

Predicting the Academic Success of Female Engineering Students During the First Year
of College Using the SAT and Non-Cognitive Variables

by

Therese A. Lovegreen

Thesis submitted to the Faculty of the
Virginia Polytechnic Institute and State University
In partial fulfillment of the requirements for the degree of
Master of Arts in Education
in
Higher Education and Student Affairs

Approved:

Don G. Creamer, Chairperson

Cathryn Turrentine, Research Director

Landrum L. Cross

April 2003

Blacksburg, Virginia

Predicting the Academic Success of Female Engineering Students During the First Year
of College Using the SAT and Non-Cognitive Variables

By

Therese A. Lovegreen

Cathryn Turrentine, Research Director

(ABSTRACT)

The purpose of this study was to determine the value of the Non Cognitive Questionnaire (NCQ) and the Scholastic Aptitude Test (SAT) in predicting the academic achievement of first year female engineering students. Ancis and Sedlacek (1997) studied non-cognitive variables with a general population of undergraduate women. Their study validated the NCQ as a predictor of academic success for women students. The present study extends the work of Ancis and Sedlacek to examine female engineering students, a group for which no similar study has yet been published.

Participants included 100 female first-year engineering students at a large, public Doctoral Research –Extensive institution located in the mid-Atlantic region of the United States. By race or ethnicity, the participants were White, Non-Hispanic (81%), Black Non-Hispanic (9%), Asian or Pacific Islander (4%), Hispanic or Latino (1%), Non-Resident Alien (1%), and Unknown Race or Ethnicity (6%).

This study defined academic achievement as first semester Grade Point Average, which was used as the dependent variable. Participants completed the NCQ during summer orientation. NCQ scale scores and SAT Verbal and Math scores were used as independent variables in a step-wise regression analysis.

The major finding of this study was that the NCQ scale scores did not add to the predictive value of the SAT scores in determining the first semester GPA of female engineering students. This was an unexpected finding in light of previous research that had documented the value of using non-cognitive variables, and specifically the NCQ, to predict the academic success of groups that are a minority in their educational settings.

Because the major finding of this study is at odds with a large body of similar studies, the most important implications of this study relate to understanding this difference. Included in the discussion are questions about the methodology used in previous NCQ studies and about the influence of the single institution that has been the site of almost all previous NCQ research.

Acknowledgements

This research study was made possible with the support of many people who shared their expertise, time, encouragement, and kindness. I wish to express my sincere gratitude and appreciation to them.

I have been very fortunate to have a wonderful and supportive thesis committee. Dr. Don Creamer, Chair, encouraged and supported this study from its inception. His wisdom and experience provided guidance and challenged me to extend my efforts to achieve professional quality. I also appreciate his counsel that grounded and comforted me during times of frustration.

Dr. Landrum Cross patiently shared his time and knowledge of research methods and advanced statistics for which I am very grateful. His instruction has given me a greater appreciation for quantitative research and increased my understanding of statistical concepts. Dr. Cross not only supported my work but has encouraged me to pursue future research.

I truly owe the success of this project to Dr. Cathryn Turrentine, who served as Research Director for this study. Her knowledge and expertise helped me to formulate the topic of this thesis and apply the appropriate data analysis. She should be granted sainthood for her patience, thoughtfulness, and caring support. Dr. Turrentine directed my research, taught me true scholarship, led me toward self-discovery, and continues to inspire me through her example.

I am grateful for the assistance of professional researchers and educators who work at other universities. This study would not have been possible without Dr. William Sedlacek who granted me his permission to use the Non Cognitive Questionnaire. His years of research on the academic success of students from minority student groups provided the basis for this study.

Dr. Raymond Ting was extremely helpful and important to the outcome of this study. Dr. Ting was very generous in giving of his time and experience by instructing me on how to score

the Non Cognitive Questionnaire. His patient explanation of the NCQ scoring key provided me with specific directions that eliminated all of my confusion on calculating the NCQ scale scores.

Without the help and support of the staff in Office of Academic Affairs of the College of Engineering data collection for this study would not have been possible. I am grateful for Dr. Bevelee Watford's enthusiasm for the study and help with administering the surveys during freshmen orientation. Additionally, I want to thank all of the entering female engineering students who took their time to participate in this study. I wish them all success in the study of engineering or any other field of study.

Most importantly, I am eternally grateful for the love and support of my daughter and my husband. My daughter, Mary Lovegreen, never seemed to tire of my requests for her help with things like technology and family meal preparation. Not only are we mother and daughter, but we are friends, and we became study buddies. Her positive attitude and dedication toward academic achievement and scholarship were my inspiration. My husband, Bill Lovegreen assumed both of our roles and responsibilities in the home which gave me the freedom to work and study. His support, encouragement, and faith in my ability never wavered. He provided me with great strength that endured even through the most challenging times. Thank you Mary and Bill, you both have made many sacrifices which made it possible for me to pursue my educational goal and my dreams.

Table of Contents

Abstract.....	ii
Acknowledgements.....	iv
Table of Contents.....	vi
List of Tables.....	x
List of Appendices.....	xi
Chapter One: Introduction.....	1
National Issues Related to Diversity in Technical Fields.....	1
Under Representation of Women in Engineering.....	4
Cognitive Predictors of Academic Success.....	5
Non-Cognitive Predictors.....	9
Use of the Non Cognitive Questionnaire.....	13
Purpose of the Study.....	15
Definitions.....	15
Academic Success.....	15
GPA.....	15
Non-Cognitive Variables.....	16
Setting.....	16
Significance.....	18
Organization of the Study.....	18
Chapter Two: Review of the Literature.....	20
Variables that Affect the Academic Success of Female Engineering Students.....	21
Historic Gender Bias in Education.....	21

Female Achievement and Persistence in Engineering.....	29
Cultural and Educational Gender Differences.....	30
Family Reinforcement and Early Education.....	33
Gender Bias in the Classroom.....	35
Reinforcement from Instructors.....	36
Self-Defined Gender Roles.....	38
Peers.....	39
Strong Support Person and Role Models.....	40
Self-Esteem.....	43
Gender Bias in Math and Science Classes.....	45
Math and Science Achievement and Course Taking.....	47
Relationship between Cognitive and Non-Cognitive Variables and Academic Success...50	
Related Theories.....	53
Tinto.....	53
Astin.....	54
Sternberg.....	55
Traditional and Non-Traditional Predictors of Academic Success.....	56
Traditional Predictors of Academic Success.....	56
Problems Associated with Predicting Academic Success using Traditional Measures.....	59
Non-Traditional Predictors of Academic Success.....	63
Predicting Academic Success and Persistence in Engineering.....	64
Non Cognitive Questionnaire (NCQ).....	68
Positive Self-Concept or Confidence.....	69

Realistic Self-Appraisal.....	69
Understands and Deals with Racism.....	70
Prefers Long-Range Goals to Short-Term or Immediate Needs.....	71
Availability of Strong Support Person.....	71
Successful Leadership Experience.....	72
Demonstrated Community Service.....	72
Knowledge Acquired in a Field.....	72
Use of the NCQ in Research.....	73
Chapter Three: Methods.....	78
Sample Selection.....	78
Instrument.....	79
Scoring the NCQ.....	81
Reliability and Validity.....	84
Reliability.....	84
Validity.....	85
Data Collection Procedures.....	86
Data Analysis Procedures.....	87
Chapter Four: Results.....	89
Sample Description.....	89
Data Analysis.....	90
Chapter Five Discussion.....	98
Major Finding.....	98
Dependent Variable.....	100

Population.....	101
Campus Climate.....	102
Methodology.....	103
Limitations and Implications for Research.....	105
Sample Size and Composition.....	106
Single Institutions.....	107
Implications.....	109
University Administrators.....	109
Financial Aid Officers.....	110
Admission Office Personnel and Officials in the Engineering College.....	110
Secondary School Personnel.....	111
Female Students.....	111
Federal Government Policy.....	112
State Government Policy.....	113
Conclusion.....	114
References.....	115
Appendices.....	128

List of Tables

Table 1: Letter Grades Associated with Grade Points.....	17
Table 2: Score Ranges of the Eight Non-Cognitive Scales Measured by the Non Cognitive Questionnaire.....	83
Table 3: Number and Percent of Participants and Non-Participants by Race/Ethnicity.....	91
Table 4: Chi-Square Analysis of Distribution of Race/Ethnicity between Participants and Non-Participants.....	92
Table 5: T-test Results for SAT Verbal and SAT Math Scores between Participants and Non-Participants.....	93
Table 6: Means and Standard Deviations of Independent and Dependent Variables.....	94
Table 7: Results of the Step-Wise Regression Predicting Grade Point Average Using SAT Verbal SAT Math, and Non Cognitive Questionnaire Scale Scores.....	95

List of Appendices

Appendix A: The Non Cognitive Questionnaire.....	128
Appendix B: Permission to use the Non Cognitive Questionnaire.....	131
Appendix C: Scoring Key.....	133
Appendix D: Exemption Approval.....	138
Appendix E: Questionnaire Packet.....	140

Chapter One: Introduction

Women have risen above many historical barriers and are becoming successful competitors and contributors in many traditionally male-dominated professions. However, women continue to be an underrepresented minority in the fields of science and engineering (National Science Foundation [NSF], 2002). Gender ratios in the field of engineering remain highly unbalanced, with women making up only 20% of engineering majors and 9% of engineering professionals (NSF, 2002).

National Issues Related to Diversity in Technical Fields

The under representation of women and racial and ethnic minorities in science and engineering fields has important negative consequences for the United States. These consequences relate to the nation's competitiveness in the global marketplace, its readiness to compete in major scientific endeavors of international importance, and its ability to plan effectively for workforce development in an era of increasing demographic diversity.

National success in a global market demands a workforce of individuals who are capable of high achievement and have the flexibility to use technological and scientific skills in a variety of different contexts (Lucena, 2000; NSF, 2002). People with different talents, perspectives, and experiences can produce better ideas and innovations to further advance science and technology (NSF, 1998).

The U.S. has staked much of its international reputation on its position as the leader of the world's scientific community. Efforts to produce more and better trained scientists and engineers have existed since the late 1950s in reaction to the Russian launch of Sputnik. As a result of these efforts, the U.S. is now recognized internationally as a leader in scientific research and technology (Altbach, Berdahl, & Gumport, 1999). Despite the need for graduates in

technical fields to support the nation's scientific goals, attrition is a serious problem in engineering curricula, and it is especially a problem for women and students from underrepresented racial and ethnic groups (Oakes, 1990).

In the U.S., approximately 25-30% of all students entering college plan to major in science and engineering fields, but only 50% of these students actually complete a science or engineering program. Engineering degrees represent only 5% of all bachelors degrees awarded. Females and students from underrepresented racial or ethnic groups drop out of engineering programs at an even higher rate than majority males (NSF, 2002).

According to the National Science Foundation (1998), the U.S. must rely on all of the nation's human resources and the talents of all citizens to maintain scientific and engineering contributions to this country's excellence. A diverse and globally oriented workforce of scientists and engineers is a strategic goal that will contribute to national achievement in the international arena. Well educated scientists and engineers of different genders along with those from various racial and ethnic backgrounds can provide the diversity and challenge necessary for national success in industry and technology (NSF, 1998).

The under representation of women and racial and ethnic minorities in science and engineering fields is a particular concern for national workforce development planning in the 21st century, since changes in the U.S. population show a continuous increase in the number of groups traditionally thought of as minorities (American Association of State Colleges and Universities [AASCU], 1999). This national trend will decrease the available proportion of White males in the workforce and in the engineering profession, and necessitate the recruitment and training of a more diversified population into the engineering field (AASCU, 1999; NSF, 2002). To ensure national success in the technologically oriented global marketplace, colleges

and universities must provide a diverse workforce of scientists and engineers who are globally oriented (NSF, 1998).

The increasing diversity of the U.S. population is reflected in the student bodies of colleges and universities. During the last few decades there has been an increase in the number of students attending institutions of higher education, and the student population on college campuses is becoming increasingly diverse. This diversity provides a great resource for the various talents and skills needed for successful international competition in science and engineering (Gurin, 1999; NSF, 1998).

Despite the increase in diversity on college campuses, several demographic groups are under represented in science and engineering. These include African-Americans, Hispanics, Native Americans, and women (Oakes, 1990). Enrollment in science and engineering programs is dominated by White and Asian males. Traditionally, these two groups have filled a disproportionate share of technical spots in colleges and positions in the workforce (Etzkowitz, Kemelgore, & Uzzi, 2000).

The dominance of White and Asian males in the engineering profession creates a perception that highly technical fields exclude minority participants and do not offer the support necessary for success. Improving the image of science and engineering will serve and attract all citizens with the most talent and creativity regardless of their race or gender. Women and members of other minority groups need to see that engineering is an option that is available to a variety of people (NSF, 1998).

Millions of dollars from both public and private funds have been devoted toward producing gender equity in science and engineering fields, so far to no avail (Barber, 1995). For example, the National Science Foundation is in charge of funding science and engineering

education in the U.S. and provides insight and direction in science and engineering issues that address the needs of the nation. The NSF recognizes that females and students from minority groups can contribute to highly technical fields by increasing the absolute number of scientists and engineers and also by providing a diversity which can lead to further discovery (Lucena, 2000). Despite the support and funding of the NSF and other national efforts, the problem of lack of diversity in technical fields persists and continues to place the U.S. at a competitive disadvantage globally.

Under Representation of Women in Engineering

While the issue of diversity in technical fields includes race, ethnicity, and gender, the focus of this study is gender alone and its curricular focus is engineering. According to the National Science Foundation (1998) no other scientific field shows a greater disparity in the employment and enrollment in college majors between men and women than engineering. In terms of employment, women represent about nine percent of the workforce in the engineering field (National Science Board [NSB] of the NSF, 2000). The under representation of women in science and engineering study has been documented from historical, disciplinary, and cultural perspectives. These documents cite similar patterns of low participation and success of women in the pursuit of engineering study and practice (NSF, 1998; Oakes, 1990; Rossiter, 1995).

