889	.7526	

Note: n=365 for persisters, n=289 for non-persisters. *p<.05, **p<.01

Although I calculated scores in different ways, common themes emerge from the analysis. The data suggest factors related to high school experiences both socially and academically were highly significantly different for persisters and non-persisters no matter how I calculated scores. Persisters and non-persisters performed significantly differently in the area of academic college expectation with respect to the PCA score and highly significantly different for the other scores. Persisters and non-persisters social college expectations were not significantly for the PCA scores, but were highly significantly different for the averaged score. Ability to pay was significantly different between persisters and non-persisters only for the averaged scores. Institutional commitment was not significantly different for persisters and non-persisters with reference to the PCA score, but significantly different for the averaged score. I found no significant differences between persisters and non-persisters in the area of locus of control. However, the averaged scores along this factor were approaching significance ($p=.18$). The data displays good construct validity along six of the seven factors. Due to the strong theoretical linkage of locus of control and the fact that it is approaching significance, I will use it in further analysis, however caution should be used in its interpretation and its value as a significant variable/factor.

In addition to the expectation of differences in means, the literature also suggests how persisters and non-persisters should perform along these variables. I recoded all variables used in Table 4 so that according to current research persisters would score higher on each factor than non-persisters. If indeed persisters performed better than nonpersisters, we would expect positive t-values. As this is the case, I have excellent evidence, except for locus of control, for construct validity.

Table III requires an interpretation along each individual factor to establish some type of construct validity. The positive values t-values for academic integration and social integration are supported by the literature in that persisters would be more likely to have better experiences in high school and expect to have better expectations of the college experiences. The negative t-value for the factor FINANC suggests persisters indicated they were less likely to perceive themselves having financial problems than non-persisters.

Two other variables/factors require the establishment of construct validity, plans to join a sorority or fraternity and problems associated with transportation. Item 17 on the survey, "I plan to join a fraternity or sorority.", was removed as an attitude construct. The literature suggests that joining a social organization is positively correlated with student persistence. A t-test performed on the variable FRATSO was significantly different for persisters and non-persisters ($t=-1.763$, $p<.05$, $df=652$). The negative t value suggests that intent to join a social organization influences student retention negatively. At first glance this appears to contradict Astin's (1975) research. However, Astin's research used the actual fact of whether the student actually joined a social organization, in this survey it is the desire to join that is being measured. As this variable discriminates between persisters and non-persisters, I included this variable in further analysis.

The effects of reliable transportation and college residence to student persistence are well documented. A t-test performed on the variable TRNRES showed a significant difference between persisters and non-persisters ($t=2.067$, $p<.01$, $df=652$) with non-persisters indicating agreement with not having reliable transportation coupled with living off campus. The literature equally documents this.

Although the other variables on the survey do not require validity analysis as they represent demographic variables, since other research has documented their relationship to persistence, I performed associated t-tests. A t-test between persisters and non persisters on the variable AGE indicated no significant difference between persisters and non-persisters ($t=.465$, $p=.321$, $df=642$). This result is most likely because approximately 80% of the respondents gave a rating in the age range of "18 or less."

Parents level of education has also been determined to influence student persistence. The relationship between student persisters and parents' education is positively correlated. That is, the more education a student's parent has the more likely the student is to persist. The variable PAREDU, parents level of education, was a significant variable with respect to student persistence($t=3.00$, $p<.01$, $df=652$). The positive t-value supports the literature findings that persisters have parents with higher level's of education.

Item 2 reported the respondent's gender. I coded the variable as "4" if female and "5" if male. A Chi-square test of independence suggests that gender is not independent of persistence ($\chi^2=109.049$, $p<.01$, $df=651$). Further analysis reveals that females are more likely to persist than males.

Item 3 is a measure of the number of hours per week the respondent plans on working. The variable WORK was highly significant ($t=-3.128$, $df=652$, $p<.01$). The negative t value suggests that non-persisters indicated that they planned on working more hours per week than persisters.

An analysis of the final variable on the survey, item 4, type of school attended just prior to entering this university revealed almost 97% of the respondents indicated their

prior school attended was high school. Small numbers in other categories do not allow for further analysis.

The final variables to be discussed are academic performance variables. This includes the respondents high school grade point average on a 4 point scale, HSGPA, the student's composite score on the American College Test, CACT, and the student's score on the College Base's Computerized Placement Test, MCPT. Tests for differences of means for these academic performance variables show significant differences between persisters and non-persisters. High school grade point average showed the highest significance ($t=6.168$, $p<.005$, $df=652$) followed by composite ACT score ($t=4.273$, $p<.005$, $df=652$). Persisters and non-persisters also score differently on the math portion of the computerized placement test ($t=3.740$, $p<.005$, $df=652$).

Reliability analysis was performed using Cronbach's standardized alpha. An overall reliability measure is .5876. Although I would prefer a higher overall score, this value is within other established values for this type of survey (Helmstadter, 1984, as cited in Borg & Gall, 1989). In addition to the overall reliability score I also computed reliability estimates for each scale. The results are presented in Table V. The low reliability on the last factor could be caused by the few number of items, or due to unrelated variables. Again, the reader is urged to use caution when interpreting this factor.

TABLE V

RELIABILITY ESTIMATES FOR FACTOR/CONSTRUCTS

Factor	Variables	Cronbach's alpha
AIHSCH	HSSTUD	.5856
	TESTQN	
	ASKHEP	
	SUCEFF	
	KNWFAC	
	STUD20	
AICOLL	GRAD4Y	.6295
	COLGGR	
	GRDSCH	
	SURMAJ	
	DIFCRS	
	KNWFAC	
	STUD20	
	PAREXP	
	ECURGT	
SIHSCH	HSXACT	.4398
	FAMENC	
	FRIEND	
	PAREXP	
SICOLL	HNDLST	.4977
	NFREND	
	LECTRE	
	HLTPRB	
	FRIEND	
FINANC	DIFPYX	.5275
	SCHGRT	
	NSTULN	
COMMIT	PTRANS	.5038
	ECURGT	
LCCNTL	CRBYCL	.2028
	CWASTE	

Relationship of Variables to Success or Failure In Collegiate Mathematics

To answer the second research question, "Do differences exist between successful and unsuccessful students in college algebra on these emerging factors as well as academic performance indicators and demographic variables?", I selected from the available data set those students who elected to take MATH 1513 College Algebra. This resulted in a reduction of the sample size to 307 respondents. I begin by examining overall differences in the calculated factor scores variables identified by the factor analysis above between students who were successful in MATH 1513 College Algebra and those who were not. Independent t-tests were performed to determine if significant differences exist. The results are presented in Table VI.

Table VI shows significant differences between students who were successful and non-successful only on the factor AICOLL. This indicates that for these measures only the student's belief that they will do well academically in college is significant. Approaching significance is SICOLL and LCCNTL. These variables measure the student's belief that they will be able to be socially involved in college and have a more internal locus of control. I also perform comparisons using averaged scores for the factors. The results are given in Table VII.

Again the variable AICOLL is significant, but LCCNTL is also significant. The negative t value not surprising. This indicates that students who believe that taking courses not directly related to their major is a waste of time and believe that when they do not do well in a class it is because of reasons beyond their control are less likely to be

TABLE VI

TEST FOR SIGNIFICANT DIFFERENCES AMONG FACTORS USING PCA SCORES

Factor	Mean	s.d.	t
AIHSCH			
successful	.0681	1.0830	.491
unsuccessful	-.0065	1.0607	
AICOLL			
successful	.0716	.9400	1.912*
unsuccessful	-.1451	1.0175	
SIHSCH			
successful	.0608	.9974	.926
unsuccessful	-.0460	.9748	
SICOLL			
successful	-.0134	.9763	-1.148
unsuccessful	.1141	.9140	
FINANC			
successful	.0374	1.0329	-.671
unsuccessful	.1144	.9075	
COMMIT			
successful	.1538	.9468	.652
unsuccessful	.0805	.9910	
LCCNTL			
successful	.0176	.9876	-1.053
unsuccessful	-.1071	1.0556	

Note: n=185 for successful, n=122 for unsuccessful. *p<.05, **p<.01

TABLE VII

TEST FOR SIGNIFICANT DIFFERENCES AMONG FACTORS USING AVERAGED SCORES

Factor	Mean	s.d.	t
AIHSCH			
successful	3.6405	.6587	-.452
unsuccessful	3.6742	.6055	
AICOLL			
successful	4.1766	.5593	1.877*
unsuccessful	4.0574	.5208	
SIHSCH			
successful	4.5532	.5164	.759
unsuccessful	4.5055	.5111	
SICOLL			
successful	3.7009	.5893	-.700
unsuccessful	3.7486	.5771	
FINANC			
successful	2.5532	.7086	.354
unsuccessful	2.5246	.6666	
COMMIT			
successful	3.6486	.6981	-1.199
unsuccessful	3.7500	.7640	
LCCNTL			
successful	3.2054	.7597	-1.625*
unsuccessful	3.3484	.7466	

Note: n=185or successful, n=122 for unsuccessful. *p<.05, **p<.01

successful in MATH 1513 College Algebra. I also noted the variable COMMIT is nearing significance. The negative value here indicates that non-successful students are more likely to disagree with the statement "I am sure ECU is the right university for me" and perhaps are just at East Central University to pick up some basic courses.