The number of females enrolled in U.S. higher education overall now exceeds the number of male students (Weidlein, 2001). Substantial progress has been made by women in pursuit of study in non-traditional majors and careers in traditionally male dominated fields (NSB, 2000). In 1995 women earned 73% of the degrees awarded in psychology, 50% in agriculture and biological sciences, and 50% in the social sciences. About 33% of the degrees in physical sciences, earth and atmospheric sciences, and in mathematics and computer sciences

were earned by female students. However, women earned only 17% of the bachelor's degrees awarded in engineering (NSF, 1998). This gender imbalance in engineering suggests that women experience barriers to entry and achievement in this field (Astin & Sax, 1996; Seymour & Hewitt, 1997).

Female students in engineering programs function as a minority group (NSF, 1998). The minority status of women in science and engineering fields presents a number of challenges to female students that are not encountered by the male majority (Kahle, 1996; Levin & Wyckoff, 1995; Oakes, 1990). To increase opportunity for female students to succeed in engineering programs, college administrators need to identify and measure variables that are related to female academic achievement in engineering majors. Understanding these variables could lead to better admission decisions and also to more effective support programs for women in engineering.

Cognitive Predictors of Academic Success

Academic success in college is most often measured by traditional letter grades which generate an overall grade point average (GPA). The cumulative college GPA is used as an indicator of academic success because it reflects the entire scholastic performance of a student at a particular college and within a specific program of study (Burton & Ramist, 2001; Camara & Echternacht, 2000).

Colleges try to admit students who possess characteristics that are indicative of their ability to earn passing grades at the institution in their chosen major. Students who lack academic ability cannot benefit from the education being offered. Often students' failure can mean that a college program may be admitting students who are not able, or the program may be failing to provide necessary support services to those who are able. Therefore, it is in the best interests of the institution and the student to assess accurately the applicant's potential to succeed at the

institution (Gutmann, 1987). Specifically, institutions hope to predict the first semester college GPA because students who fail during the first semester of college often also fail to continue on toward graduation (Astin, 1993; Tinto, 1993). Unfortunately, predicting academic success in college is difficult, and students from various backgrounds possess individual characteristics and abilities that make this assessment even more difficult (Astin, 1993).

High school grades provide college admission officers one good indication of student academic ability (Astin, 1993). However, they are not necessarily a good means of comparing students' experiences and achievements. This is because high school grades reflect the standards and quality of a particular school or school system. These standards differ according to region, state, school district, and even individual school. These between-schools differences are not reflected in high school grades. Therefore, using high school grades alone does not give admission officers a clear indication of how applicants across various educational systems compare to one another in ability (Burton & Ramist, 2001).

To solve this problem, a system of standard examinations was created to provide an assessment of the cognitive ability of potential students. These standard tests are offered by corporations that are unaffiliated with any educational institution or government agency in order to provide a consistent measure by which colleges can compare student ability (Willingham, 1985; Willingham, Lewis, Morgan, & Ramist, 1990). Standardized tests provide a quantitative measure with a focus on student ability in mathematics, analytical reasoning, verbal, and writing skills that are not associated with a particular high school curriculum (Etzkowitz et al., 2000).

Traditionally, institutions rely on the predictive ability of standardized test scores from the Scholastic Assessment Test (SAT) or American College Test (ACT), together with the student's high school GPA to determine pre-college cognitive ability. These traditional measures

utilize a quantitative, cognitive assessment to predict a student's college GPA and potential academic achievement (Astin, 1993).

Although SAT scores and high school GPA are significant predictors of college success for many students, these predictors are susceptible to non-cognitive variables (Camara & Echternacht, 2000). Pre-college abilities and accomplishments are only partially assessed by the cognitive measures provided by SAT scores and high school GPA (Astin, 1993; Sedlacek, 1987). Determination of student ability needs to be accurate to ensure that all able students are granted access into programs where achievement is possible. The increasing diversity within the student population can make accurate prediction difficult if the measures of student success have limited predictive ability for some groups (Sedlacek, 1987; Tinto, 1993).

Recent research on student academic success has challenged the traditional cognitive predictors by suggesting that these measures account for only 25% of college academic performance (Mouw & Khanna, 1993). Other studies demonstrate that academic success in college is influenced not only by cognitive ability, but also by non-cognitive variables as well (Astin, 1993; Pascarella & Terenzini, 1991; Volet, 1997). The traditional cognitive measures, SAT scores and high school GPA, have not been found to be significant predictors of non-cognitive ability in college (Camara & Echternacht, 2000).

Controversy continues over whether the standardized tests are fair to students from populations other than the male majority. Supporters argue that the tests are a common and objective measure that helps to identify students from various backgrounds who are capable of succeeding in college (Camara & Echternacht, 2000). Critics assert that the assessment provided by the standardized tests is culturally and educationally inappropriate for females and students from racial and ethnic minority groups. The test scores are supposed to identify the different

abilities of individuals, but averages do not reveal these differences (Burton & Ramist, 2001; Fleming & Garcia, 1998).

According to predictions made by traditional cognitive measures, both male and female students admitted into engineering programs demonstrate high ability to achieve academically (Astin, 1993). However, students who are members of a minority group often encounter a bias in the predictive ability of traditional cognitive assessments that does not exist for students in majority groups. The bias is the result of cultural differences that exist for minority groups (Burton & Ramist, 2001; Tracey & Sedlacek, 1987).

Existence of gender differences that affect male and female academic performance suggests that the predictors of academic success may also be susceptible to gender influences (Ancis & Sedlacek, 1997). The design of the SAT was based on the White male student and there is evidence to suggest that it may not be as valid a predictor for females or students from racial and ethnic minorities. Existing evidence shows that gender bias in the SAT and other standardized tests may give males the advantage of scoring higher on the exam over females (American Association of University Women [AAUW], 1992; Kobrin & Milewski, 2002).

For example, differences persist between females and males in high school course preparation. Males still complete more advanced courses in science and math than females. These differences affect performance on standardized tests (Burton & Ramist, 2001). Perhaps more importantly, when colleges use the SAT to predict the achievement of students in specific fields of study, then the use of the SAT is being extended beyond its intended purposes (Sedlacek & Adams-Gaston, 1989; Stern & Briggs, 2001; Tracey & Sedlacek, 1989).

Reliance on the traditional measures as the only predictors of academic success may result in disadvantages for the female student. One disadvantage may be in limited access into

college or specific college majors. Access to college engineering programs is highly selective. Students accepted into engineering programs have relatively high SAT scores and high school GPAs (Ludwig, 1995). Additionally, the under prediction of female grades may result in decreased opportunity for non-need based financial aid. Lower predictions of success for female students may also bring negative reactions from advisors or counselors who may discourage female students' career plans or academic goals (Ancis & Sedlacek, 1997; Burton & Ramist, 2001; Levin & Wyckoff, 1995).

Non-Cognitive Predictors

Researchers have concluded that the SAT and high school GPA have limited predictive ability when considered separately, but are most accurate when used together and in conjunction with measures of non-cognitive variables (Ancis & Sedlacek, 1997; Burton & Ramist, 2001; Larose & Roy, 1995). Including additional measures in the admission criteria may increase predictive ability for students who use different skills and behaviors to achieve (Burton & Ramist, 2001; Tracey & Sedlacek; 1984).

Many colleges have acknowledged the importance of non-cognitive variables in their admission practices by including essays, interviews, and recommendations among the factors that determine admissibility. These requirements attempt to assess the non-cognitive variables not measured by SAT scores or high school GPA. These variables can indicate whether or not a student possesses the skills necessary for a successful transition to college and to achieve academically (Astin, 1993; Pascarella & Terenzini, 1991).

Efforts have been made by researchers to understand better which non-cognitive variables enable a college student to succeed as measured by good college grades and eventual graduation. Results of this research have identified certain non-cognitive variables that can lead

to academic success for all college students. These factors include social and academic integration, interaction and experiences with peers and faculty, student demographic characteristics, career and vocational goals, and degree of involvement in the institution (Astin, 1993; Pascarella & Terenzini, 1991; Tinto, 1993; Tracey & Sedlacek, 1984).

Researchers have attributed the development of these non-cognitive characteristics at least in part to pre-college experiences. Such experiences can set the stage for collegiate academic success by shaping personal values, skill in interpersonal interactions, socially responsible behavior, healthy relationships, intercultural awareness, and career objectives contribute to individual ability and skill needed for academic success (Astin, 1993; Pascarella & Terenzini, 1991; Tinto, 1993; Tracey & Sedlacek, 1984).

The characteristics and skills needed for achievement can differ across student populations (Ancis & Sedlacek, 1997; Astin, 1993; Fleming, 1984; Tinto, 1993). Results of extensive research demonstrate that female students and students in underrepresented racial and ethnic groups experience differences in society and education. These differences result in the student's adaptation and development of characteristics in response to the educational environment. (Tinto, 1993; Tracey & Sedlacek, 1984).

Females encounter cultural differences in academic practices of gender bias that often require a different set of behavioral responses from those expected of males (Sadker & Sadker, 1994; Tinto, 1993). Women's life experience can also shape the non-cognitive characteristics they develop (AAUW, 1992; Ancis & Sedlacek, 1997; Fox, 1997; Hall & Sandler, 1982; Sadker & Sadker, 1994). In response to gender bias in society and the education system, a female student learns to use different characteristics than the male student in order to succeed academically (Ancis & Sedlacek, 1997).

Several non-cognitive variables have been identified by researchers as predictors of female academic achievement and persistence. These variables include family background and encouragement, peer support, role models or mentors, self-esteem, leadership roles, locus of control, and self-efficacy of mathematical ability (Astin, 1993; Felder, Forest, Baker-Warf, Dietz, & Mohr, 1994; Hanson, 1996; Huang & Brainard, 2001; Oakes, 1990; Sax, 1992; Tidball, Smith, Tidball, & Wolf-Wendel, 1999).

Research on men and women who are in science and engineering fields has greatly increased the level of understanding of the non-cognitive influences that gender has on success in these areas (Astin, 1993; Hanson, 1996; Oakes, 1990). Gender influences which affect academic performance for both men and women in engineering majors include such factors as socialization of gender role, family background, mathematics and science ability, and educational climate in the schools (Etkowitz et al., 2000; Hanson, 1996).

Since educational differences exist between female and male students, research has examined the predictors of academic achievement for possible differences (Ancis & Sedlacek, 1997; Burton & Ramist, 2001; Levin & Wyckoff, 1994). Recent studies of academic achievement in engineering fields have focused on non-cognitive or non-traditional measures which may specifically predict female achievement (Astin, 1993; Levin & Wyckoff, 1994, 1995; Oakes, 1990). These include gender attributions towards roles and future goals (Hughes, 2002; Seymour & Hewitt, 1997), previous math and science ability (Eccles, 1992; NSF, 1998), previous culture or environmental experiences in and out of the classroom (Hall & Sandler, 1982; Sadker & Sadker, 1994), self-efficacy and assertiveness (Astin & Sax, 1996; Sax, 1992), family background and support (Hanson, 1996; Levin & Wyckoff, 1994), and influential mentors

including teachers and advisors (Eisenhart & Finkel, 2001; Levin & Wyckoff, 1994, 1995; Seymour, 1995).

If colleges hope to admit a more diverse student body and promote academic achievement for students from underrepresented groups, they must use admission criteria and support interventions that are targeted to the characteristics of those students (Ancis & Sedlacek, 1997; Gurin, 1999). In addition to the traditional cognitive predictors of student academic achievement, an assessment of the non-cognitive variables which affect student success may be useful. Institutions that base their admission criteria at least in part on the use of non-cognitive variables have been able to admit more traditionally underrepresented students into their programs (Sedlacek, 1987).

Researchers have examined non-cognitive variables as predictors of academic achievement for females and minority students and found them to be superior to traditional cognitive predictors in some cases (Ancis & Sedlacek, 1997; Pascarella & Terenzini, 1991; Tracey & Sedlacek, 1984; 1989). These results support the importance of considering non-cognitive variables in determining the likelihood of female academic achievement and persistence (Astin, 1993; Tidball et al., 1999).

In addition, assessment of non-cognitive variables can help institutions devise appropriate support programs for the students they have already admitted. Since female students and other minority student populations have different characteristics from White men, the support that they need in education can also be different (Ancis & Sedlacek, 1997; Tinto; 1993). Therefore, using non-cognitive measures can aid institutions in graduating a more diverse cohort of engineers, by demonstrating the strengths of students who might not otherwise be admitted, and by identifying the support programs that some students may need to succeed.

Use of the Non Cognitive Questionnaire

A series of studies has examined the value of eight non-cognitive variables in predicting academic achievement. The following non-cognitive variables have been identified through these studies to be indicators of student success: (a) positive self-concept; (b) realistic self-appraisal; (c) understanding of and the ability to deal with racism; (d) preference of long range goals over immediate needs; (e) availability of a strong support person; (f) successful leadership experience; (g) demonstrated community service; (h) nontraditional and culturally related knowledge acquired in a field along with the ability to demonstrate that knowledge (Ancis & Sedlacek, 1997; Boyer & Sedlacek, 1988; Fuertes & Sedlacek, 1995; Ting, 2000; Tracey & Sedlacek, 1984, 1985, 1989).

Tracey and Sedlacek (1984) developed the Non Cognitive Questionnaire (NCQ) in order to assess these eight non-cognitive variables quantitatively. A copy of this instrument appears in Appendix A and a complete description appears in Chapter Three. Several studies have demonstrated the effectiveness of the NCQ in predicting academic achievement for various groups when used in combination with SAT scores (Ancis & Sedlacek, 1997; Boyer & Sedlacek, 1988; Fuertes & Sedlacek, 1994; Sedlacek & Adams-Gaston, 1989; Ting, 2000; Tracey & Sedlacek, 1985, 1989). These studies found that the NCQ may appropriately be used to supplement traditional predictors of student ability.

Studies using the NCQ have examined the ability of the SAT and NCQ to predict various forms of academic achievement among African-Americans, Asian Americans, Hispanics, international students, student athletes, and female students. These studies have shown that the NCQ is most helpful when used with the SAT in predicting the academic achievement of students who often experience inequity in a college environment (Ancis & Sedlacek, 1997;

Boyer & Sedlacek, 1988; Fuertes & Sedlacek, 1994; Sedlacek & Adams-Gaston, 1989; Ting, 2000; Tracey & Sedlacek, 1985, 1989). Since evidence exists that female students often experience bias or inequity in their educational environment (Fox, 1997; Sadker & Sadker, 1994), the NCQ can help identify and measure the non-cognitive variables related to a woman's academic achievement.