As a final comparison between successful and non-successful students, I performed t-tests with respect to academic variables and demographics. The results are given in Table VIII.

Significant differences exist between successful and nonsuccessful students on all academic performance indicators. The large t-value for HSGPA indicates this variable should receive much more attention than currently accorded by universities and colleges who rely on ACT and SAT scores. Significant differences also exist between successful and nonsuccessful students in their parent's education, students who come from families whose parents are more educated are in general more likely to be successful.

Examination of Variables with Respect to "At Risk" And Collegiate Mathematics

In answering research question 2, no regard was given to students who are classified as at risk. I define a student as at risk if any subscore on the ACT was less than 19 and corresponding scores on the Computerized Placement Test were less than 75. Students in this category are considered remediated as East Central University requires them to take one or more developmental courses before proceeding to collegiate level courses. Given this designation, I classified each student into one of four groups. If a student is considered in need of a developmental course as evidenced by low ACT and

TABLE VIII

TEST FOR SIGNIFICANT DIFFERENCES AMONG ACADEMIC PERFORMANCE INDICATORS AND DEMOGRAPHICS

Factor	Mean	s.d.	t
HSGPA			
successful	3.4940	.4312	6.045***
unsuccessful	3.1670	.5092	
CACT			
successful	21.6378	3.2594	3.159**
unsuccessful	20.4262	3.3326	
MCPT			
successful	78.2216	24.1744	5.226***
unsuccessful	64.0824	21.6305	
AGE			
successful	4.8000	.5497	1.017
unsuccessful	4.7295	.6560	
WORK			
successful	3.2486	1.2653	1.086
unsuccessful	3.4098	1.2841	
FRATSO			
successful	2.4919	1.0790	-.466
unsuccessful	2.5481	1.0489	
RESTRN			
successful	3.7622	1.3342	.211
unsuccessful	3.7295	1.3113	
PAREDU			
successful	2.6297	.7460	1.204*
unsuccessful	2.7336	.7306	

Note: n=185or successful, n=122 for unsuccessful. *p<.05, **p<.01, ***p<.005

Computerized Placement Test scores I classified them as at risk, if they subsequently pass MATH 1513 College Algebra I classified them as "remediated-successful." If they do not pass MATH 1513 College Algebra, I classified them as "remediated-unsuccessful." If a student is not classified as at risk and passes MATH 1513 College Algebra, I classified them as "nonremediated-successful." If the student is not at risk and does not pass MATH 1513, they are considered "nonremediated-unsuccessful. After reclassification the sample sizes for each group are remediated-successful, 26 students; remediated-unsuccessful, 32 students; nonremediated-successful, 159 students; nonremediated-unsuccessful, 103 students.

I performed a one-way analysis of variance (ANOVA) on the data to determine if differences exist between groups. For variables or factors where differences exist, I use Bonferroni's method to decide where those differences exist. I first compared the groups with respect with the calculated factor scores. The results are given in Table IX.

None of the calculated factor scores show significant differences between groups remediated-unsuccessful, remediated-successful, non-remediated-successful, and non-remediated-unsuccessful. I compared groups along each factor by using the averaged scores. The results are given in Table X.

As expected based the lack of significance using PCA scores in the previous analysis, no significant differences exist between the groups based on these scores as well. Only the variable COMMIT approaches significance ($p=.119$).

Since the t-tests performed earlier on the academic performance variables were highly significant, I would expect differences between groups on those variables. By

TABLE IX

ANALYSIS OF VARIANCE ON CALCULATED FACTOR SCORES FOR AT RISK/NOT AT RISK AND SUCCESSFUL/UNSUCCESSFUL

		F						
Source	df	AIHSCH	AICOLL	SIHSCH	SICOLL	FINANC	COMMIT	LCCNTL
Group	3	1.010	1.656	1.868	.864	.922	1.148	.450
Error	303	(1.150)	(.946)	(.969)	(.909)	(.969)	(.927)	(1.036)

Note: Values enclosed in parentheses represent mean square errors.

TABLE X

ANALYSIS OF VARIANCE ON AVERAGED FACTOR SCORES FOR AT RISK/NOT AT RISK AND SUCCESSFUL/UNSUCCESSFUL

		F						
Source	df	AIHSCH	AICOLL	SIHSCH	SICOLL	FINANC	COMMIT	LCCNTL
Group	3	.565	1.192	.813	.784	.771	1.964	1.017
Error	303	(.408)	(.298)	(.265)	(.342)	(.479)	(.521)	(.572)

Note: Values enclosed in parentheses represent mean square errors.

performing an ANOVA on academic performance variables I compared the groups with respect to academic performance variables. The results are given in Table XI.

TABLE XI

ANALYSIS OF VARIANCE ON ACADEMIC PERFORMANCE VARIABLES FOR AT RISK/NOT AT RISK AND SUCCESSFUL/UNSUCCESSFUL

		F		
Source	df	HSGPA	CACT	MCPT
Group	3	25.739*	30.197*	31.848*
Error	303	(.193)	(8.655)	(448.736)

Note: Values enclosed in parentheses represent mean square errors. *p<.005

As expected there are significant differences between groups with respect to academic performance variables. Using Bonferroni's multiple comparison tests to compare which groups differ with respect to HSGPA, I found significant differences between remediated-unsuccessful and remediated-successful (mean difference=-.3337, standard error=.118, p<.01), non-remediated-unsuccessful (mean difference=-.4249, standard error=.092, p<.005) and non-remediated-successful (mean difference=-.6986, standard error=.087, p<.005). The remediated-successful group performed differently from the non-remediated-successful (mean difference=-.3649, standard error=.093, p<.005), but not differently from the non-remediated-unsuccessful. The group non-remediated-unsuccessful performed differently from non-remediated-successful (mean difference=-.2738, standard error=.058, p<.005). This suggests that while HSGPA may discriminate between most groups it does not discriminate between those at risk students who do succeed and those who are not at risk and fail to succeed.

Using Bonferroni's multiple comparison tests to compare which groups differ with respect to CACT, I found significant differences only between remediated students at

either any level and non-remediated students at either level. That is, the variable CACT is not a good indicator of whether the student is successful or unsuccessful once identified as either not at risk or at risk. Results suggest that remediated-unsuccessful students differ from both non-remediated-unsuccessful students (mean difference=-3.8804, standard error=.619, $p<.005$) and non-remediated-successful (mean difference=-4.6824, standard error=.586, $p<.005$). Remediated-successful differs from both non-remediated unsuccessful students (mean difference=-3.0727, standard error=.653, $p<.005$) and non-remediated-successful (mean difference=-3.8747, standard error=.622, $p<.005$).

Using Bonferroni's multiple comparison tests to compare which groups differ with respect to MCPT, I found significant differences between remediated-unsuccessful and non-remediated-unsuccessful (mean difference=-22.4754, standard error=4.454, $p<.005$) and non-remediated-successful (mean difference=-34.9358, standard error=4.217, $p<.005$), but not between remediated-successful. The remediated-successful group performed differently from the non-remediated-unsuccessful (mean difference=-14.9464, standard error=4.705, $p<.10$) and from the non-remediated-successful (mean difference=-27.3769, standard error=4.481, $p<.005$). There was also a significant difference between non-remediated-unsuccessful and non-remediated-successful (mean difference=-12.4605, standard error=2.775, $p<.005$).

Results suggest that while HSGPA provides excellent discrimination between groups it does not by itself distinguish between remediated-successful and non-remediated-unsuccessful. We should give additional attention to MCPT scores since this score does discriminate between these two groups. The variable CACT may not provide any additional information helpful in distinguishing between groups.

Demographic variables may also provide information concerning classification. I examined these scores first by using an ANOVA and then for those variables which show significant differences examine how the individual groups differ using Bonferroni's multiple comparison tests. Results of the ANOVA are given in Table XII.

TABLE XII

ANALYSIS OF VARIANCE ON DEMOGRAPHIC VARIABLES FOR AT RISK/NOT AT RISK AND SUCCESSFUL/ UNSUCCESSFUL

		F				
Source	df	AGE	WORK	TRNRES	PAREDU	FRATSO
Group	3	13.724**	1.799	.217	1.411	2.338*
Error	303	(.298)	(.265)	(.479)	(.521)	(.572)

Note: Values enclosed in parentheses represent mean square errors. *p<.05, **p<.01

Using Bonferroni's multiple comparison tests to compare which groups differ with respect to AGE, I found significant differences between only between remediated students at either any level and non-remediated students at either level. The variable AGE is not a good indicator of whether the student is successful or unsuccessful once identified as either not at risk or at risk. Results suggest that remediated-unsuccessful students differ from both non-remediated-unsuccessful students (mean difference=-.5696, standard error=.118, p<.005) and non-remediated-successful (mean difference=-.5679, standard error=.112, p<.005). Remediated-successful differs from both non-remediated

unsuccessful students (mean difference=-.4849, standard error=.124, p<.005) and non-remediated-successful (mean difference=-.4833, standard error=.119, p<.005).

The variable FRATSO also has a marginal F value of 2.338. Multiple comparison tests do not show any significant differences between groups. The most significant difference occurs between remediated-unsuccessful and non-remediated-unsuccessful (mean difference= -.5181, standard error=.223, p=.125).

Classification Analysis

To answer research question 3, "Using discriminant analysis on academic performance indicators, demographic variables, and the factors high school academic experiences, high school social experiences, college academic expectations, college social expectations, institutional commitment, finances, and locus of control, can a classification system be developed as an aid in identifying class membership in remediated-successful, remediated-unsuccessful, nonremediated-successful, and nonremediated-unsuccessful groups?", I performed a discriminant analysis on the data. Since several factor variables were not significant, I approached this classification problem using a "shotgun" approach. I used all the variables available including single answers on the survey and applied a stepwise discriminant analysis to determine which variables are more useful in determining group membership. To provide for a selection of variables in the model, I set the alpha entry level at .10 and the alpha exit level at .45. This will make variable entry as a selection variable much easier and its removal more difficult. I used Wilks' Lambda as the entry/exit criterion.

No variable which entered was subsequently removed in further analysis. The variables selected for the classification analysis were MCPT, CACT, AGE, HSGPA, TESTQN, KNWFAC, FRIEND. It was not unexpected that academic performance variables would appear in the analysis. Their high significance in the earlier analysis of variance made them excellent candidates for use as discriminating variables. The variable AGE was also significant in the analysis of variance. No factor scores appeared to be more discriminating than single response items. The other three variables are responses to the items "When I study for a test, I develop practice test questions." (TESTQN), "I plan to get acquainted with faculty at ECU." (KNWFAC), and "I have friends at ECU." (FRIEND). These variables load on the factors AIHSCH, AICOLL, and SIHSCH respectively. The variable KNWFAC also loads on AIHSCH as well.

The classification analysis had a low classification percentage of 53.4%. The cross validation percent correctly classified was 50.2% suggesting good cross validation. Results are given in Table XIII.

The largest group of missclassified students occurred for those nonremediated students who should have been successful and were not. This large missclassification is a serious error. Less serious is the error of missclassification arising from classifying a student as unsuccessful when in fact they were successful. Calculating the percentage of students who should have been successful and were not correct gives a missclassification percentage of 14.0%. This relatively small percentage is excellent for discrimination purposes, however does not solve the problem of students who fail at collegiate mathematics.

TABLE XIII

PERCENTAGE CLASSIFICATION RESULTS FOR AT RISK/ NOT AT RISK AND SUCCESSFUL/UNSUCCESSFUL

	Predicted Group Membership			
	Remediated		Non-remediated	
	Unsuccessful	Successful	Unsuccessful	Successful
Remediated				
Unsuccessful	56.7	23.3	20.0	0.0
Successful	26.9	34.6	11.5	26.9
Non-remediated				
Unsuccessful	14.1	6.5	46.7	32.6
Successful	3.1	13.2	23.9	59.7

Path Analysis

I answered the final research question, "Using academic performance indicators, demographic variables, and the factors high school academic experiences, high school social experiences, college academic expectations, college social expectations, institutional commitment, finances, and locus of control, can a path model be determined which shows factors and variables important to a student's final grade in MATH 1513 College Algebra?", by constructing a path model based on a temporal model. I hypothesized a model based on a temporal model using the variables identified in the study. (See Figure 1)

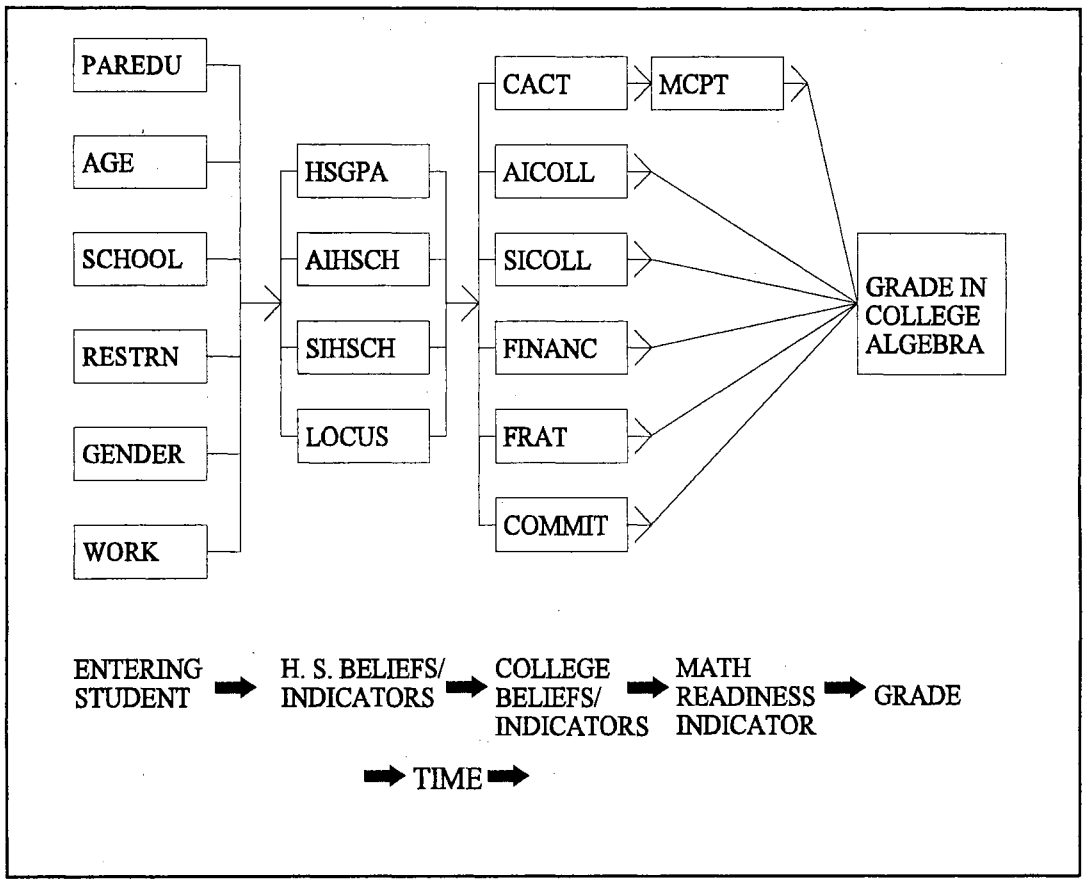

Figure 1. Initial Path-Analytic Model: Influence of Demographics, Highschool Experiences, College Expectations, and Math Readiness and Final Grade in MATH 1513 College Algebra.

I identified six characteristics entering students may display which are not related to high school characteristics. These variables are PAREDU, AGE, SCHOOL, TRNRES, GENDER, and WORK. I hypothesize these values to be exogenous variables, other variables are considered to be endogenous variables. The entering student after finishing high school has developed several indicators and/or beliefs about the high school experience, HSGPA, AIHSCH, SIHSCH, and LCCNTL. I hypothesized that the exogenous variables above directly influence these variables. The next variables are

indicative of college beliefs and/or indicators. I hypothesized these college belief/indicator variables, CACT, AICOLL, SICOLL, FINANC, FRATSO, and COMMIT are directly effected by the high school beliefs/indicators and not by the exogenous variables. I hypothesized the college belief/indicators to influence MCPT directly. The variable MCPT is designated as a math readiness variable. I hypothesize the variable MCPT to influence the student's grade in MATH 1513 College Algebra directly.

To test the model I first calculated correlations between exogenous variables for both at risk and not at risk students. The results are given in Table XIV.

TABLE XIV

CORRELATIONS BETWEEN ENDOGENOUS VARIABLES

Variable	1	2	3	4	5	6
1. PAREDU	—	.030	-.007	-.003	.279*	-.019
2. AGE		—	.566***	-.061	-.120	-.074
3. SCHOOL			—	-.024	-.068	.038
4. TRNRES				—	.003	-.062
5. GENDER					—	.076
6. WORK						—

Note: *p<.10, **p<.05, ***p<.01

A significant positive correlation exists between the variables PAREDU and GENDER suggesting that females are more likely to have parents with more education. The negative correlation between AGE and GENDER suggests that females tended to be

younger. However in both cases care should be taken in the interpretation as the variable GENDER is a nominal variable. There also exists a high positive correlation between AGE and SCHOOL. This indicates that older students tend not to come directly out of high school. Again care should be used in the interpretation of this relationship as there are limited numbers of some cases for both variables.