One published study has specifically examined the ability of the NCQ to predict academic achievement of female students (Ancis & Sedlacek, 1997). Using the GPA of the participants as the dependent variable, this study sought to determine the validity of the NCQ and the SAT as predictors of women's achievement throughout college. The results suggest that both cognitive and non-cognitive variables significantly predict the GPA of female students in the first year and throughout their college years. These researchers found that both verbal and math SAT scores were predictive of female student success. In addition, they found that community service activities, realistic self-appraisal, nontraditional knowledge, successful leadership experience, and having a strong support person were significant non-cognitive predictors of female academic achievement (Ancis & Sedlacek, 1997).

This research demonstrates that in addition to traditional cognitive measures, examination of non-cognitive variables can help predict the academic achievement of female students. The results of such an examination can also aid in developing effective educational interventions that may lead to increases in academic achievement and decreased attrition rates for female college students (Ancis & Sedlacek, 1997).

A lot is known about the value of the NCQ when used with the SAT as a predictor of academic achievement for a variety of minority populations. Ancis and Sedlacek (1997) studied non-cognitive variables with a general population of undergraduate women. Their study

validated the NCQ when used with SAT scores as a predictor of female academic success. However, there is no specific information about the value of the NCQ as a predictor of academic achievement specifically for the minority population of female engineering students. The present study extends the work of Ancis and Sedlacek (1997) to examine female engineering students, a group for which no similar study has yet been published.

Purpose of the Study

The purpose of this study was to determine the value of the NCQ and SAT in predicting the academic achievement of first year female engineering students. The participants' first semester GPA was used as the dependent variable. The study was guided by the following research question: What are the contributions of each NCQ scale score, the SAT Math score, and the SAT Verbal score in explaining the variance in female engineering students' first semester GPAs?

Definitions

The following terms will be used throughout the study and are defined below:

Academic success. In this study, the concept of academic success is determined by the persistence of a student within a collegiate institution with a specific grade point average (GPA). For the purposes of this study, students who are academically successful in college are those with a 2.0 GPA or above.

GPA. The definition of grade point average (GPA) in this study is based on the work of Astin (1993) who identifies GPA as a final grade used to evaluate performance. This grade evaluates many performances and achievements. It is a measure that is taken over a period of time and not just one instance. Additionally, the GPA is not only a measure of individual learning, but also a way to compare one student's performance against another.

The current academic policy set by the institution where this study was conducted determined the GPA of the participants. In this system the GPA is computed by dividing the total number of credits earned by the total number of hours attempted at the institution, except for courses that are taken on a Pass/Fail basis. This institution uses the credit hour as its unit of credit. To earn one credit in a term, the student is expected to spend three hours each week in the classroom or laboratory. Currently, the minimum standard for academic good standing is a cumulative GPA of 2.0. Table 1 displays the grade points earned for each letter grade at this institution.

Non-Cognitive Variables. The definition of non-cognitive variables used in this study is based on the work of Tracey and Sedlacek (1984). In this study, non-cognitive variables refer to those non-intellectual aspects of student's personality which influence learning, such as affect and motivation. Non-cognitive variables are measured in this study using the NCQ.

Setting

The setting for this study was a large Doctoral Research-Extensive institution located in the mid-Atlantic region of the United States. The institution is a publicly supported, comprehensive, land-grant university located in a rural setting. It offers 200 degree programs and has more than \$150 million in research expenditures every year (White, 2000). The university enrolls about 28,000 students. In 2001, 59% of undergraduate students were male and 41% were female. By racial or ethnic category, undergraduates were 81% White (non-Hispanic), 7% Asian or Pacific Islander, 5% Black (non-Hispanic), 3% non resident aliens, 2% Hispanic, 2% race or ethnicity unknown, and less than 1% American Indian or Alaskan Native (Office of Institutional Research and Planning Analysis, 2003).

Table 1

Letter Grades Associated with Grade Points

Letter Grade	Grade Points For Each Semester Hour
A	4.0
A-	3.7
B+	3.3
B	3.0
B-	2.7
C+	2.3
C	2.0
C-	1.7
D+	1.3
D	1.0
D-	0.7
F	0.0

Significance

This study is significant because of the value that it has for research. The scholarly literature is rich with studies that address the issues involved in the participation of women in the sciences and engineering. There is also a growing body of literature about the value of non-cognitive variables to predict academic success for certain groups. This study will bring together these two important lines of research in an area of national concern.

Future women engineering students will benefit from this study since it will provide evidence of the best predictors of their academic success in a highly selective curriculum. If secondary school personnel use the results of this study to improve their curriculum, admissions officers use the results to aid in their admissions decisions and financial aid incentives, and engineering faculty and administrators use the results to devise appropriate support programs, then women will be more likely to be admitted and to graduate in engineering.

Ultimately, this study may have national significance if its results are used improve the admission and graduate rates for women in engineering programs. Such a change would lead to increased diversity of the workforce in technical fields, to improved ability of the U.S. to lead scientific endeavors of major international importance, and to improved national competitiveness in the global marketplace.

Organization of the Study

The study is reported in five chapters. Chapter One introduced the study and its purpose, the research questions, selected definitions, and the expected significance of the study. Chapter Two examines the literature available on the variables associated with the academic success of female engineering students, the relationship between cognitive and non-cognitive variables and academic success, traditional and non-traditional predictors of academic success, and the use of

the Non-Cognitive Questionnaire (NCQ). Chapter Three describes the methods used in the study, including sampling, data collection, and data analysis techniques. Chapter Four reports the results of the study, which are followed in the final chapter by a discussion of those results and their implications.

Chapter Two: Review of the Literature

The discrepancy between the number of degrees awarded to females in engineering and the number awarded in other fields has caused educators to examine the reasons why females tend not to succeed in this field of study (NSF, 1998). In response, researchers sought to discover the barriers and motivating factors associated with academic achievement by female students (Fass, 1991). To address these factors, scholars have examined both traditional and non-traditional predictors of academic success. The literature is rich in research on the relevance of these predictors to academic success for female students in science and engineering fields (Astin, 1993; Levin & Wyckoff, 1994, 1995; Oakes, 1990; Sax, 1994; Seymour, 1995; Solomon, 1985).

Examination of cognitive variables uses traditional predictors of academic success such as high school grade point average (GPA) and standardized test scores. Conclusions in the research have focused primarily on the relationship of these common cognitive variables to academic ability and success (Oakes, 1990). However, predicting female success and persistence in an engineering program is much more difficult than predicting female academic performance in general, and this has led researchers to conclude that studying non-cognitive variables might improve prediction of both academic success and persistence (Levin & Wyckoff, 1994, 1995; Oakes, 1990; Solomon, 1985).

Non-traditional predictors focus on non-cognitive variables such as biographical information, attitudes, and personality. Development of these variables is influenced by a variety of factors, most notably cultural and societal roles, gender bias and expectations, and gender differences in education (Etzkowitz et al., 2000). The literature on women's choice of an engineering major and career often refers to variables such as student attitudes, interests, support,

and achievement in mathematics and science as important contributors to the academic success of female engineering students (Oakes, 1990).

Research findings suggest that factors other than academic ability play an important part in women's success in an engineering program (Brainard & Carlin, 2001). Educators recommend that a combination of cognitive and non-cognitive variables may provide the best indication of female persistence and success in the study of engineering (Levin & Wyckoff, 1995; Oakes, 1990; Solomon, 1985). However, despite the fact that the success and retention of female students in engineering is an issue of national consequence, few studies have examined the relationship of both cognitive and non-cognitive variables to female academic success in engineering (Levin & Wyckoff, 1995).

This chapter presents literature on the variables associated with academic success of female engineering students, the relationship between cognitive and non-cognitive variables and academic success, traditional and non-traditional predictors of academic success, and the use of the Non-Cognitive Questionnaire (NCQ).

Variables That Affect the Academic Success of Female Engineering Students

Historic gender bias in education. Historically, the role of women in U.S. education developed differently from that of men. The origins of education in the United States, in the colonial period, saw institutions that were founded and formed by prestigious White men for the education of young White males. Those who were educated had professional and career opportunities that were not available to women. At that time, the cultural need was to educate White men in order to continue the traditions of the church and current politics. Since females were not permitted to officiate in the church or in politics, there was no need for them to be educated (Fox, 1997).

Throughout the 1700s women were viewed as morally and intellectually inferior and education for the great majority of women was limited to the domestic skills that they learned at home. Late in the 1700s education was available to a very small number of women from wealthy families. Receiving instruction was not easy even for these select females. They were instructed for short periods of time on days when it was inconvenient for boys to attend (Fox, 1997; Sadker & Sadker, 1994).

Early in the 18th century public demand led to the establishment of separate schools for women so that they could become better teachers to their children. Female interest in education was so strong that not all female students could be admitted to the new schools. Limited funds and classroom space for women in these segregated schools forced the opening of coeducational schools that provided instruction below the college level. Strong public criticism arose against educating both males and females in the same classrooms. Some members of society argued that societal values and morals would deteriorate in a mixed classroom and female students should only be encouraged to pursue traditional roles (Sadker & Sadker, 1994).

By the 1820s, in response to the criticism of coeducation, schools with a religious affiliation began to open for women. These schools were known as seminaries where female students were provided a curriculum of instruction in domestic necessities, basic grammar, and arithmetic. Education in seminary school provided women with instruction on how to be a proper wife and mother and a traditional member of society with strong moral values (Sadker & Sadker, 1994).

These seminaries of the early 1800s began to nurture women's educational aspirations and teach them somewhat more than home economics. Many of the female graduates of these institutions became teachers. The public came to recognize the value of women as educators of

young men who would lead a newly formed nation. Women were particularly valuable as school teachers because they would accept lower pay than men. Instruction in the seminaries supported the role of women in education and provided a basis for higher education for women (Fox, 1997).

In the 19th century, administrators in higher education recognized a need for a domestic labor force in the totally male institutions. Women were seen as a solution to the domestic needs of the colleges. Oberlin was the first college in the U.S. to admit female students but only permitted them to attend classes on specific days so that they could spend time working in domestic labor for the male students who were enrolled in regular college level courses (Fox, 1997; Goree, 1993).

Soon after female students were admitted to Oberlin, other small church related colleges began to admit women. Although the female students performed as well as males in the classroom they were not able to receive a degree. They were only permitted to enroll in high school and special preparatory classes. It was not until the middle of the 19th century, almost 200 years after the first college in the nation was opened to men, that women began vocally to demand and gradually to receive places in institutions of higher education. In 1837 the first college degrees equal to those received by men, were granted to women (Goree, 1993).

The Civil War marked a period where national concerns encouraged educational policy change. During the Civil War male enrollment in higher education declined, and economic concerns expanded educational opportunity to women. In order to survive, institutions that were traditionally male began to admit women. The high casualty rate and economic devastation caused by the war meant that women needed vocational training so that they could find employment (Fox, 1997; Goree, 1993).

In the period following the Civil War, institutions offering higher education to women were established. Many of these institutions were founded to accommodate the growing number of women who wanted a higher education while keeping them separated from men. Later, state agencies charged with regulating and funding education realized that it was cheaper to admit women to coeducational institutions than it was to operate separate institutions for them. Regardless of the institution, women were finally able to receive an education that was modeled on classical and literary curriculums characteristic of a liberal arts education, as well as vocational training. Women recognized that a higher education could open the doors to many occupations and even tried, unsuccessfully, to obtain degrees from graduate and medical schools (Fox, 1997; Goree, 1993).

In this period of the 19th century, institutions of higher education, known as normal schools, were established to train men and women as teachers in the growing public education system. Although these schools did not provide an education equal to that of a college, they increased the educational aspirations of their female students. The normal schools and female teachers were supported by the new nation because of economic benefits to the country. Not only were the schools well funded, but female teachers continued to be paid much less than male teachers and education costs could be greatly reduced (Fox, 1997; Goree, 1993).

Following the Civil War, the U.S. government approved The Morrill Land Grant Act. This policy provided greater opportunity for students to enroll in higher education, including many women who had not previously had access to education. In approving the Morrill Act the government recognized the need for a large number of highly trained and skilled workers that would contribute to the good of the nation. National concerns indicated a need for well-educated citizens who would advance technology, increase the production and quality of crops, and

provide community services. Land Grant institutions were forming in many states in response to the national need to provide greater access to education in agriculture and mechanical arts to a wider population of students. The establishment of the state Land Grant colleges and universities contributed to the educational opportunities offered to females and other students of racial and ethnic minorities (Gehring, 1998).

Late in the 19th century, despite many advances for women, many obstacles to their education remained. Societal critics of women's education held the opinion that women should not be educated along with men. Female students who did pursue an equal education at a co-educational institution often faced hostility from professors, administrators, and male classmates (Goree, 1993).

Increased access to state colleges for women did not provide increased acceptance in educational programs or society. Through the late 19th century critics asserted that women were inferior to men, both physically and intellectually. This group argued that a woman's health would suffer if she were educated the same as the men. Since women were thought to be intellectually inferior, it was believed that women could not succeed at advanced collegiate study. The fear also existed that the education of male students would be slowed if less advanced females were in the classroom (Goree, 1993).

The traditional societal role of women in the late 1800s was still in opposition to the education of women. Society placed a woman's role in the home and in service to the community. Contrary to societal expectations, education provided women with the choice to remain unmarried. Strong beliefs existed that a woman who received the same education as a man would refuse to accept her appointed domestic responsibilities (Fox, 1997; Goree, 1993).

Despite these pressures, an increasing number of women sought enrollment in institutions of higher education during the second half of the 19th century. They began to demand and gradually to receive placement in even the traditionally male institutions. By the early 20th century women aspired to higher education in large numbers, and in the 1920s women represented almost half of all enrolled college students (Fass, 1991).

Early in the 20th century women's higher education was closely associated with ideals of equality and intellect. Women's schools continued with the mission of providing an education equal in quality and in content to that of men. The economic depression in the 1930s and World War II created economic demands and brought a variety of educational offerings for women. Educational offerings were being designed to meet women's specific needs in the labor market and to provide leadership opportunities. The war resulted in a decrease in the enrollment of male students, and females were the majority of all students in higher education by the 1940s (Goree, 1993).

Following World War II, during the 1950s and early 1960s, many women were more invested in marriage goals than in career goals, and it was not long before the trend in education for women shifted from vocation back to marriage and family (Fox, 1997). In the 1950s, the prevalent view of female education was that women were receiving more education than they seemed to need. Many females viewed their enrollment in college as temporary until they were married. Many wanted to have their first child by age 25, and most wanted at least two children (Fass, 1991).

Overall, the enrollment of females in higher education fell to 30%, the lowest of the century (Fass, 1991). Female students on campus complained of a dissonance between their

education and their future lives as housewives and mothers. This topic became a subject of great debate and was often referred to as the female paradox (Fass, 1991).

The female paradox was evident in the administration and curriculum of women's higher education throughout the 1950s and early 1960s. Some institutions responded by providing instruction that pertained to the needs of a family. Others faced the challenge by increasing concentration on preparing for a future occupation. Generally, educators pointed out that women seeking higher education would always struggle due to the conflict between higher education and the desire for motherhood and marriage (Fass, 1991).

The conflicts experienced by female students in the U.S. would soon become a national concern. In the 1950s, the nation was very concerned with international competition in science and technology. A national crisis in science and engineering education had been declared in response to launch of the Russian space craft Sputnik, and the U.S. did not want to be left behind in the space race. One of the demands placed on higher education was to increase the number of students enrolled in science and engineering programs in order to provide a highly skilled workforce. As the demand increased over time, women were recognized as a resource that would increase the supply of highly skilled workers (Lucena, 2000).

However, female access to certain institutions and many fields of study continued to be restricted. During the mid-1960s and into the 1970s, sentiments emerged that promoted ideas of academic success versus popularity and career versus marriage. Women began to fight discrimination in higher education and employment. The struggle for equality was supported by major historical events which encouraged women to speak out for their educational and employment rights (Fox, 1997; Lucena, 2000).

The most significant event was the passage of the 1964 Civil Rights Act, which prohibited discrimination in education on the basis race, color, or national origin. In the early 1970s, as the U.S. moved toward success in the space program with the Apollo missions, mostly White males were highly skilled and highly paid in highly technical positions. American minorities criticized high cost government funding of science programs like the Apollo missions that did nothing to improve minority representation in science. Members of minority groups criticized national policy that used science programs for space exploration while not addressing the national need to correct past disparity in educational opportunity, especially in the fields of science and technology (Gehring, 1998; Lucena, 2000).

Throughout the 1970s, minority groups argued that their diverse backgrounds would provide intrinsic knowledge valuable to solving many of the nation's social problems. Policy makers agreed that diversity could be valuable and recognized that an increase in the number of minority students would lead to an increase of skilled workers. New mandates were implemented to provide funding for minorities studying in the sciences (Lucena, 2000).

The advancements of equal rights for minority groups during the 1960s and 1970s increased the vocalization of women's rights alongside the struggle for civil rights (Fox, 1997; Gehring, 1998; Lucena, 2000). Title IX of the Educational Amendments of 1972 prohibited discrimination based on gender in educational programs and activities that received federal funding. Beginning with this legislation, equal educational opportunities were mandated. Officially, the policy requires that all school programs be examined for gender biased discrimination. Title IX called for equal treatment in all courses, services, financial aid, and employment (Fox, 1997; Gehring, 1998).

The impact of Title IX policy has increased access for women into many fields that had been traditionally male oriented. It has not reduced informal sources of gender bias in education. The policy has been limited in reducing the segregation of male and female students in different fields of study. Women continue to be outnumbered and restricted in many areas of scientific and technical majors and careers due to patterns of gender bias such as classroom interaction, course procedures, and lack of faculty support (Fox, 1997).

Female students are under represented in the field of engineering. In engineering, only 17% of the degrees awarded go to women (NSF, 1998). An unequal representation in engineering education translates into an under representation of females in the engineering profession. As a minority group in the field of engineering, females experience many challenges due to differences in background characteristics. The difference between male and female participation in the field of engineering has led to increased study of the factors associated with academic achievement in engineering programs. These factors include gender differences in culture and in education, as well as several cognitive and non-cognitive variables (Astin, 1993; Felder et al., 1994; Hanson, 1996; Kahle, 1996; Oakes, 1990).

Female achievement and persistence in engineering. Although the past few decades have seen a great increase in the number of college degrees awarded to women, an under representation of females earning degrees in math and science curriculums, and especially in engineering, is evident. Currently, the number of women attending college and receiving degrees now exceeds the number of men. In 1995 the composition of the U.S. population between the ages of 18 to 24 was 49% female. In that same year, women earned 55% of the awarded bachelor's degrees in the U.S. (NSF, 1998).

Mathematics and science are two academic areas that require further attention and intervention so that female students can succeed and be encouraged to pursue careers in these areas (NSF, 2002). In 1995, 46% of the bachelor's degrees awarded in science and engineering were awarded to women. In contrast, 59% of the degrees in non-science and engineering fields were awarded to women. When the various fields of science are examined for the participation of women, the difference in the degrees awarded in engineering is even more obvious (NSF, 1998).

In 1995 women earned 73% of the degrees awarded in psychology, 50% in agriculture and biological sciences, and 50% in the social sciences. About 33% of the degrees in physical sciences, earth and atmospheric sciences, and in mathematics and computer sciences were earned by female students. However, women earned only 17% of the bachelor's degrees awarded in engineering (NSF, 2002).

This trend is often attributed to the notion that at this point in their education females choose not to pursue a major or a career in science or technology (Oakes, 1990). A recent study shows that only 2 out of 10 female college students choose science or engineering as a major. This is compared to the 4 out of 10 male students who are choosing to major in a science or engineering field (Barber, 1995).

Literature on the success and failure of women in the fields of science and engineering provides an examination of the problem. Several factors emerge as influences in female choice and persistence of engineering as a major field of study in college and as a career. Those most often identified in the literature are socialization, education, and preliminary career decisions (Hewitt & Seymour, 1991; McIlwee & Robinson, 1992; Oakes, 1990).

Cultural and educational gender differences. Gender differences in the educational experience on college campuses today have much to do with the history of higher education as

well as the socialized roles throughout history that men and women played and still play today (Fox, 1997). Cultural, social, and economic concerns of the nation have shaped education policy in the U.S. from the beginning. In turn, education policy has determined the role of education in the nation and defined the roles of those who participate in the educational system (Lucena, 2000).

The different language that we use with men and women and the different behaviors that we expect from them are a part of our current culture and are reflected in the education of U.S. students. This culture was partially formed in history during times when gender discrimination was a prevailing factor (Shalom, 1996). Even if gender discrimination is no longer permitted by society or politics, the current norms and practices are reflective of the past discriminatory practices and beliefs (Shalom, 1996).

Many educators believe that knowledge is socially constructed (Astin, 1993; Tidball et al., 1999). Therefore, knowledge gained through experiences in an individual's environment may be different for men and women due to socially constructed norms of gender specific roles (Baxter Magolda, 1992; Belinky, Clinchy, Goldberger, & Tarule, 1986).

Gender specific roles and stereotypes can greatly influence the educational experiences of male and female students (Sadker & Sadker, 1994; Solomon, 1985). Historic cultural and social gender roles and stereotypes are transferred to the students through parents and home life, and often supported by instructors in the classroom (Sadker & Sadker, 1994; Seymour, 1995). Learning the gender expectations of society demonstrates to students that men and women have different abilities, interests, and professional choices. An individual learns these stereotyped roles and expectations through reinforcement, punishment, modeling, observation of others, and direct instruction (Baxter Magolda, 1992; Hewitt & Seymour, 1991; Sadker & Sadker, 1994).

Although great progress has been made to overcome the discrimination of the past, continuing gender bias in education has nevertheless resulted in educational differences that affect the academic achievement and career choices of many women (Noble & Smyth, 1995; Tidball et al, 1999). Traditionally, females are expected to enter fields that are supportive, clerical, nurturing, and service oriented (Etzkowitz, 2000; Kahle, 1996). The gender bias in education creates an impression that math, science, and technical fields are not for females (Eccles, 1992; Kahle, 1996; Oakes, 1990).

Generally, being female is negatively associated with achievement and persistence in the study of engineering (Astin, 1993). The minority status of females in the field of engineering is most often cited as contributing to females' not choosing engineering as a major and career path (Oakes, 1990). Factors affecting female persistence in engineering include societal pressures and opinions that negatively affect females' pursuit of engineering as a profession. Negative family and social views of a woman studying or working in a field which is predominantly male can undermine engineering as a career choice for women (Etzkowitz et al., 2000; Rosser & Zieseniss, 2000).

Often the female student decides not to pursue engineering in order to maintain her femininity and female social role (Hanson, 1996; Noble & Smyth, 1995). Strong cultural definitions of femininity and feminine attributes are contrary to the male dominated world of science and engineering professions. Women experience difficulties in a male dominated classroom and workplace that lacks female role models and mentors (Hewitt & Seymour, 1991; Oakes, 1990; Rosser & Zieseniss, 2000).

Gender stereotypes create educational differences between male and female students that can result in limited educational opportunity for some female students (Oakes, 1990; Sadker &

Sadker, 1994). Educational disparity occurs in the home, through interaction with instructors, in the structure of the education system, in participation in activities, and in peer acceptance (Eccles & Jacobs, 1986; Hanson, 1996; Kahle, 1996; Oakes 1990; Sax, 1992; Seymour & Hewitt, 1997).

Eccles and Jacobs (1986) state that the masculine image of science and math has usually been incorporated by children by the time they reach elementary school through learning that takes place from significant others such as the parents. The study further explains that the concept of a masculine scientific role is promoted by neglect or discouragement of females throughout their educational experience in primary as well as secondary school. The concept is reinforced at home through parental perceptions, especially those of the mother, that mathematics is difficult and not important for their daughters. Female and male students may attend the same schools and take the same classes, but the educational experience is not the same for the different genders (Eccles & Jacobs, 1986).

Family reinforcement and early education. Educational gender bias often starts at home through family members who encourage societal traditions of gender expectations in their children (Eccles & Jacobs, 1986; Etzkowitz et al., 2000). Parental expectations are usually dependent upon the sex of the child, and these expectations may influence future career choices (Kahle, 1996; Oakes, 1990). Males are often expected to possess characteristics to be ambitious, aggressive, independent, intelligent, and successful; females are expected to be kind, loving, nurturing, attractive, and a good wife and mother (Etzkowitz et al., 2000; Kahle, 1990).

Gender role stereotypes often influence parents' choice of toys and activities for a child. These choices provide different experiences in play and tasks, while encouraging gender specific behavior (Kahle, 1990; Oakes, 1990). A male child is more likely to experience more mechanical and technical activities in play. The mastery of more complex tasks in play encourages a male to

pursue complex and technical study in the future. As a male, the child will play by throwing balls and use toy tools, motors, along with toys that allow him to construct things such as building blocks and Legos (Kahle, 1990). These and other similar play experiences for a male child provide a basic introduction to positive experiences in science and technology (Kahle, 1990).

If girls are not encouraged to participate in similar play, they do not receive an early educational experience that is equal (AAUW, 1992). A female child is more likely than a male child to play with dolls, plastic food and dishes, musical instruments, and nurturing toys that promote the role of mothering and homemaking (Kahle, 1990). Experiences in play expose a female child to subject matter that is more familiar and requires less investigation, reasoning, or exploration. Activities encouraged for female children are more relevant to the biological sciences than those of the physical and mechanical sciences (Kahle, 1990, 1996).

Parental influence plays a significant role in math achievement and career aspirations, especially in the choice of an engineering career (Blaisdell, 1995; Hanson, 1994). Findings by Jacobs, Finkin, Griffin, and Wright (1998) show that an intrinsic value and interest in science for females needs to be encouraged and supported by family and peers. Hewitt and Seymour (1991) explain that parents are unlikely to provide encouragement needed for their daughters to perform well in science. Results of other studies also demonstrate that interest in the pursuit of a science or engineering major for a female student is related to positive attitudes of family and peers (Hanson, 1996; Oakes, 1990).

When family members support and encourage the education of a female science or engineering student, the student tends to remain in the fields of science and engineering (Astin, 1993; Hanson, 1996). Family support includes not only encouragement, but also the behavior of the parents in terms of level of involvement in their daughter's education. This parental

involvement includes a monitoring of homework, attendance at school conferences, providing technical equipment in the home, and holding and encouraging high educational expectations (Hanson, 1996; Oakes, 1990).

Having a father in the home who is highly involved and who encourages a daughter's education is strongly correlated with the level of a female's science achievement and persistence (Astin, 1993; Hanson, 1996; Oakes, 1990). In a study by Hanson (1996) 95% of females who pursued scientific study in college reported that their fathers monitored their homework in their pre-college experience, in contrast to 75% for females who did not choose to pursue science or engineering (Hanson, 1996).

Other significant family contributions to females' choice of science or engineering are the level of education of the parents and the high status of parental careers. Females who pursue study in science and engineering tend to have mothers who have high levels of education and who work in professional jobs (Hanson, 1996; Sax, 1992). Findings suggest that females in these family environments may have been exposed to less stereotypical expectations through the family. As a result, it is likely that they tend to hold less traditional gender views of occupations and see less conflict between career choice and home life (Kahle, 1996; Levin & Wyckoff, 1994; Oakes, 1990).

Gender bias in the classroom. Societal influences of gender expectations and limitations are reinforced in the classroom through interaction with instructors, curricular materials, and the influence of peers (Sadker & Sadker, 1994; Seymour, 1995). Females today still encounter various forms of gender differences in education from kindergarten through higher education (Kahle, 1996). Classroom differences impact the development of both gender role and self-concept (Seymour, 1995).

Female students often receive faulty feedback in the classroom regarding their academic performance (Hall & Sandler, 1982; Sadker & Sadker, 1994). Faulty feedback at all levels of education for females can include disparaging comments from instructors, favoritism toward male students, discouragement from academic or career pursuits, and inattentiveness to female students in general (Levin & Wyckoff, 1994; 1995). In the classroom, instructors are less likely to give their attention to women while focusing more on the men and accepting their responses more often (Sadker & Sadker, 1994).