I also computed correlations between exogenous variables and the endogenous variables. The results are given in Table XV. To test the model, I calculated twelve separate regression equations, regressing each of the twelve endogenous variables on the exogenous variables. Standardized beta weights are used as path coefficients. I tested standardized beta weights for significance levels. The results are given in Table XVI.

Only one exogenous variable, PAREDU (parental education, recall low values suggest higher levels of parental education) has a direct effect on the student's final grade in MATH 1513 College Algebra. This direct effect is important even when other variables have been taken into account. The negative value suggests that students with parents who are more educated tend to have a higher final grade. The path model with significant paths indicated is given in Figure 2. In addition to this direct effect on the final grade in the course, PAREDU is correlated directly with college belief indicators. The variable PAREDU is negatively correlated with the variable SICOLL. This would indicate that students whose parents have higher levels of education believe they will make new friends at ECU, handle stress well, and not have difficulty with lecture classes. The variable PAREDU is negatively correlated with CACT indicating that students whose parents have higher levels of education generally have higher composite ACT scores.

TABLE XV

CORRELATIONS

Variable	7	8	9	10	11	12	13	14	15	16	17	18
1. PAREDU	-.150**	-.634**	.024	-.105	-.076	-.157**	-.309**	.038	-.024	-.059	-.045	-.114
2. AGE	.328**	-.045	.308**	.088	.104	-.043	-.101	-.037	.151**	.086	.333**	.099
3. SCHOOL	.108	-.014	.240**	-.024	-.053	.027	-.046	-.024	.141*	.049	.146*	.030
4. TRNRES	-.100	-.063	-.025	.028	.004	-.097	.134*	.036	.000	-.006	.004	.002
5. GENDER	-.253**	-.327**	-.072	.046	-.012	-.030	.100	-.043	.044	.010	-.055	-.057
6. WORK	-.103	.026	-.083	.002	.032	.020	.017	.096	-.014	.016	-.035	-.054
7. HSGPA					.446**	.068	-.061	.039	-.053	.100	.434**	.384**
8. AIHSCH					.127*	.023	-.002	.039	.091	.071	-.043	-.013
9. SIHSCH					-.032	-.007	.053	-.019	.103	.063	.070	.037
10. LOCUS					-.083	-.026	-.022	-.036	.098	-.038	.028	.093
11. CACT											.473**	.237**
12. AICOLL											.090	.118
13. SICOLL											.021	-.083
14. FINANC											.065	-.045
15. FRAT											.006	-.044
16. COMMIT											.085	.045
17. MCPT												.345**
18. MGRADE												

Note. n = 56, *p<.1, **p<.05, ***p<.01

TABLE XVI

STANDARD PATH COEFFICIENTS

Variable	7	8	9	10	11	12	13	14	15	16	17	18
1. PAREDU	-.089	-.588**	.043	-.126*	-.189**	-.249**	-.567**	.121	.050	-.018	.080	-.187*
2. AGE	.355**	-.101	.245**	.158*	.049	-.133	-.126	-.037	.137	.067	.249**	-.110
3. SCHOOL	-.111	.026	.096	-.107	-.109	.086	.001	-.002	.070	.000	.021	.016
4. TRNRES	-.086	-.068	-.011	.035	.038	-.104	-.105*	-.056	.006	.017	.042	.042
5. GENDER	-.188**	-.174**	-.043	.093	.082	-.001	.137*	-.037	.075	.077	.028	.042
6. WORK	-.073	.018	-.058	.002	.074	.014	.007	.106	-.016	.026	-.017	-.015
7. HSGPA					.502**	.068	-.062	.078	-.115	.095	.208**	.293**
8. AIHSCH					.241**	.150*	.312**	.099	.157*	.084	.062	-.129
9. SIHSCH					.105*	.006	.139*	-.020	.067	.030	-.047	.003
10. LOCUS					-.161**	-.037	-.061	-.033	.094	-.065	.024	.041
11. CACT											.357**	-.012
12. AICOLL											.064	.059
13. SICOLL											.047	.150*
14. FINANC											.039	-.069
15. FRAT											-.035	-.011
16. COMMIT											.030	.002
17. MCPT												.246**
18. MGRADE												

Note. n = 56, *p<.1, **p<.05, ***p<.01

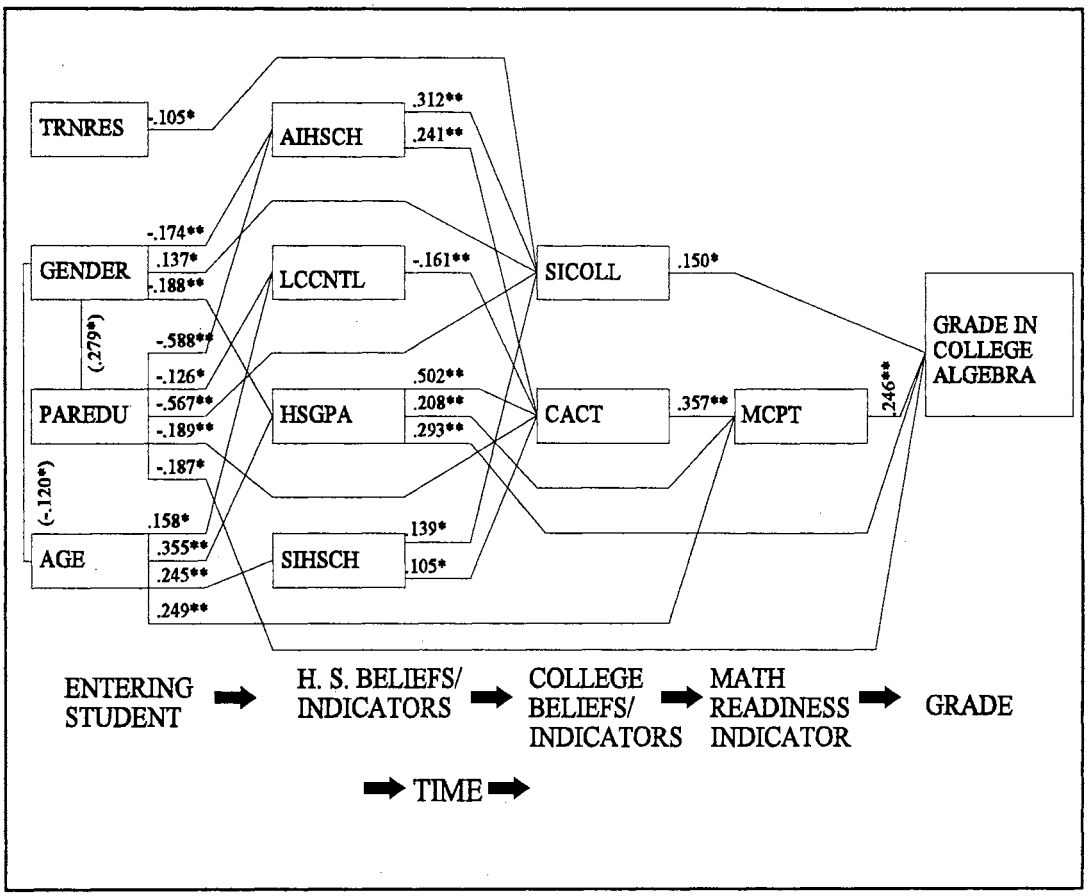

Figure 2. Path Analysis for Success in MATH 1513 College Algebra. Numbers in parenthesis are correlations, other numbers are standardized path coefficients. Only those paths with significant path coefficients are shown. *p<.05, **p<.01.

Significant direct effects not accounted for by the hypothesized model exist between HSGPA (high school grade point average) and both MCPT (score on the math portion of the computerized placement test) and the student's final grade in MATH 1513 College Algebra. This indicates that students with goos high school grade points are likely

to do well in the course even if they have lower ACT composite scores and lower scores on the mathematics portion of the computerized placement test.

The variable GENDER exhibits a direct positive effect on the college belief indicator SICOLL. This indicates that males are more likely to believe they will make new friends at ECU, handle stress well, and not have difficulty with lecture classes.

A direct effect also exists between the variables AGE and MCPT. This positive correlation indicates that students who are younger tend to make higher scores on the mathematics portion of the computerized placement test. This is not unexpected as stop-out may have occurred for older students. Again care should be used in this interpretation due to the few number of older students.

The final significant direct effect not accounted for by the hypothesized model is between TRNRES and SICOLL suggesting that students who plan to live on campus and have reliable transportation believe they will make new friends at ECU, handle stress well, and not have difficulty with lecture classes.

Other significant paths have the hypothesized structure of entering (exogenous) variables with direct effects on high school variables leading to direct effects with college variables leading to their grade in MATH 1513 College Algebra. Seven of these paths exist and I will examine each of them. The first path is along the variables PAREDU, LCCNTL, CACT, MCPT, MGRADE. This path indicates that parents with more education are more likely to have children with an internal locus of control. These children will do better on the ACT, have a better score on the college placement exam, and do better in MATH 1513 College Algebra. A second path much like the first begins with the variable AGE and is along the variables AGE, LCCNTL, CACT, MGRADE.

This path indicates that younger students tended to have an external locus of control which may lead to a lower score on the ACT. This low score then would make it more difficult to succeed at MATH 1513 College Algebra. A third path also starting at AGE is along the variables AGE, to SIHSCH then to either of the college belief indicators SICOLL or CACT. This path indicates that a student with less post secondary education (i.e., fresh out of high school) is more likely to have positive beliefs about his or her high school social life and either expects to have positive social integration in college leading to a better grade in MATH 1513 College Algebra or to do better on the ACT and mathematics portion of the computerized placement test and achieve a better grade in MATH 1513 College Algebra.

The fourth path is along the variables AGE, HSGPA, CACT, MCPT, MGRADE. The beta coefficients indicate that a student who is younger is more likely to have a higher HSGPA, do better on the ACT, do better on the MCPT, and have a better grade in MATH 1513 College Algebra. The fifth path is much like the fourth except it starts at GENDER. This path would indicate that males are more likely to have a higher HSGPA, do better on the ACT, do better on the MCPT, and have a better grade in MATH 1513 College Algebra.

A sixth path also starts at GENDER. It is along the variables GENDER to AIHSCH then to either SICOLL or CACT. This path indicates that males have better expectations of their high school academic experiences leading to a better score on the ACT and finally a better score in MATH 1513 College Algebra. Alternatively these males who report a better academic experience in high school believe they will make new friends

at ECU, handle stress well, and not have difficulty with lecture classes leading to a better final score in MATH 1513 College Algebra.

A seventh and final path is much like the sixth except it starts at PAREDU. This path would suggest that students whose parents have more education have better expectations of their high school academic experiences leading to a better score on the ACT and finally a better score in MATH 1513 College Algebra. Alternatively these students whose parents have more education believe they will make new friends at ECU, handle stress well, and not have difficulty with lecture classes leading to a better final score in MATH 1513 College Algebra.

Parental education has a profound effect on the final grade in MATH 1513 College Algebra. Overall young, non-commuting, students who are fresh out of high school stand the best chance of doing well in MATH 1513 College Algebra, provided they had a favorable experience in high school.

Conclusions

The factor analysis of the survey yielded a 7-factor solution which exhibited construct validity on 6 of the factors. Persisters tended to be male, younger, come from families whose parents have more education, have positive beliefs about their high school experiences, and expect those positive experiences to be repeated in college. They are less likely to experience difficulties in paying for college and believe that ECU can provide the educational experience they are expecting.

These same factors did not in general distinguish between success in MATH 1513 College Algebra. Only academic expectations of college appeared to be significant.

Locus of control, a variable which did not exhibit good construct validity, appeared to be somewhat related to overall success. This might be related to the item, "I believe that taking courses not directly related to my major is a complete waste of time." It could be that mathematics courses are perceived as one of these "useless" courses. Parental education continued to play an important role in determining success at MATH 1513 College Algebra. The more education a parent has the more likely it is for the student to succeed in collegiate mathematics.

Linkage of success in collegiate mathematics and persistence variables produced mixed results. Indeed, only two of these factors AICOLL and LCCNTL, appeared to have direct effects. However the path analysis indicated that an two additional survey factors SICOLL and SIHSCH may have an indirect effects. This indicates that students' perceived ideas about highschool and college relating to friends and parental expectations may contribute to success in collegiate mathematics, but in an indirect fashion.

CHAPTER V

RESULTS AND DISCUSSION

Introduction

Overall results are a confirmation of established research. Persisters outperformed nonpersisters on several scales. Successful students in MATH 1513 College Algebra outperformed unsuccessful students on several factors previously identified by other researchers. Expected differences emerged between at risk and not at risk students when comparing their success in MATH 1513 College Algebra. However, no clear distinction could be drawn between at risk students who were unsuccessful and not at risk students who were unsuccessful. Only one variable MCPT (computerized placement math score) appeared to distinguish between these two groups. The path analysis showed definite paths along the constructs leading to success in MATH 1513 College Algebra and indirect effects for some variables which did not show direct effects. What follows is a discussion of each research question in detail followed by suggestions for further study and concluding remarks.

Discussion of the Factor Analysis and Relationship To Persisters and Nonpersisters

Research question 1 asks if the student survey yielded a set of underlying factors that the research literature identified as factors linked to student persistence or models of student persistence? The exploratory and confirmatory factor analysis coupled with the analysis between persisters and non-persisters revealed 7 potentially useful constructs:

(1) Academic Integration - High School Experiences,

(2) Academic Integration - College Expectations,

(3) Social Integration - High School Experiences,

(4) Social Integration - College Expectations,

(5) Financial - Ability to Pay,

(6) Institutional Commitment - Loyalty to Institution, and

(7) Locus of Control - Maturity.

The first six constructs showed remarkable content and construct validity and all six were statisically significant. Locus of Control - Maturity was approaching significance. All of the above factor/variables performed as previous literature on persisters and nonpersisters have indicated.

Tinto's (1975) model suggests that student who fail to find a good fit with the university are less likely to persist. He emphasizes several causes of voluntary dropout: adjustment to college both socially and academically, lack of clearly defined goals, uncertainty about why they are attending a university, and commitment to degree completion. He also notes to a lesser extent the factors of academic difficulty and

finances. The success of the student according to Tinto is directly related to the students ability to integrate into the university and become part of the community. In our study we found similar findings, but at a much earlier stage. That is, perhaps these factors are present at enrollment and unless the collegiate experience alters those belief, students may leave the institution before completing a degree program. I found that students' initial beliefs about college are also indicators of persistence.

The two emergent factors AICOLL and SICOLL appear to be indicative of Tinto's theory. The factor AICOLL represents the respondent's beliefs of graduating in four years, obtaining good grades, obtaining an advanced degree, getting to know faculty, identifying a major, and expecting difficult courses. These variables at least on the surface appear to be indicators of commitment to degree completion and clearly defined goals. In addition they hint that the student knows why they are attending the university.

The factor SICOLL suggests an expectation to make new friends and that the respondent believes they handle stress well. In addition they do not expect to have difficulty with lecture classes. These variables on the surface also appear to indicate a willingness to integrate into the university.

In addition to these two factors I also identified a factor representing institutional fit. This fit between student and institution is what Tinto identifies as institutional commitment. I found that students who believe that East Central University is the "right" university are more likely to persist.

Bean's (1980) model of student persistence also found institutional commitment to be an important factor in persistence. Bean's model differs from Tinto's in two very important ways. One, several background variables are included in the study, and two,

departure is seen from a lack of satisfaction with the institution. Although several variables in each model appear to be overlapping, it is the perspective which is important. In this study we also included several background variables. The background variables in this study were not however the same as in the Bean model. As Bean found significant differences between persisters and nonpersisters on the background variables in his study, I found significant differences between persisters and nonpersisters on the background vriables TRNRES (reliable transportation and/or on campus residence), PAREDU (parent's education), and WORK (number of hours per week planned on working).

Astin's work (1967, 1975, & 1979) took a longitudinal look at factors favoring student persistence. He found that previous academic background, family background, educational aspirations, study habits, expectations of college, and age. The findings in this study substantiate his results.

In general, at East Central University, dropout prone students are more likely to have had less favorable experiences in high school both socially and academically and expected to have less favorable experiences in college. These students are more concerned about difficulties with paying for college and were less certain that obtaining a degree from East Central University was a priority. Nonpersisters were less academically prepared as evidenced by lower high school grade point averages, lower composite scores on the ACT, and lower scores on the math portion the College BASE's Computerized Placement Test. Nonpersisters were older in age and less likely to come from families with higher levels of education. Nonpersisters indicated plans to live off campus and may have problems associated with transportation. Nonpersisters also indicate they plan to work more hours.

Reliability analysis showed a low, but acceptable level of internal reliability overall. Reliability was low on one factor, Locus of Control, but this is likely the result of few indicator variables.

Differences Between Successful and Unsuccessful Students in College Algebra

Research question 2 asked if differences exist between successful and unsuccessful students in college algebra on these emerging factors as well as academic performance indicators and demographic variables? Students who were successful in MATH 1513 College Algebra, displayed significantly higher scores on the factors Academic Integration - College Expectations and Locus of Control - Maturity. Successful students appeared to be more mature as evidenced by a more internal locus of control and have better expectations of a good academic experience in college. In the later path analysis some of these factors did show indirect effects.