Several studies have found that gender differences in attitudes, self-confidence, and achievement are often the result of disparate treatment of males and females at all grade levels in the classroom (Hall & Sandler, 1982; Sadker & Sadker, 1994; Seymour & Hewitt, 1997). This disparate treatment often results in unequal experiences by males and females in science, mathematics, computer technology, and engineering (Eccles & Jacobs, 1986; Oakes, 1990; Sadker & Sadker, 1994). Unequal participation in these fields for female students is often the result of the characteristics of the education system, including access to qualified instructors, access to the number of math and sciences courses offered, access to resources and equipment, and judgments about abilities (Eccles & Jacobs, 1986; Fennema, 1990a; NSF, 1998).

Reinforcement from instructors. Instructor interaction can encourage the stereotypes of society and family (Hanson, 1996; Oakes, 1990). Classroom instructors bring to the classroom their own socially influenced expectations of gender appropriate behavior and academic achievement. By treating males and females differently, teachers encourage characteristics in the males that are generally connected with mathematical achievement, such as acknowledging assertive behavior and praising completion of complex tasks which fosters self-confidence and

problem solving ability. In general, teachers expect females to be passive and dependent, while expecting males to be assertive and competitive (Sadker & Sadker, 1994).

Studies of gender differences in the classroom illustrate that male students receive much more attention and interaction from instructors (Sadker & Sadker, 1994; Tidball et al, 1999). In their research, Sadker and Sadker (1994) noted that males are more likely than females to interact with instructors. Male students tend to be more vocal in volunteering to answer more questions, and are more likely to receive feedback from instructors through praise and criticism.

Koehler (1990) noted that female students often find that they are not called on in class as often as their male classmates. Additionally, their comments are often ignored, and they can be over-praised for simplistic answers. In order to gain acceptance from their instructors, intelligent female students give up their assertive and risk taking behavior and take on societal gender roles of selflessness and cooperation.

These differences in the classroom may negatively impact the self-esteem and assertiveness of the female students (Sadker & Sadker, 1994; Tidball et al., 1999). This disparity in the classroom can lead female students to suffer from a lack of access to instruction in the classroom. Conversely, gender differences in educational experiences can provide male students with greater expectations, encouragement, and opportunity to learn science and math (Eccles, 1992; Kahle, 1996; Seymour & Hewitt, 1997).

At the college level a significant amount of research has found that the more frequent interaction that a student has with faculty, the more likely the student is to persist (Astin, 1993; Pascarella & Terenzini, 1991). Research on gender differences demonstrates that the college classroom is not free from gender bias. Instructors are more likely to reinforce and interact with male students both in and out of the classroom. For example, professors are less likely to give

their time and attention to women, while focusing more on the men and accepting their responses more often (Fox, 1997). This bias is one variable that may affect a student's academic achievement (Fox, 1997; Pascarella & Terenzini, 1991).

Even when student background characteristics and college experiences are held constant, student-faculty interaction is positively and significantly correlated with educational aspirations and persistence (Pascarella, 1985; Seymour, 1995). Research demonstrates that student behavior and achievement are impacted through interaction with faculty behavior norms, values, and attitudes. The positive influences of this interaction are enhanced when interaction extends beyond the classroom (Pascarella & Terenzini, 1991).

Self-defined gender roles. The influence of societal gender roles and bias exerts a great influence on the identity and self-concept of an individual (Belenky et al., 1986). Females learn valuable lessons and develop specific characteristics from their experience in relationships, how they deal with crises, and their involvement in community activities (Belenky et al, 1986). Differences in self-perceived gender role related skills and major choices between female and male students tend to influence future career plans (Eccles, Jacobs, & Harold, 1990).

When examining students' choice of major, a gender specific pattern is apparent (Jacobs, 1986). A concentration of women is found majoring in nursing, home economics, education, library science, the social sciences, and the humanities. The majors chosen by male students are concentrated in engineering, architecture, the physical and natural sciences, and computer science (Kahle, 1996; Solomon, 1985).

Many students believe that males understand science better than females and that studying science is more important and valuable for males than it is for female students (Eccles et al., 1990; Hughes, 2002; Solomon, 1985). Females who perceive that the fields of science and

engineering are mostly for males or are masculine subjects do not view these areas as relevant to their female roles (Barker, 2001; Eccles et al, 1990; Hughes, 2002).

Females who hold less traditionally defined views of gender role career choice tend to be more successful in the non-traditional fields of science and engineering (Barker, 2001; Hanson, 1996; Hughes, 2002). These females hold a more contemporary view of gender roles and tend to have more progressive attitudes toward a females place in society. As a result, these women have more interest in education and demonstrate higher academic achievement such as grades, and they are also more likely to aspire to non-traditional professions (Astin & Sax, 1996; Hanson, 1996).

Astin (1993) explains that one factor positively associated with persistence and success in the study of engineering is a student's choice of engineering as a career goal. The choice to major in engineering tends to reflect the value and interest a student has in pursuing a career in engineering (Astin, 1993; Hanson, 1996). This positive correlation is supported by research conducted by Jacobs et al. (1998), who found that females tend to maintain interest and demonstrate success in science when they see an intrinsic value in their pursuit. According to the study, there is a strong relationship for female students between the intrinsic value and interest in subject matter and choosing a scientific profession (Jacobs et al., 1998).

Peers. In a classic study, Nevitt Sanford (1966) noted that the ability of a person to achieve when faced with a challenge is a function of the amount of support available to the individual. According to Sanford (1966) the amount of support found in the peer culture of an institution affected the motivation for academic success of female students. His study of female students at Vassar College demonstrated that peers influenced career decisions and placed limitations on acceptable lifestyles and work ambitions. The peer culture in his study reinforced

the norms of society and undermined any impact of the Women's Rights movement at the time (Fass, 1991).

A study comparing female background characteristics to academic achievement and persistence in science and engineering found that a female's self-rating and concern with social popularity among peers was negatively related to success in those fields (Sax, 1992). Additional research suggests that a female's non-persistence can be attributed more to social factors and peer influences than to academic or cognitive variables. This research suggests that males tend to be more persistent in the pursuit of engineering than females due to differences in the social environment (Hanson, 1996; Levin & Wyckoff, 1994).

Hanson (1996) indicates that female students tend to choose not to study mathematics or science in order to maintain their femininity. Female students do not want to appear masculine to their peers. Social rejection, peer acceptance, and loss of appeal to the opposite sex are concerns of female students who decide not to pursue scientific study (Hanson, 1996). Females who do not experience negative peer reactions or opinions regarding the study of science are more likely to choose to continue on to higher levels of education in those fields (Hanson, 1996; Levin & Wyckoff, 1994).

Strong support person and role models. Female students who persist and succeed in science and engineering courses report a strong support person influenced and encouraged them in the pursuit of scientific study (Brainard & Carlin, 2001; Levin & Wyckoff, 1994). By the time students are at the senior high school level, females show more negative attitudes toward math and science and tend not to pursue opportunities in these fields. Female high school students who choose to major in science and engineering fields attribute their choice to a positive pre-college

experience in science due to encouragement and support of influential others (Astin & Sax, 1996; Brainard & Carlin, 2001; Seymour & Hewitt, 1997).

Women who have positive attitudes about the study of science have strong support from a family member, instructor, mentor, or role model who reinforces a propensity for scientific pursuit in a female (Eccles & Jacobs, 1986; Levin & Wyckoff, 1994). Similarly, females who succeed in science and engineering fields report that their undergraduate experience was positive due to the support they received while in the program. Like the high school students, these successful females credit the support to a mentor, advisor, professor, or lab instructor (Brainard & Carlin, 2001; Etzkowitz et al., 2000; Oakes, 1990).

A lack of professional role models and mentors in non-traditional fields contributes to gender discrepancies in education (Astin & Sax, 1996; Brainard & Carlin, 2001; Hanson, 1996). For example, the structure of the school systems and colleges signals a disparity between males and females. Women in the academic and professional communities tend to be in lower positions and receiving lower pay (NSF, 1998). Female students see teachers and untenured professors who are mostly female, while administrators and tenured faculty are predominately male. This limits the number of females in senior positions who can act as role models or mentors to young female students (Hanson, 1996; Mickelson & Smith, 1995).

Research shows that women mentors have more influence on female students than men who are mentors to females (Seymour & Hewitt, 1997). Students are less likely to encounter females who are in powerful positions in science and engineering. A lack of female role models and mentors in nontraditional female occupations such as science and engineering perpetually limits female study and occupational choice in fields that are not traditionally female (Astin & Sax, 1996; Oakes, 1990). Since females were overtly discriminated against in the past, then there

are fewer females today that have the kinds of job connections, faculty positions, or exemplary roles that can be helpful to friends, relatives, or other aspiring females (Fox, 1997).

A lack of role models and gender bias can also be found in curricular materials that often reflect traditional gender roles and behaviors (Sadker & Sadker, 1994). Materials at all educational levels contain a number of character examples which are predominately male. Text books used throughout all levels of education add to discrimination in the classroom by using mostly male examples of successful scientists or assigning traditional roles such as educator, or nurse to females. The dominance of the male role is even more pronounced in math and science materials (Michelson & Smith, 1995; Sadker & Sadker, 1994).

Once a female student has been admitted to an engineering program, institutional efforts may include interventions that support and promote student academic success (Eisenhart & Finkel, 2001). These interventions rely on research findings to identify non traditional, non-cognitive predictors of female achievement in engineering majors. Engineering colleges often develop and implement program interventions that address the non-cognitive variables that promote female academic achievement and persistence in an engineering program (NSF, 1998).

Female engineering students who participate in program interventions that provide support tend to achieve in the study of engineering (Brainard & Carlin, 2001; Hathaway, Sharp, & Davis, 2001). Support programs often depend on senior female peers, female administrators, professional mentors, and female and male faculty members in the major as a source of support to new female students in engineering major. These programs aim to provide encouragement and support through an understanding of experienced discomfort, self-doubt, or criticism, and by providing suggestions of effective strategies to overcome negative experiences (Etzkowitz et al., 2000).

Self-esteem. The self-concept or self-esteem of a student has been positively correlated with academic achievement (Astin, 1993; Huang & Brainard, 2001; Pascarella & Terenzini, 1991). Self-concept and self-esteem are terms that are often used interchangeably in the literature to express the level of one's sense of competence and ability to meet the challenges of life with success in relation to the ability of others (Pascarella & Terenzini, 1991). Levels of confidence and in one's academic ability and educational goal attainment are positively correlated with academic achievement (Astin, 1993; Seymour & Hewitt, 1997).

Gender differences exist in levels of self-esteem and impact academic success and academic expectations (Pascarella & Terenzini, 1991). Gilligan, Lyons, and Hammer (1990) noted that during the junior high school years girls' levels of self-confidence steadily decline. Researchers note that it is at this point in time that many girls give up the pursuit of science (AAUW, 1992; Hanson, 1996).

Self-confidence in ability for a female student is often dependent upon the judgment of others, and some may find it difficult to determine the adequacy of their own performance (Belinky et al., 1986; Etzkowitz et al, 2000). Throughout the high school years females' sense of self-efficacy becomes mostly dependent on the external opinions of others for validation and motivation (Hewitt & Seymour, 1991). Without the support of instructors or others at all levels of education, a female who does not have a well developed confidence in her mathematical or science ability may have difficulty determining if her performance is adequate (Etzkowitz et al, 2000; Seymour, 1995).

Although female students enter college with higher grades and overall test scores than males, they are much less confident in their academic ability (Belenky et al., 1986). In academic, mathematics, and scientific ability women consistently express lower levels of self-confidence

(Astin & Sax, 1996). Women are also less likely than men to expect success in their academic courses and future career goals (Fox, 1995; Noble & Smyth, 1995). Female students who demonstrate a high self-confidence in math and science ability are more likely to choose engineering as a major than female students with lower self-confidence (Sax, 1992; Oakes, 1990). Women who have high self-efficacy and self-esteem are more likely to overcome negative classroom bias and attain higher levels of academic and professional achievement (Tidball et al., 1999).

Levels of self-efficacy and locus of control are predictors of academic achievement and persistence for females in engineering sciences (Sax, 1992; Seymour, 1995). In a study by Felder et al. (1994) both self-efficacy and locus of control had a direct impact on course achievement. This study examined gender differences between female and male attitudes toward themselves, their education, and their academic achievement in an introductory chemical engineering course. Male participants attributed poor performance in the course to a lack of hard work or unfair treatment practices. Female participants blamed their poor performance in the course on their lack of ability.

Self-efficacy in math and science ability is highly related to majoring and persisting in the field of engineering (Hanson, 1996; Oakes, 1990). Women tend to view their grades as the primary indicator of their academic success and overall college experience. Female students tend to attribute their failures, especially mathematical failure, to a personal lack of ability. A belief in personal failure often causes females to drop out of an engineering program even if they can do the work (AAUW, 1992).

Individual self-efficacy and self-esteem substantially contribute to career related choices (Sax, 1992; Seymour & Hewitt, 1997). Female students who have high levels of self-esteem tend

to major in the core sciences, including engineering, and aspire to nontraditional careers (Tidball et al, 1999). High self-esteem can contribute greatly to female academic achievement and persistence in the field of engineering (Huang & Brainard, 2001).

Increased levels of self-confidence and self-efficacy in mathematics increase academic achievement in the fields of science and engineering (Huang & Brainard, 2001). Research demonstrates that women's self-esteem can be greatly increased through leadership experience, which is very important to learning and academic success (Astin, 1993; Pascarella & Terenzini, 1991).

Gender bias in math and science classes. In addition to the gender bias in classrooms that was described earlier, government studies have shown that gender differences in education are most evident in the areas of math and science. In 1990, two decades after the mandates of Title IX, researchers reviewed educational practices throughout K-12, in 25 school districts in 21 states (Schmuck & Schmuck, 1992). The results of the review showed Title IX violations in terms of gender segregation in higher level math and science level courses (Schmuck & Schmuck, 1992).

Classroom instructors foster traditional societal roles by providing more encouragement to male students to participate in mathematics, science classes, and activities since these fields have traditionally been considered male oriented (Seymour & Hewitt, 1997). Conversely, the learning environment encountered by female students includes less experimentation and exploration. Female students encounter fewer challenges and fewer opportunities for hands-on experience with equipment, technology, and scientific experimentation (Hanson, 1996; Etzkowitz et al., 2000). Due to a lack of exposure to structured and prescribed scientific

experiences, self-motivation and scientific exploration are often not encouraged and are unfamiliar for females (Kahle, 1996).

Research observations of math and science classroom interaction found several gender differences. Eccles (1992) observed the mathematics classrooms of junior high and middle school students over a 10 year period. Observations showed that male students got more attention from instructors, especially in the form of criticism. The study also found that interaction between instructors and students was usually initiated by the students. Male students were much more likely to initiate the interaction in the classroom than their female classmates. Often, specific students in math classes were targeted for attention and these students tended to be male. Other research shows that students who were targeted for attention were more often participants in math and science related activities such as experiments, science fairs and projects, and science related field trips (Eccles, 1992; Kahle, 1990; Sadker & Sadker, 1994).

Hanson (1996) studied women in science through collecting data on gender differences in school resources. Her research describes different ways in which education can be affected by gender and how these differences can affect achievement in science. Hanson (1996) examined male and female characteristics, educational achievement, and scientific tendencies from grade 7 through the early adult years. The research used longitudinal data sets from a large, representative, national sample provided by the National Center for Education Statistics. The study used a combination of grades, test scores, and interviews of students as well as teachers and administrators (Hanson, 1996).

Results of the study showed gender differences in terms of participation in math and science activities. The male students in the study were more likely to have interacted with a scientist, been a science club member, conducted a science experiment, and used more

technological equipment than the female students. Hanson (1996) found that females who had similar participation in math and science activities are more likely to pursue advanced scientific study.

The findings of Hanson (1996) are consistent with those found by Eccles (1992) where the results showed that an increase in hands-on activities that allowed for problem solving led to increases in participation and achievement in math for female and minority students (Eccles, 1992). These and other studies demonstrate that active learning and learning groups can provide motivation for female students to study math and science. However, as demonstrated in the literature, many classrooms do not provide an equal opportunity for female students (Kahle, 1996; NSF, 1998; Oakes, 1990).

Math and science achievement and course taking. Due to lack of encouragement in the home, classroom, and peer groups, females tend not to pursue higher levels of mathematics and science courses (Eccles & Jacobs, 1986; Levin & Wyckoff, 1994; Oakes, 1990). As a result, many women who graduate from high school tend to be less well prepared in math and science courses than males. As a consequence, they are not enrolled in collegiate math, science, engineering, or other technical courses with the same frequency as male students (AAUW, 1992; Mickelson & Smith, 1995).

A lack of female students preparing for the field of engineering can be noted at different educational levels (Hanson, 1996). High school preparation for a future engineering student often includes taking several upper level math and science courses. Although more female students are taking upper level science and math courses in high school than in the past, female students tend to drop out of the science and math programs in their senior year of high school. Other females

decide to drop out of science or math programs prior to completing the first year of college (Oakes, 1990).

Male and female students who are interested in pursuing science and engineering majors in college were similarly prepared in both math and science (NSF, 1998). Data from an NSF study (1996) are consistent with other results and indicate that first year college males and females who enrolled in math and science majors had taken similar numbers of math and science courses. Research demonstrates that the number of math and sciences courses taken strongly influences the achievement of undergraduate students who major in science and engineering (NSF, 1998).

Studies often attribute a discrepancy in female achievement and attrition in science and math to different course taking behavior between males and females (Eccles, 1992; Hanson, 1996; NSF, 1998). Discrepancies in science and math achievement scores may be attributable to differences in the type of courses taken rather than the number of courses. Female students are more likely to take biology and courses in the social sciences than courses in computer science or the physical sciences (Fisler, Young, & Hein, 2000; Hanson, 1996; NSF, 1998).

Eccles (1992) explains that the gender differences in the types of math courses taken in schools are seen mostly in 8th and 9th grade levels. It is at this point that male students begin to outnumber the female students enrolled in algebra courses which lead to advanced mathematical study throughout high school. Another difference is noted during the junior and senior levels in high school when many females tend not to enroll in calculus courses (Hanson, 1996). The results of a national mathematics assessment conducted by the National Center for Education Statistics [NCES] (1997) showed that there is an increasing similarity in the *number* of high school math courses taken by male and female students. Differences in math courses taken occur

in the subjects of trigonometry and calculus where female students do not enroll in the courses with the same frequency as their male peers (NSF, 1998).

Students who demonstrate high levels of mathematical and scientific ability in high school show high success rates in college engineering programs (Astin, 1993; Oakes, 1990). Research has examined the differences in math and science ability and achievement between female and male students (Oakes, 1990). The results showed a strong, positive correlation between mathematical and science ability and student success in the pursuit of science and engineering programs (NSF, 1998; Oakes, 1990).

Ability and achievement were analyzed for differences in course taking and achievement levels between the genders (Oakes, 1990; NSF, 1998). A 1997 study completed by the NCES examined mathematics and science achievement levels of pre-college students and the changes in achievement over time. The researchers administered periodic assessments to students at the 4th, 8th, and 12th grade levels to determine basic, proficiency, and advanced levels of achievement (NCES, 1997a, 1997b).

When looking at levels of achievement, the results of the NCES (1997a) study showed that the gap between male and female math achievement is narrowing. Only at the 4th grade level was there a statistically significant difference in basic math scores with males out scoring the female students. Assessment test scores showed no statistically significant difference between males and females at the 8th and 12th grade levels (NCES, 1997a). However, assessment results showed that there were statistically significant differences in achievement levels at the proficiency and advanced levels. At both of these levels, males scored higher than females (NCES, 1997a).

The science assessment in the NCES (1997b) study measured science achievement in a variety of areas. These included a measure of achievement in knowledge of facts, concepts, analytic reasoning, experimental investigation, observations, use of materials and equipment, and ability to evaluate and communicate knowledge (NCES, 1997b). The results showed a statistically significant difference at the 12th grade level. The assessment showed that the female students scored lower on the assessment in terms of science achievement. The assessment also showed that female students tend not to take the same number of advanced science courses as male students (NSF, 1999). These results are congruent with Hanson (1996), who notes that females tend to be far outnumbered by their male peers in physics courses (Hanson, 1996).

Female students who take the same math and science courses as male students in high school tend to perform equally as well in these courses (Hanson, 1996; NSF, 1998). These female students are equally prepared and qualified for admission into highly technical programs in college or to pursue scientific occupations (AAUW, 1992; Hanson, 1996; NSF, 1998). Nevertheless, these same female students tend not to pursue science and engineering programs, or they tend to drop out of those, to have more negative attitudes toward the scientific and engineering fields, and to score lower on standardized measures of math and science ability (NSF, 1998; Oakes, 1990).

Relationship between Cognitive and Non-Cognitive Variables and Academic Success

Academic achievement and student ability to succeed have been defined in many ways. Prominent educators include intellectual or cognitive ability, non-cognitive student development, and persistence toward degree attainment in these definitions (Astin, 1993; Pascarella & Terenzini, 1991; Tinto, 1993).

Academic success is achieved intellectually through curriculum and classroom instruction. The student develops intellectually through cognitive learning and demonstrates academic success through traditional measures such as grades (Astin, 1993). Traditional cognitive measures such as standardized tests and high school GPA tend to predict the academic success of a traditional engineering student. High standardized test scores and high pre-collegiate GPAs are strongly related to academic success in college engineering programs for traditional (White male) engineering students, but not for those who are female or from racial or ethnic minority groups (NSF, 1998; Oakes, 1990).

Persistence to graduation is another way of defining academic success (Astin, 1993). Students who drop out of college and do not graduate are not considered as academically successful as those who graduate (Tinto, 1993). While persistence can be viewed as an intellectual measure, much of the research had focused on the psychological measures that determine a student's persistence (Astin, 1993; Pascarella & Terenzini, 1991; Tinto, 1993).

While academic achievement can be a strong cognitive predictor of success in an engineering program, non-cognitive factors also appear to affect student success (Astin, 1993; Oakes, 1990; Sax, 1992; Solomon, 1985). Efforts have been made by researchers to understand better how certain non-cognitive factors affect how a student achieves academic success, measured in terms of both grades and graduating (Astin, 1993; Pascarella & Terenzini, 1991; Tinto, 1993). Non-cognitive or affective learning occurs through experiences in and outside of the classroom. Success is determined by the development of personal affective skills acquired by the student and the resulting changes in behavior (Astin, 1993; Pascarella & Terenzini, 1991; Tinto, 1993).

Non-cognitive variables contribute to learning and the development of personal characteristics that can help students achieve in the classroom. These characteristics include students' personal values, interpersonal interaction, intercultural values, socially responsible behavior, healthy relationships, and career objectives (Astin, 1993; Tinto, 1993; Tracey & Sedlacek, 1987). Research has identified non-cognitive variables that lead to academic success. These factors include social and academic integration, interaction and experiences with peers and faculty, student demographic characteristics, career and vocational goals, and degree of involvement in the institution (Astin, 1993; Pascarella & Terenzini, 1991; Tinto, 1993).

Gender differences encountered in education by the female student may lead to the development of a set of characteristics which can contribute to academic success (Ancis & Sedlacek, 1997). Certain cognitive and non-cognitive variables relevant to the academic achievement of female students in science and engineering majors have been identified by researchers. These include previous societal or environmental experiences in and out of the classroom (Hall & Sandler, 1982; Levin & Wyckoff, 1994; Sadker & Sadker, 1994; Sax, 1992); perceiving an intrinsic value and interest in choosing and pursuing a scientific career (Astin & Sax, 1996; Jacobs et al., 1998); peer support (Hanson, 1996; Jacobs et al., 1998; Sax, 1992); family support (Astin, 1993; Hanson, 1996; Sax, 1992); influential mentors including teachers and advisors (Blaisdell, 1995; Holland & Eisenhart, 1992; Levin & Wyckoff, 1994, 1995); self-esteem (McIlwee & Robinson, 1992; Seymour & Hewitt, 1997); self-efficacy and locus of control, especially in mathematical ability (Eccles, 1992; Felder et al., 1994; Sax, 1992); and math and science ability (Astin, 1993; Eccles, 1992; Sax, 1992).

Related Theories

Tinto. In his research, Tinto (1993) used student persistence toward obtaining a degree as a measure of success. He proposed a theory of retention that demonstrates a connection between a student's integration in campus activities and persistence. Tinto's theory (1993) explains that integration is the degree to which the student shares the values and norms of the college faculty and collegiate peers and follows the requirements for belonging to the institution. Integration occurs in both the academic system and the social system of the institution. The greater the degree of student integration into the institution, the greater the chances are for academic success. Institutional integration leads to retention and the student is viewed as academically successful (Tinto, 1993).

This theory suggests that student behavior is both academic and social. According to Tinto (1993) a student may be able to achieve integration into the academic domain of college but fail adequately to achieve integration into the social side and therefore drop out. Conversely, a student may achieve integration into the social domain of college, but fail to persist due to lack of integration into the academic.

Tinto (1993) theorized that a student's behavior and ultimate integration are a result of the individual characteristics and skills that the student brings to college, including the influence of pre-collegiate characteristics such as personal intentions and goals. He cites such non-cognitive variables as individual characteristics, personal commitment and intention, financial and community obligations, family support, skills, personality, participation in organizations, and educational goals. His research shows how these non-cognitive characteristics can directly impact student achievement and persistence in education and resulting career opportunities. Individual characteristics can change and are often modified through interactions between the

individual student, the institutional structure, and the people in the academic community. Students who have the ability to adapt to the new environment find positive and rewarding interactions that encourage integration into the institutional system.

Integration behavior associated with student academic achievement depends on the perceived comfort level that the student feels in the campus environment. The hypothesis is that if a student is not comfortable on the campus, then involvement and integration with the campus is likely to be minimal. The discomfort felt by students who are members of a minority group in the educational environment may cause the student not continue on to degree completion (Astin, 1993; Tinto; 1993).

Tinto (1993) hypothesized that any student who is a member of a minority group in an educational environment tends to feel isolated and unsupported in educational endeavors which may result in poor academic performance. As a minority group in science and engineering fields of study, women often report the academic climate as hostile and unwelcoming (NSF, 1998; Oakes, 1990). According to Tinto (1993) student academic performance in the first semester of freshman year is crucial to their perception of comfort, integration into the university community, and ultimate academic achievement. The extent to which female students adapt to the field of engineering may depend upon the possession of the characteristics indicative of female success in the field (Etzkowitz et al., 2000).

Astin. Integration is closely related to another area of research that looks at student involvement and its relationship to development and academic success. Results of this research indicate that there is a definite relationship between a student's active participation in the learning process and academic success. This research demonstrates that active participation leads

to academic achievement, increases in motivation, and student persistence (Astin, 1993; Pascarella & Terenzini, 1991).

Astin (1993) explains that involvement is the amount of physical and psychological energy that a student uses during his or her college experience. Although a student's involvement in the college experience is linked to intellectual measures of academic success, the focus of involvement is not what an individual is thinking, but instead what the individual is doing in terms of behavior.

Involvement facilitates student development through learning appropriate behaviors, which in turn leads to academic achievement (Astin, 1993). Examples include the amount of time that a student devotes to studying; the amount of time a student actively participates in institutional activities, and frequent interaction with faculty and peers. If a student is not comfortable on the campus, then involvement with the campus is likely to be minimal. This minimal level of involvement may cause the student not to continue on to degree completion (Astin, 1993).

Sternberg. The Sternberg theory (1985) explains that a relationship exists between traditional experiences and non-cognitive variables. Sternberg hypothesized the existence of three types of intelligence which explain differences in basic abilities that a person may possess (Sternberg, 1985). Componential, contextual, and experiential intelligence are the three types of intelligence explained by the theory.

Componential intelligence is explained as analytic intelligence or the ability of an individual to interpret information in an organized, unchanging context. It explains how an individual internally interprets and defines intelligent meaning and the ability to use the intelligence behaviorally (Sternberg, 1985). Individuals who experience a wholly traditional

societal context are typically associated with the ability to structure intellectual thought. Those who have difficulty in demonstrating their ability in a traditional context often have past experience in a variety of contexts or the context of their traditional experience was unstable. Sedlacek (1993) states that college admission criteria utilize standardized tests, such as the SAT, which provides a measure of a student's ability in traditional contexts or a measure of componential intelligence.