Not surprisingly successful students had higher scores on all academic performance variables. Highly significant were high school grade point average and the score on the math portion of College BASE's Computerized Placement Test. Also, significant was parental education. Those students who come from families with more education are more likely to be successful. No significant differences emerged with respect to age and work, although each of these values was approaching significance. No significant differences existed for the factor/variables. This would indicate those persistence variables other than demographics and academic performance indicators have little if any effect on college students performance in MATH 1513 College Algebra.

Less clear is how at risk and not at risk students differed with respect to success at MATH 1513 College Algebra. No significant differences emerged between these 4 groups on any of the factors/variables. This contradicts part of a study by Umoh, et al., (1994) on persistence in a developmental mathematics class. While finding no significant differences between persisters and nonpersisters the Umoh study indicated that for developmental students goal commitment and academic integration were more important than academic performance. I found academic performance to be an indicator of success. The Umoh study also contradicts ours in that it found no direct effects by age, grade point average, or parent's education. The study performed here does correlate well with House's (1996) study on overall college grade point averages. He found as I did that academic self-concept and expectation of college as well as parental education are positively correlated with good grades. Significant differences did emerge with respect to academic performance variables. High school grade point average is significant with respect to all groupings except at risk students who are successful and not at risk students who are successful. Composite ACT score showed differences between successful and unsuccessful at risk students and between successful and unsuccessful students who are not at risk and also between at risk and not at risk successful students and at risk and not at risk unsuccessful students. This study confirms studies by American College Testing Program (1991), College Entrance Examination Board (1984), Gibson (1989), Hudson (1989), Lovel and Fletcher (1989), Thornell and Jones (1986), and others.

The academic predictor found to be the most significant was high school grade point average. This agrees with studies by Myers and Pyles (1992), Sawyer (1989), Newman (1994), Ang and Noble (1993), and Dwinell (1985). I agree with Crouse and

Trusheim (1989) that secondary school performance should be given greater emphasis in placement and admission's decisions.

The math score on College BASE's Computerized Placement Test closes the prediction hole left by both the other academic performance variables, showing significant differences between unsuccessful not at risk students and successful at risk students. This would suggest that this score should be given consideration for cases in which either ACT score or high school grade point average is "borderline." This math score shows no significant difference between at risk unsuccessful students and at risk successful students suggesting that other non academic factors may be more important.

The student's age is the only other really significant variable in determining differences between groups. However, much of the population under study falls into one group of very young students. We should interpret significant differences in this area therefore with care. Age appears to determine success in MATH 1513 College Algebra, but only within separate groups. That is if a person is determined to be either at risk or not at risk, the age of a student may determine the success of the student. Overall younger students in either group are more likely to be successful.

Classification Analysis

Research question 3 asks if using discriminant analysis on academic performance indicators, demographic variables, and the factors high school academic experiences, high school social experiences, college academic expectations, college social expectations, institutional commitment, finances, and locus of control, can a classification system be developed as an aid in identifying class membership in remediated-successful, remediated-

unsuccessful, non-remediated-successful, and non-remediated-unsuccessful groups? Analysis in this area indicated no factor/variable was important. This was to be expected after the poor performance in showing significant differences among the 4 groups with respect to the factor/variables derived from the survey. As expected all of the academic performance variables were selected in the stepwise discriminant analysis. The only demographic variable was age. Three single variables from questions on the original survey were also selected, TESTQN, KNWFAC, and FRIEND. These questions indicate that these variables influence a student's chance of being classified into one or more groups. One would assume that having friends at ECU (social support system) or planning to get to know the faculty (mentoring) or good having good study techniques (When I study for a test I make up test questions.), may moderate the effects of low academic performance or age.

The classification analysis only correctly placed approximately 53% of the students. Most serious was the missclassification of 32.6% of the unsuccessful nonremediated students as successful. However if we only count those students who were predicted to be successful and were not, only 14% of the students were missclassified.

The inability to distinguish between groups may signal a more direct problem. Only the variable MCPT showed some discriminant ability between remediated-successful students and nonremediated-unsuccessful students. However, with the low overall level of correct classification, it seems to do so only marginally. It appears that little effort is required to predict that students who do exceptionally well on academic performance indicators will do well in later classes. Equally easy is to predict that those students who do not do well on these same indicators will not do well. High correlations between these

academic performance indicators may be the direct result of including these extreme cases. A more important questions is whether the same results could be obtained by deleting the higher and lower scoring students. That is, consider only the "borderline" students.

Path Analysis

Research question 4 asks if using academic performance indicators, demographic variables, and the factors high school academic experiences, high school social experiences, college academic expectations, college social expectations, institutional commitment, finances, and locus of control, can a path model be determined which shows factors and variables important to a student's final grade in MATH 1513 College Algebra? It appears that the student who comes from families whose parents have higher levels of education will be successful. Students who come from these households will generally have better social and academic experiences in high school which may lead to better social and academic expectations in college. These students will also generally have better academic performance scores and have a more internal locus of control. All or any of theses factors will lead to eventual success in MATH 1513 College Algebra.

The path analysis indicates that students with low academic performance indicators face multiple challenges to succeed. Although the results in this study could be effected by low sample sizes, it echos the results of Umoh, et al., (1994) and Kanoy, et al., (1989) that traditional measures of ability are insufficient to determine which at risk students will succeed. Designing educational opportunities for success for these students will be impossible until further studies either identify factors or create path models to explain success or failure.

Implications for East Central University

Persistence for academic institutions is a significant problem and for East Central University retaining students has become a priority. East Central University should begin to look more closely at student's high school grade point average. Admitting students with better high school grade point averages even if other academic performance scores are weak, should be considered. Currently ECU is allowed to admit a specified number of students who do not meet entrance requirements. When determining which students in this group to admit, ECU should base this on high school grade points. In addition, efforts to attract those students who have proven track records in high school should be increased. Scholarships tied to high school grade points rather than ACT scores might be one method. Another might be to use high school-college relations personnel to actively seek out those individuals.

Once students are admitted East Central University would do well to develop systems to allow students to integrate socially and academically into East Central University. Early intervention is an absolute necessity. Solutions might include inducements for upper-class students to act as support personnel or assigning faculty as "homeroom" teachers with responsibility to insure student success. Financial inducements might be based on an overall rate of persistence for those students assigned to individual teachers. It is my individual feeling that every faculty member should teach a student orientation seminar, what is commonly referred to as freshman orientation occasionally.

Training students and teachers for this task is a necessity and will require both time and finances. East Central University would do well to invest in workshops to not only

assist instructors in understanding problems these students encounter, but also learning how to deal with these problems. These workshops might be on availability of support organizations within the school and financial aid for example.

The entering student should not face a confusing, complicated maze of regulations, and procedures. Enrollment procedures should be simplified with few if any lines. Personalized contact with faculty or support staff at this early stage would be preferable. Having a friendly face where a student feels comfortable asking questions would greatly enhance a student's first impression of the university. Assignment of students to faculty or student mentors could assist the student in integrating into the university.

East Central University should identify student's needs and desires and attempt to design programs which satisfy these expectations and still maintain its educational commitment to those students. This might occur by encouraging participation in collegiate activities such as intermural sports, academic or special interest clubs, and/or social organizations. In any case providing a place where students feel comfortable to meet and engage each other both academically and socially is essential.

With respect to success in MATH 1513 College Algebra, East Central University should reconsider it placement strategy. In determining both admissions and subsequent placement little if any attention is given to the academic performance variable which gives the greatest predictive power, high school grade point average. The score currently in use for placement in MATH 1513 College Algebra, the math score on the College BASE's Computerized Placement Test, appears to differentiate at least marginally well with respect to placement. For those students who are academic under-performers, care should be used in placement particularly if the student's scores are borderline. Raising the "cut

score" for placement into a developmental class might be one solution to avoid the many students who should be successful, but are not. This solution may present more problems than it would solve. It would not, for example, address the issue of students who once placed in a developmental course still fail MATH 1513 College Algebra. It would also place additional burdens on these already under-prepared students by forcing them to take additional courses. In addition the institution must offer additional classes to meet demand adding additional financial burdens to an already tight budget.

Those students who are considered at risk or who have border line academic performance scores pose particular problems for East Central University and this study does little to assist in solving this problem. Identification of factors which differentiate between students who are successful and unsuccessful for these underperforming students is elusive. Some generalizations can however, be drawn from the associated studies on retention. East Central University should begin to develop courses which not only provide educational advancement, but provide a nurturing and supporting environment as well. Students should not be forced into an academic environment which effectively prevents them from interacting with students who are not at risk. The faculty should become aware of the unique difficulties faced by these students and develop methods of dealing with those problems.