Experiential intelligence refers to the ability of an individual to interpret information in contexts that are dynamic. This type of intelligence is best demonstrated in an individual's ability to respond creatively when confronted with change in the context of an environment (Sternberg, 1985). To be successful, individuals with nontraditional experiences may have to develop and demonstrate these intellectual abilities (Sedlacek, 1993).

The contextual theory of intelligence explains that the societal context defines the behavioral intelligence of an individual. Depending upon the context, an individual will adapt behavior to the present environment, select a different environment, or redesign the environment so that it better fits with the interests, skills, and values of the individual (Sternberg, 1985). The individual's ability to understand the workings of the environment and manipulate the structures to accommodate self better is explained by this type of intelligence. It is critical to the successful development of an individual with a nontraditional background to have the ability to interpret the systematic workings of the environment (Sedlacek, 1993).

Traditional and Non-Traditional Predictors of Academic Success

Traditional predictors of academic success. In higher education, prediction of student academic achievement affects access to an institution, institutional choice, financial aid, and placement in a particular course of study (Burton & Ramist, 2001). Student college grades are

highly correlated with persistence and graduation from an institution, admission to graduate and professional programs, and occupational opportunity (Pascarella & Terenzini, 1991; Tinto, 1993).

Traditional predictors of academic achievement measure student cognitive ability and intellect. These measures utilize high school grade point average (GPA) and the scores of standardized tests such as the Scholastic Aptitude Test (SAT) or the American College Test (ACT) to determine a student's potential to succeed and persistence at a specific institution and within a certain fields of study (Astin, 1993).

Willingham (1985) examined over 30 factors to determine which would best predict college grades. He reported that only six of the factors were significant contributors to predictions of student academic achievement in college. The strongest predictor of college grades was the high school GPA of the student. The study showed that the best indicator of future performance in college was past performance in high school (Willingham, 1985).

Willingham (1985) and Willingham et al. (1990) found that standardized test scores were the second best predictor of college grades. Data in the longitudinal study showed that these test scores predicted future performance almost as well as high school GPA. The standardized tests were found to be valid predictors of first year college grades (Willingham, 1985; Willingham et al., 1990).

A study by Ford and Campos (1977) gathered data for ten years from 1964 to 1974. Their study found that the average correlation of freshmen grades were 0.370 for the verbal SAT and 0.320 for the math SAT. The study also demonstrated that this correlation was accurate in the earlier years of the study as well as in the later years of the study.

A combination of high school GPA and standardized test scores provides a better prediction of college ability than either of the factors used alone (Mouw & Khanna, 1993; Willingham, 1985; Willingham et al., 1990). Studies demonstrate a correlation between first year college GPA and the combination of SAT and high school GPA (Ford & Campos, 1977; Ramist, Lewis, & McCamley-Jenkins, 1994). Researchers use the college first year GPA as a measure of success (Ancis & Sedlacek, 1997; Burton & Ramist, 2001; Ramist et al., 1994). The first year college GPA is most often used in the research on student success due to several factors, including the availability of this measure to researchers, comparable grading standards in the first year courses, and the similarity in required first year courses (Burton & Ramist, 2001).

A correlation has been noted between first year academic performance, a student's adjustment to college, and future academic success (Kobrin & Milewski, 2002). First year grades may be "the single most revealing indicator of successful adjustment to the intellectual demands of a particular college's course of study" (Pascarella & Terenzini, 1991, p. 388). Researchers found that high school grades and standardized test scores were related to first year college grades and were useful in predicting student academic achievement in relation to admission and placement decisions (Mouw & Khanna, 1993; Willingham, 1985).

Research conducted by Ramist et al. (1994) examined students in 11 different colleges. The results of this study found a correlation between freshmen grades and the combination of SAT score and high school GPA to be 0.420.

A report by the National Research Council of the National Academy of Sciences explains that SAT scores can be used accurately to predict performance for students independent of race or gender. The report also states that the scores are more accurate predictors of academic success

for White males who tend to score higher on the tests than racial minorities or females of any race (Fleming & Garcia, 1998).

The combination of high school grades and standardized test scores has been used to evaluate traditional and non-traditional applicants for admission into institutions of higher education and specific programs within the institutions (Astin, 1993; Tracey & Sedlacek, 1984). Many public institutions publish a formula that is used where certain combinations of high school grades and standardized test scores guarantees admission (Burton & Ramist, 2001).

Problems associated with predicting academic success using traditional measures.

Research has determined specific problems associated with reliance on traditional measures of cognitive ability as accurate predictors of academic success. High school grades used as predictors of college grades cover a broad range of both academic and non-academic skills but are limited in terms of reliability when making comparisons between students. Standardized test scores used in admission criteria are reliable when used to compare student aptitude but provide limited view of academic knowledge and little or no measure of nonacademic skills (Burton & Ramist, 2001; Koblin & Milewski, 2002).

Researchers have demonstrated another problem in the limited ability of traditional predictors to offer a high correlation between past success and future persistence in college (Burton & Ramist, 2001; Levin & Wyckoff, 1994; Tracey & Sedlacek, 1984). High school GPA indicates past achievement in specific subjects and the SAT was designed to predict the grades of freshmen students and not academic achievement beyond the freshmen year (Sedlacek & Adams-Gaston, 1989; Stern & Briggs, 2001; Willingham, 1985).

Astin (1993) compared high school GPA with college GPA of students. The study found that grades decline once the student reaches college. Results show that half of the participants in

the study received lower grades in college than in high school. Further comparison in the study showed that one in three students had the same grades in college as in high school, while only one in five students saw an improvement in college GPA over high school (Astin, 1993).

Longitudinal studies have examined the predictive ability of the SAT and high school GPA and determined that the effectiveness of these measures decreases over time. Long term measures of academic success such as cumulative GPA, graduation, and post college income level are even more difficult to predict than freshman GPA. These studies indicate the significant contribution of non-cognitive variables as predictors of the academic achievement of students over time as well as first semester freshmen GPA (Burton & Ramist, 2001; Sedlacek, 1987).

A problem often cited by educators is that the traditional measures provide an assessment that is a fairly accurate predictor of college GPA only for students who are from majority groups (Astin, 1993; Tinto, 1993; Tracey & Sedlacek, 1984). College admission programs and policy reflect many years and a significant amount of experience of evaluating student applicants from a traditionally White male population. Students from minority population groups with non-traditional backgrounds and experience present a greater challenge to admission personnel who must determine which students are most likely to succeed within a particular college and degree program. Admission officers are less familiar with the differential features of non-traditional applicant credentials and inexperienced with student characteristics that can identify and predict student success in college (Sedlacek, 1993; Tinto, 1993).

Earlier research conducted by Linn and Werts (1971) showed that the reported results of studies on predictive measures can be misleading if important measures used in admission decisions are omitted from the study of predictors. Research that includes a wider range of

predictors other than those used in admission criteria at a particular institution might provide improved admission procedures (Burton & Ramist, 2001).

Willingham (1985) and Willingham et al. (1990) determined that additional factors contributed to a student's ability to achieve in college. In his study he found that a student's behavior outside the classroom and other personal characteristics contributed to accurate predictions of college performance. Willingham cited several non-cognitive variables that increased accurate predictions including "a commitment to success in one or more areas," self-knowledge and ability to communicate this insight to others, and educational resources.

Burton & Ramist (2001) reviewed all of the current research on predictive ability of high school grades and standardized test scores from the SAT. This review revealed that nonacademic factors contribute to student academic achievement. These factors include non-cognitive variables such as motivation, individual interests, extra curricular activities and accomplishments. Their study concluded that although the high school GPA and SAT scores consistently made predictions of college student ability that were substantially accurate, supplementing these traditional measures with measures of non-cognitive predictors would further improve the validity of admission decisions.

Predicting college freshmen GPA using a combination of standardized test scores and high school GPA is not as accurate for students who are members of a minority group as for majority students (Burton & Ramist, 2001; Tracey & Sedlacek, 1984; Willingham, 1985). Research results indicate that the predictive ability of the SAT scores and high school GPA for college success of minority students is a bit more complicated. Traditional predictors of college achievement have limited validity when used to predict academic potential of non-traditional students (Burton & Ramist, 2001; Camara & Echternacht, 2000).

A study by Ramist et al. (1994) included a comprehensive look at Blacks in 11 predominantly White colleges. The study showed that although the student SAT scores were similar the predictive value for academic success was less for Black students than for White students. This study found that the average correlation for Black students' grades was 9% while the White students' correlation was 17.6% (Ramist et al., 1994).

Arguments against testing practices include evidence of bias against minority populations and students from low socioeconomic backgrounds who score lower on the tests, and as a result may be deprived of educational as well as occupational opportunity (Burton & Ramist, 2001; Gurin, 1999). Critics argue that the assessment provided by the standardized tests is culturally and educationally inappropriate for females and students from racial and ethnic minority groups (Burton & Ramist, 2001; Fleming & Garcia, 1998).

Individual performance on tests can be influenced by prevailing gender or racial factors if students are aware of the climate (Tidball et al., 1999). Significant differences were found in test scores between female and male students on assessments of academic performance and ability when they perceived that they were being evaluated in a gender related context (Steele, 1997). Research conducted by Steele (1997) showed that female students performed below males when they perceive that their gender is known during testing. His study explains that students who can be stereotyped according to race or gender achieve differently when they perceive or experience specific behaviors or attitudes (Steele, 1997).

Traditional cognitive measures may be better predictors of the academic ability of male students than female students (Ancis & Sedlacek, 1997). Expert reports and validity studies show that the SAT predicts college success differently for males than for females (Burton & Ramist, 2001; Willingham, 1985; Willingham et al., 1990). The SAT under predicts academic

performance for females in their first year of college and over predicts the achievement of male students (Burton & Ramist, 2001; Willingham, 1985).

Non traditional predictors of academic success. Research on college academic success demonstrates that the intellectual predictors of student ability account for just one part of academic performance (Astin, 1993; Mouw & Khanna, 1993; Pascarella & Terenzini, 1991; Tinto, 1993). Pre-college academic ability cannot totally account for college academic success. Non-intellectual factors or non-cognitive variables are examined in these studies as additional predictors of college success.

These variables include self concept or self esteem, experiences with faculty, family support, previous academic achievement, student demographics, and type of institution. Research suggests that these non-cognitive variables have statistical relationships to predictions of academic achievement similar to the relationships found with the traditional cognitive variables (Ancis & Sedlacek, 1997; Larose & Roy, 1995; Levin & Wycoff, 1994, 1995; Mouw & Khanna, 1993; Tracey & Sedlacek, 1984).

Mouw and Khanna (1993) concluded that factors other than pre-college intellectual ability determine college academic success. The research was conducted to determine the effectiveness of using the SAT score and high school GPA in predicting college academic success. Two groups of students in a mid-western university were examined during their freshmen year. The first group included those students who were predicted to be academically successful based on their SAT score and high school GPA.

The research used a second group of participants who were students not expected to succeed because of low SAT scores and poor high school grades. Results showed that there was a correlation between pre-college ability and college academic success. However, individual

student characteristics of effort and use of basic academic skills are also crucial factors. This study also illustrates that students' non-cognitive characteristics and high school extracurricular activities were significantly related to their first year grades (Mouw & Khanna, 1993).

The Test of Reaction and Adaptation in College (TRAC) is a newer instrument designed to measure a student's non-cognitive tendencies (Larose & Roy, 1995). The instrument was designed to measure non-cognitive variables such as personal characteristics, beliefs, behavior, and emotional responses as predictors of academic achievement. The instrument is a questionnaire containing 50 items that are answered on a 7-point Likert-type scale. Nine variables on the questionnaire are Fear of Failure; Examination Anxiety; Examination Preparation; Quality of Attention; Assistance from Peers; Seeking Help from Teachers; Giving Priority to College Studies; Belief in Effective Work Methods; and Belief in Easiness (Larose & Roy, 1995).

A study conducted by Larose and Roy (1995) examined the validity of TRAC as a predictor of student success in college. The results present a measure of students' personal characteristics that are likely to affect their adjustment to college and academic achievement. This study demonstrated that TRAC results offer better predictions of achievement in college than high school grades or standardized test scores and those traditional pre-college measures alone do not predict academic success in all instances (Larose & Roy, 1995).

Predicting academic success and persistence in engineering. Declines in enrollment and attrition in colleges of engineering for both male and female students is a major source of concern for institutions, students, parents, and funding agencies (Moller-Wong & Eide, 1997). Student attrition in engineering colleges in the freshman and sophomore years has resulted in only a 44% graduation rate (Astin, 1993; Reichert & Absher, 1997). A variety of research has

been conducted in an attempt to understand student academic achievement and persistence in general and within specific major fields of study. Findings of this research identify both cognitive and non-cognitive predictors of academic persistence. (Astin, 1993; Felder et al., 1994; Tinto, 1993).

The high attrition rate of engineering students was observed by Astin (1993) in a longitudinal study designed to assess student interest and achievement in certain majors and careers. The study included 217 higher education institutions throughout the U.S. and involved 25,000 participants. The study used data collected from a survey questionnaire issued in 1985 and additional data from a 1990 follow-up survey. The study demonstrated that student interest in engineering begins to decrease between freshmen and sophomore years.

Astin (1993) attributed some of the high attrition and waning interest in engineering programs found in his study to the grading methods used by engineering instructors. The researcher observed that the instructors tended to curve the grades of the students. This method of grading has a tendency to place students in an average category. Students graded as average, who perceive themselves as individuals with high ability, are likely to feel inadequate and experience frustration. These feelings correlate with a student's perception of a positive or negative college experience and can affect persistence in a degree program.

A longitudinal study conducted by Felder et al. (1994) collected data on various academic predictors. Participants in the study were 124 college freshmen at the University of North Carolina who were enrolled in a chemical engineering introductory course. The researchers collected data on various academic predictors including SAT scores, community and family background, attitudes, personality, and freshman year grades in college. These various predictors were then correlated with individual student course performance.