If East Central University is to solve its persistence problems and increase success in mathematics it must:

1. Increase funding for those programs directly involved in recruitment and assessment of students as well as support programs for those students,
2. Increase faculty involvement in creating a student centered campus,

3. Increase faculty contact with students outside of the classroom by requiring club sponsorships, coaching intermural clubs, or involvement with student orientation.
4. Provide funding for programs designed to train faculty to recognize student problems so that early intervention is possible and inducements for faculty attendance at these programs,
5. Devise new and more efficient methods for determining course placement,
6. Develop and fund programs which allow for student interaction such as intermural activities, student tutoring centers, and student clubs.
7. Provide inducements for faculty to "be responsible" for individual assigned students by rewarding faculty whose advisees persist to graduation,
8. Form student focus groups to air grievances and provide insight into student needs and desires.
9. Remodel and/or redesign existing student complexes to reflect more closely the desires of the students, such as dorm rooms which are more like apartments.

Suggestions for Further Study

This study is limited to one university. Expanding the results here to encompass other universities as well as other types of universities should be considered. Differences between universities of different types and differences between universities of the same type may not allow for expansion of the conclusions arrived at here. Finding that similar results exist for other institutions would be useful.

Different institutions define remedial courses differently. In some institutions college algebra would be considered a remedial course. Although we would expect the methods used here to be applicable for other classes, the results may vary from course to course. Using this method to find factors which may explain success in other courses should be undertaken.

Small sample sizes for at risk students in this study are problematic. A replication of this study with larger sample sizes would be appropriate. Additionally we should postulate and examine new factors with respect to at risk students who are successful and not at risk students who are unsuccessful. The classification analysis only marginally detected differences in these groups. Two glaring omissions in this study are the effects of socioeconomic status and race. Although parents' education may be an indicator of socioeconomic status, a more formal investigation of these variables should be examined. The addition of these other variables should also include multiple measures of existing variables to increase reliability.

At risk students may not take traditional paths to success. We should undertake a more detailed examination of successful at risk students and unsuccessful not at risk students to determine what factors are important to success as well as factors leading to failure. We should examine these factors to determine if we can somehow improve individual student achievement. One possibility which has merit is exploratory qualitative study, which may yield useful clues as to why these students fail to succeed.

A more critical examination needs to be given to the effects of gender on both student success in mathematics and perhaps more importantly on persistence. Early age pregnancies, high rates of unwed mothers, lack of understanding of female perspectives,

desire and needs may contribute to the success or failure of these female students. New understandings of the role gender plays for both males and females in higher education need to be examined.

Concluding Remarks

Nationally, retention rates, student satisfaction, and graduation rates are receiving extensive attention. Increased accountability from external agencies, governing boards, state and federal legislative bodies, and other constituencies are forcing institutions to pay closer attention to these areas.

The current attitude in Oklahoma education is for all students to have access to higher education and to promote success at all levels. While in a practical sense we must allow for student failures, it is critical that schools begin to consider methods allowing for student success. This includes a clearer understanding of factors leading to failure and how to mediate those effects as well as promoting those factors leading to success.

College officials should begin to consider these determinants of success and develop programs which either attracts students with these characteristics or which foster these characteristics. As students continue through the transition from high school to college to graduation, difficulties experienced by these students should be minimized.

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APPENDIXES

APPENDIX A

ENROLLMENT SURVEY

This appendix reviews the survey instrument's construction and content validity assessment of the instrument. An independent educational researcher employed by the East Central University Assessment Office constructed the survey. A major portion of the survey is based on models proposed by Tinto (1975, 1987) and Bean (1980). Tinto's model presupposes that students whose motivation and academic ability is similar to the institution's academic and social characteristics are more likely to persist. Measures from the Tinto model applicable to East Central University were determined to be academic integration, social integration, institutional commitment, and goal commitment. Bean's model of student attrition is analogous to workplace turnover which stresses behavioral intentions. Measures drawn from Bean's work include institutional quality, courses, and influences of friends and significant others. After a review of the supporting literature, the researcher identified seven attitude-type constructs as significantly influencing student persistence and generally applicable to East Central University. The constructs were academic integration measured by previous high school study habits, college integration as measured by expectations of the college experience, social integration as measured by previous involvement in social activities and ability make or keep friends at East Central University, significant others' support measured as family support, and institutional commitment as measured by certainty of major and choice of East Central University.

Additional factors relevant to student persistence were included based on work by Astin (1975), Cabrera, et al (1990), and Nora (1987). These additional factors were ability to pay as measured by financial concerns, intent to join a fraternity or sorority, age, gender, number of hours the respondent planned on working, parents level of education, residence (on or off campus), and reliability of transportation.

The survey developer included additional statements designed to show whether the respondent's locus of control was internal or external. These statements included responses to indicate whether the respondent believed that circumstances beyond the respondent's control determined past failures. These statements were added as emerging research points to the importance of maturity (see for example Frankel, 1985; Bers, 1986).

Thirty eight questions were placed on the Enrollment Survey. The first seven questions asked the respondents to indicate their age, gender, number of hours per week planned on working, type of school previously attended, college residence, mother's level of education, and father's level of education. Survey items 8 - 38 were designed to elicit responses from students which would indicate the student's agreement with a particular statement. The statements were chosen so responses would be indicators of the persistence constructs discussed above. A Likert-type scale was used and the respondent indicated their agreement or disagreement to each statement by determining if they strongly agree, agree, neutral, disagree, or strongly disagree, with the statement.

Due to time constraints, immediately after construction a bulk printing of the survey was done without further review. Assessment officials administered the survey at this time to entering students at East Central University during the Fall of 1995. At the same time other educational researchers within the university reviewed the survey to find any weaknesses within the survey related to content validity. It was determined that five questions within the attitude scale needed special attention.

The reviewers suggested Question 36, "If people shout suggestions when I'm playing a game, it doesn't upset me." was too contextual. That is, this question could have different meanings to different people depending on what the respondent's concept of "a

game" is. I agreed with the reviewers and I did not use this question in any further analysis.

The reviewers also questioned the validity of question 38, "I like myself and am proud of who I am." They did not believe that this question would provide any useful information as only the most disaffected student would respond negatively. Additionally some reviewers stated that they just did not like the question. Although I remained ambivalent about this question, I removed it from the analysis altogether as the reviewers had strong feelings about its inclusion.

The reviewers found two questions that might measure attitudes across different constructs. Question 29, "I will have financial support from my family." (FAMFIN) appeared related to two constructs, family support and finance. Question 37, "I believe taking courses not directly related to my career choice is a complete waste of time." (CWASTE) appeared related to two constructs locus of control and college expectations.

The reviewers determined question 24, "I have reliable transportation." to be a single factor not related to any of the other questions. They also determined that this question would be useful as a predictor of student persistence only if the student lived off campus. For analysis related to student persistence, they recommended combining the school residence question (question 5) with this variable to obtain a variable related to the importance of transportation. Finally, the reviewers recommended question 17, "I plan to join a fraternity or sorority." be treated as a single variable. They based this decision on the work of Astin (1975).

The reviewers of the survey grouped the remaining Likert-type questions along hypothesized constructs.

Academic Integration - High School Experiences was a four item construct consisting of:

8 During high school I rarely studied. (HSSTUD)

9 When I study for a test, I develop practice questions. (TESTQN)

33 I am prepared to postpone other activities to study twenty or more hours weekly (STDY20)

34 My past successes were determined by the amount of effort I applied. (SUCEFF)

College Integration - College Expectations was a seven item construct consisting of:

11 I expect to have difficulty with lecture classes. (LECTRE)

12 I plan to get acquainted with faculty at ECU. (KNWFAC)

13 I expect to make good grades at ECU. (COLGGR)

14 I will graduate in four years. (GRD4YR)

15 I plan to attend graduate school, someday. (GRDSCH)

16 I expect difficult courses. (DIFCRS)

37 I believe taking courses not directly related to my career choice is a complete waste of time. (CWASTE)

Social Integration - Ability to Establish Social Support System was a five item construct consisting of:

10 I was involved in high school extra-curricular activities. (HSXACT)

18 I have friends at ECU. (FRIEND)

19 It will be hard to make new friends at ECU. (NFREND)

25 When I get into difficult situations, I am not hesitant to ask for help. (ASKHEP)

38 I like myself and am proud of who I am. (LIKEME)

Family Support - Encouragement of Significant Others was a three item construct

consisting of:

20 My family encourages my college efforts. (FAMENC)

21 My parents expect me to get a degree. (PAREXD)

29 I will have financial support from my family. (FAMFIN)

Institutional Commitment - Institutional Fit was a three item construct consisting of:

22 I am sure about a major. (SURMAJ)

23 I will attend ECU to pick up my basics and then transfer to another institution to complete a degree program. (PTRANS)

32 I am sure ECU is the right university for me. (ECURGT)

Financial - Ability to Pay was a four item construct consisting of:

27 I will have difficulty paying expenses at ECU. (DIFPYX)

28 I plan to apply for scholarships and/or grants. (SCHGRT)

29 I will have financial support from my family. (FAMFIN)

30 I need student loans to attend ECU. (NSTULN)

Locus of Control-Maturity was a four item construct consisting of:

26 I handle stress well. (HNDLST)

31 Frequently, health problems interfere with my intended goals. (HEALPB)

35 When I don't do well in a class usually it is because of circumstances beyond my control. (CRBYCL)

37 I believe taking courses not directly related to my career choice is a complete waste of time. (CWASTE)

ENROLLMENT SURVEY

Directions: The Enrollment Survey is designed to evaluate the educational and personal needs of college students. By answering the following questions, you will assist college officials in identifying and developing programs and services needed by entering students. The information you supply on this survey will be kept confidential Your name and Social Security number will enable college personnel to contact you directly. The information will be used to help the university identify specific ways to assist you in reaching your college goals. If any. item requests information that you do not wish to provide, feel free to omit it. This is not a test and will not be used to determine placement.

READ EACH ITEM BELOW AND MARK YOUR RESPONSES ON THE SCANTRON SHEET. YOU MUST USE A NO. 2 PENCIL.

1. AGE: A. 18 or less B. 19-21 C. 22-30 D. 31-40 E. 41 and over

2. SEX A. Male B. Female

3. INDICATE THE NUMBER OF HOURS PER WEEK YOU PLAN TO WORK
   A. 0 to 10 C. 21to 30 E. Over 40
   B. Il to 20 D. 31to 40

4. WHAT TYPE OF SCHOOL DID YOU ATTEND JUST PRIOR TO ENTERING THIS UNIVERSITY?
   A. High School C. 2-Year College E. Other
   B. Vocational/Technical School D. 4-Year College or University

5. INDICATE YOUR CURRENT COLLEGE RESIDENCE
   A. College Residence Hall . C. Off-Campus more than 20 miles
   B. Fraternity or Sorority House D. Off-Campus within 20 miles

6. MOTHER'S LEVEL OF EDUCATION:
   A. Below High School C. Bachelor Degree E. Doctorate or Higher
   B. High School or GED D. Masters Degree

7. FATHER'S LEVEL OF EDUCATION:
   A. Below High School C. Bachelor Degree E. Doctorate or Higher
   B. High School or GED D. Masters Degree

MARK A, B, C, D, or E ON THE SCANTRON TO INDICATE YOUR RESPONSE FOR EACH OF THE FOLLOWING STATEMENTS:

A = STRONGLY AGREE B = AGREE C = NEUTRAL D = DISAGREE E = STRONGLY DISAGREE

8. DURING HIGH SCHOOL, I RARELY STUDIED.

9. WHEN I STUDY FOR A TEST, I DEVELOP PRACTICE TEST QUESTIONS.

10. I WAS INVOLVED IN HIGH SCHOOL EXTRA CURRICULAR ACTIVITIES.

II. I EXPECT TO HAVE DIFFICULTY WITH LECTURE CLASSES.

12. I PLAN TO GET ACQUAINTED WITH FACULTY AT ECU.

13. I EXPECT TO MAKE GOOD GRADES AT ECU.

[PLEASE TURN PAGE OVER AND COMPLETE THE OTHER SIDE]

A = STRONGLY AGREE B = AGREE C = NEUTRAL D = DISAGREE E = STRONGLY DISAGREE

14. I WILL GRADUATE IN FOUR YEARS.

15. I PLAN TO ATTEND GRADUATE SCHOOL, SOMEDAY.

16. EXPECT DIFFICULT COURSES.

17. I PLAN TO JOIN A FRATERNITY OR SORORITY.

18. I HAVE FRIENDS AT ECU.

19. IT WILL BE HARD TO MAKE NEW FRIENDS AT ECU.

20. MY FAMILY ENCOURAGES MY COLLEGE EFFORTS.

21. MY PARENTS EXPECT ME TO GET A DEGREE.

22. I AM SURE ABOUT A MAJOR.

23. I WILL ATTEND ECU TO PICK UP MY BASICS AND THEN TRANSFER TO ANOTHER INSTITUTION TO COMPLETE A DEGREE PROGRAM.

24. I HAVE RELIABLE TRANSPORTATION.

25. WHEN I GET INTO DIFFICULT SITUATIONS, I AM NOT HESITANT TO ASK FOR NEEDED HELP.

26. I HANDLE STRESS WELL.

27. I WILL HAVE DIFFICULTY PAYING EXPENSES AT ECU.

28. I PLAN TO APPLY FOR SCHOLARSHIPS AND/OR GRANTS.

29. I WILL HAVE FINANCIAL SUPPORT FROM MY FAMILY.

30. I NEED STUDENT LOANS TO ATTEND ECU.

31. FREQUENTLY, HEALTH PROBLEMS INTERFERE WITH MY INTENDED GOALS.

32. I AM SURE ECU IS THE RIGHT UNIVERSITY FOR ME.

33. I AM PREPARED TO POSTPONE OTHER ACTIVITIES TO STUDY TWENTY OR MORE HOURS WEEKLY.

34. MY PAST SUCCESSES WERE DETERMINED BY THE AMOUNT OF EFFORT I APPLIED.

35. WHEN I DON'T DO WELL IN A CLASS USUALLY IT IS BECAUSE OF CIRCUMSTANCES BEYOND MY CONTROL.

36. IF PEOPLE SHOUT SUGGESTIONS WHEN I'M PLAYING A GAME, IT DOESN'T UPSET ME.

37. I BELIEVE TAKING COURSES NOT DIRECTLY RELATED TO MY CAREER CHOICE IS A COMPLETE WASTE OF TIME.

38. I LIKE MYSELF AND I AM PROUD OF WHO I AM.

APPENDIX B

INSTITUTIONAL REVIEW BOARD

APPROVAL FORMS

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD

DATE: 03-02-99 **IRB #: ED-99-084**

Proposal Title: FACTORS OF SUCCESSFUL PERFORMANCE IN MATHEMATICS FOR REMEDIAL AND NON-REMEDIAL COLLEGE STUDENTS

Principal Investigator(s): Martin Burlingame, Mickle Duggan

Reviewed and Processed as: Exempt

Approval Status Recommended by Reviewer(s): Approved

==========

Signature: Carol Olson (pc) Date: March 3, 1999

Carol Olson, Director of University Research Compliance
cc: Mickle Duggan

Approvals are valid for one calendar year, after which time a request for continuation must be submitted. Any modification to the research project approved by the IRB must be submitted for approval. Approved projects are subject to monitoring by the IRB. Expedited and exempt projects may be reviewed by the full Institutional Review Board.

EAST CENTRAL UNIVERSITY

Duane C. Anderson
Vice President for Academic Affairs

ADA, OKLAHOMA 74820-6899

INTER OFFICE

MEMO

To: Mickle Duggan, Assistant Professor of Mathematics
From: Duane C. Anderson, Vice President for Academic Affairs DCA
Subject: Human Subjects
Date: March 1, 1999

The Human Subjects Review Committee reviewed your request and recommends approval of your project entitled *Factors of Successful Performance in Mathematics for Remedial and Non-remedial College Students.* I concur with their recommendation.

sm

cc: Dr. Anita Walker, Chair

Suite 100, Administration Building • 580/332-8000 Ext. 204 • FAX: 580/332-1623
Internet: DANDERSN@MAILCLERK.ECOK.EDU

VITA

Mickle D. Duggan

Candidate for the Degree of

Doctor of Education

Thesis: EXAMINATION OF PERSISTENCE FACTORS AND THEIR RELATIONSHIP TO SUCCESS IN COLLEGIATE MATHEMATICS FOR REMEDIAL AND NON-REMEDIAL COLLEGE STUDENTS AT A FOUR-YEAR INSTITUTION

Major Field: Educational Administration

Biographical:

Education: Received Bachelor of Science degree in Math Education from Central State University, Edmond, Oklahoma in May 1980; received Master of Science degree with a major in Applied Math from the Oklahoma State University, Stillwater, Oklahoma, in May 1983; post-graduate Math studies at Oklahoma State University, Stillwater, Oklahoma from 1983 to 1987. Completed the requirements for the Doctor of Education degree at Oklahoma State University in July 1999.

Experience: Employed as math instructor at Piedmont High School, Piedmont, Oklahoma from 1980-1981; employed as math instructor at East Central University, Ada, Oklahoma from 1983-1989; served as Assistant Professor of Math at East Central University, Ada, Oklahoma from 1989 to present.

Professional Memberships: National Council of Teachers of Mathematics, Mathematics Association of America, American Association of University Professors, American Mathematical Association of Two-Year Colleges, National Academic Advising Association.