The results of the study showed a positive correlation between a student's academic performance in the engineering course and the cognitive measures of intellect of the SAT scores and college freshman-year grade point average. Various non-cognitive variables were also identified in the study as positive contributors to student achievement and persistence in the engineering course. Community and family background, especially the father's level of education, amount of time the student spent in employment outside of the college, and a student's personality characteristics were non-cognitive variables which positively correlated with student achievement and persistence in the course (Felder et al., 1994).

Males and females have both similar and different characteristic variables that affect a successful pursuit of a science or engineering major (NSF, 1998; Oakes, 1990). For both genders a variety of cognitive and non-cognitive variables affects academic achievement in college engineering programs (Astin, 1993). These variables include high grades and high school GPA, high scores on standardized tests, mathematical and science ability, self-esteem, and family background including educational level (Astin, 1993; Hanson, 1996). Students who are successful in their pursuit of engineering also have a high self-efficacy in mathematical ability, are scientifically oriented, have high career goals and expectations, tend to have a father who is an engineer, and usually report that they enrolled in college because their parents wanted them to enroll (Astin, 1993, Hanson, 1996).

Levin and Wyckoff (1994) addressed attrition rates in engineering programs of study. The objective of their study was to develop models that predicted persistence and success in undergraduate engineering programs. This study also helps identify students who possess characteristics of successful persistence in engineering. The researchers analyzed five intellectual, nine non-intellectual, and five academic performance variables using the

performance of students at the end of their sophomore year of baccalaureate engineering study as the dependent variable. The sample of participants used in the study represented 65% of the population of engineering students who entered a program as freshmen at Penn State University in 1984.

A variety of sources including admission records, the University Freshman Testing Counseling and Advising Program, individual interviews, and student transcripts, and registrar records were used to collect data. Data collected on intellectual variables were high school GPA, SAT scores, and mathematical placement test scores. Non-intellectual variables were gender, attitude toward high school mathematics, physics, and chemistry, anticipated hours of study in college, focus of scientific interests, reason for choosing engineering, certainty of choice, and knowledge of an engineering major (Levin & Wyckoff, 1994).

Results provided insight into relevant student characteristics that predicted success and persistence in the study of engineering for the sample of participants. In the case of pre-enrolled students who have not begun college, the variables that predicted success and persistence at the end of the sophomore year were the intellectual variables of high school GPA, and algebra and chemistry placement scores. The non-intellectual variables that predicted success of the participants were gender, the focus of scientific interests, and the reason for choosing engineering (Levin & Wyckoff, 1994).

Levin and Wyckoff (1994) concluded that the intellectual variables demonstrated a commonly held belief that the best predictor of future performance is past performance and that high academic achievement contributes to a student's decision to persist. Additionally, they stated a need for further research on the complex interaction between persistence and academic

performance to address the characteristics of engineering students who achieve academically but do not persist.

Gender was one of three non-cognitive variables that predicted success. Being male was positively associated with successful persistence in engineering study, while being female was a negative variable. Another significant predictor variable was a student's focus of interest in science programs of study. Students had higher predicted probability of success in engineering programs when their interests were completely focused on scientific study. Finally, the predictive probability was increased if a student's reason for choosing an engineering program of study was intrinsically genuine. Participants who chose engineering because they were interested in mathematics, science, and problem solving were likely to achieve at higher levels than those who chose engineering because of foreseen employment opportunities, monetary, and status rewards (Levin & Wyckoff, 1994).

This study illustrates that it is important to distinguish between two different types of behaviors, successful academic performance and persistence, in engineering programs. The researchers noted some degree of independence between the participants who were academically successful and persisted and those who achieved academically but did not persist. Results show that both ability and interest must interact for successful persistence to result (Levin & Wyckoff, 1994).

Non Cognitive Questionnaire (NCQ)

The Non Cognitive Questionnaire (NCQ) was designed by Tracey and Sedlacek (1984, 1989) to assess non-cognitive or psychosocial variables useful in college admissions decisions. Through factor analysis, the researchers identified and validated eight variables that predict grades and retention of students who are members of minority groups (Tracey & Sedlacek, 1984,

1987, 1989). Ancis and Sedlacek (1997) determined the validity of the NCQ and SAT as predictors of female student academic achievement.

This study focuses on the eight non-cognitive variables identified and validated by Tracey and Sedlacek (1984, 1987, 1989). These variables were further assessed by Ancis and Sedlacek (1997) in their study that determined the validity of the NCQ and SAT as predictors of the college academic achievement of female students. The eight variables are Positive Self-Concept or Confidence, Realistic Self-Appraisal, Understands and Deals with Racism, Prefers Long-Term Goals to Short Term or Immediate Needs, Availability of a Strong Support Person, Successful Leadership Experience, Demonstrated Community Service, and Knowledge Acquired in a Field (Ancis & Sedlacek, 1997).

Positive self-concept or confidence. “Strong self-feeling, strength of character, determination, independence” (Sedlacek, 1993, p. 34) define the non-cognitive variable of positive self-concept or confidence. This variable on the NCQ refers to how a student refers to herself or himself. Students with a positive self-concept feel confident in their ability to do well in academic and non-academic experiences and progress successfully toward graduation. These students will make positive statements about themselves (Sedlacek, 1993).

Students who have a low self-concept make negative statements about their ability to achieve and progress through college. They do not expect to do well in academic or personal experiences and may avoid new challenges. Students without a positive self-concept believe that they will receive marginal grades in comparison to other students who are more capable (Sedlacek, 1993).

Realistic Self-Appraisal. Realistic self-appraisal, especially in relation to academic ability, is another variable identified by Sedlacek (1993). This variable is the ability of a student

to “recognize and accept any self-deficiencies” (Sedlacek, 1993, p. 34). The ability realistically to self-appraise is important for females who may receive negative or confusing feedback from instructors or family members about their academic performance (Ancis & Sedlacek, 1997). Students who realistically self-appraise appreciate and accept the positive feedback or rewards for good performance and the negative feedback or consequences of performance that is poor. These students are able to use the feedback to change their performance (Sedlacek, 1993).

Conversely, students without the ability to self appraise realistically are not able to evaluate their performance accurately. They are especially sensitive to grades received and evaluations of peers to evaluate their own ability. Low realistic self-appraisal does not allow the individual to alter behavior effectively to improve performance (Sedlacek, 1993). Female students who can accurately appraise their own academic ability despite negative or faulty feedback may have an advantage in a gender biased system (Ancis & Sedlacek, 1997).

Understands and deals with racism. In this context, racism is used as a term to identify all cultural biases directed toward a population. Students who understand and deal with racism or similar bias are able to handle a racist system and are neither “submissive to existing wrongs, nor hostile to society” (Sedlacek, 1993, p. 34). Accurate assessment of biased demands and assertive and appropriate response to the demands, are characteristic of students who have a realistic belief about racism and its effect on the educational system. Without the ability to understand and deal with racism, students may be either preoccupied with racism or neglect to see its existence. These students tend to blame others in society for their problems. Their inability to understand and deal with racism leads to inappropriate methods of handling the associated problem and negatively affects their personal and academic development (Sedlacek, 1993).

This scale on the NCQ is intended to measure students' expectations of encountering any type or form of bias, including sexism, and their ability to deal with the issue. Female students must have the ability to overcome the effects of sexism and gender bias in education in addition to the non-cognitive variables relevant to the general population (Ancis & Sedlacek, 1997). The female student who is able to understand and recognize challenges in a gender-biased system is at an advantage in overcoming the negative effects of sexism (Ancis & Sedlacek, 1997).

Prefers long-range goals to short-term or immediate needs. A student's ability to "respond to deferred gratification" (Sedlacek, 1993, p. 34) and make decisions about future goals is referenced in this non-cognitive variable. Students who have this ability are able to set goals and progress toward them without reinforcement. In academic and non-academic areas, this non-cognitive variable enables planning and provides direction. If limited in this ability, students do not work toward specific accomplishment or set goals. Instead, they proceed without a direction or plan toward goals that are undefined or unrealistic (Sedlacek, 1993).

Availability of Strong Support Person. Research demonstrates the importance of role models and mentors to female academic and career success (Ancis & Sedlacek, 1997; Tidball et al., 1989). Having one or more individuals who can provide strong support gives the student at least one individual to turn to for help, support, and encouragement if a crisis situation arises (Sedlacek, 1993). Female students who persist in engineering often report that they received encouragement and support from a significant person (Levin & Wyckoff, 1994). Students who acknowledge that they "received help, support, and encouragement" (Sedlacek, 1993, p. 34) indicate the availability of a strong support person in their lives for help in academic and non-academic matters. Strong support provides students with recourse besides their own ability to solve problems, and they are able to ask for help when needed (Sedlacek, 1993).

Successful leadership experience. It is characteristic of a student with successful leadership experiences to influence others in academic and non-academic situations. Leadership experience can be acquired through opportunities in relevant activities provided by a student's cultural background, community, church, or scholastic curriculum (Sedlacek, 1993). Students with leadership experience take the lead in group activities and are capable and comfortable with mediating and providing direction to others. A significant positive relationship exists between successful leadership experiences, increased self-esteem, and grades for female students (Ancis & Sedlacek, 1997; Pascarella & Terenzini, 1991). Students without this characteristic do not show initiative in a situation, are non-assertive, and are overly cautious (Sedlacek, 1993).

Demonstrated community service. Students who are involved in their community through association with a cultural group are identified by this non-cognitive variable (Sedlacek, 1993). These students have relationships with others in the community and together they have accomplished community goals. Students who do not participate in community activities have not learned to identify or rely on others who are similar to accomplish goals or problem solve. These students have limited participation in activities, experience marginality, and engage in more solitary activities (Sedlacek, 1993). Females who participate in community activities enjoy group participation and acquire and express knowledge outside of an academic setting are more likely to succeed (Ancis & Sedlacek, 1997).

Knowledge acquired in a field. This non-cognitive variable identifies students who have a non-traditional knowledge about an area or field of study other than the view presented within a formal school instruction. Traditional ways of acquiring knowledge may not be as relevant for female students as for males since women traditionally experienced inequity in education and an academic climate of gender bias, especially in the sciences (Sadker & Sadker, 1994; Seymour,

1995). These students have gained their knowledge through a variety of innovative ways including cultural, racial, or gender based views (Sedlacek, 1993).

Students who do not demonstrate evidence of this non-cognitive variable pursue learning in a very traditional way (Sedlacek, 1993). Female students who seek alternative or non-traditional ways of acquiring knowledge are more successful than females who take a traditional approach (Ancis & Sedlacek, 1997).

Use of the NCQ in research. The relationship between the identified eight non-cognitive variables and student academic success of minority groups is examined in six major studies; one of these studies examines the academic success of women. The first study was designed by Tracey and Sedlacek (1984) to determine the reliability, construct validity, and predictive validity of the NCQ for both African American and White students. The NCQ was designed to measure the eight non-cognitive variables indicative of student success. The researchers used the instrument with and against student SAT scores to examine how well the non-cognitive variables predicted success.

Three important results were found in the Tracey and Sedlacek study (1984). The study first demonstrated reliability and construct validity of the NCQ. Second, the NCQ proved to have predictive validity of grades for both African American and White student samples when used alone and in connection with scores on the SAT. The final finding showed that the variables were highly predictive of persistence for the African American students. This study established the importance of relating non-cognitive variables to measures of academic achievement when assessing African American students.

Another study using the NCQ was conducted by Boyer and Sedlacek (1988), who examined non-cognitive predictors of academic success for international students in a

longitudinal study that spanned eight semesters. Participants in the study were from various countries and functioned as a minority group within the larger student body. Boyer and Sedlacek (1988) found the NCQ to be an effective measure of non-cognitive variables that predict the GPA international students. For international students, the non-cognitive variables of self-confidence and the availability of a strong support person consistently predicted the GPA. The results of the study demonstrated that the NCQ had predictive validity for the persistence of international students. Results showed that the NCQ predicted persistence for this group, and that all variables were related to persistence at one point of time or another in the student's academic career. International students who understand racism, can combat its effects, and perform community service had the higher rate of persistence.

The NCQ was used with SAT scores to determine the predictive ability of these instruments as measures of the academic achievement of student athletes in a study conducted by Sedlacek and Adams-Gaston (1989). Male and female freshmen athletes were administered the NCQ at their fall orientation. The results showed that the SAT had no correlation with the grades of freshmen athletes, while the NCQ did predict the first semester GPA. Three non-cognitive variables of self-concept, strong support person, and community involvement were identified as predictors of GPA for freshmen athletes. The researchers concluded that SAT scores should not be used to decide if a freshman athlete should be allowed to compete in the first year. The authors recommended that colleges consider student athletes as non traditional or minority students with their own cultures and problems in relating to the larger institutional system.

A study conducted by Fuertes and Sedlacek (1995) sought to determine if the eight non-cognitive variables measured by the NCQ predicted the grades and retention of Hispanic college students. The research found that the NCQ effectively predicted both the GPA and retention of

Hispanic students. Results of this study show that the ability of the students to identify and deal with racism, a non-cognitive variable measured by the NCQ, was predictive of grades for the first three semesters in college for Hispanic students.

Ting (2000) used the NCQ and the SAT to predict the first year college GPA of Asian American freshmen attending a predominately White university. As a minority group on campus, Asian American students face a variety of challenges, but little information existed to explain the academic performance of students in this group. Studies using traditional, cognitive measures such as the SAT and high school GPA to predict the academic achievement of Asian Americans have shown low validity.

Using a sample of 96 first-year Asian American students at a Southeastern public land grant research university, Ting (2000) examined factors that were related to academic performance and retention of this minority group on the campus. Results of this study showed that the SAT mathematics score along with three non-cognitive variables significantly predicted the first-year GPA of this group of students. The predictive non-cognitive variables for Asian American students were realistic self-appraisal, successful leadership experience, and demonstrated community service (Ting, 2000).

Women experience an educational climate that contains subtle and overt forms of gender bias, which correspond with a decrease in academic and career aspirations (Ancis & Sedlacek, 1997; NSF, 1998). The NCQ was used in a longitudinal study with and against SAT scores by Ancis and Sedlacek (1997) to examine how well the non-cognitive variables predicted female academic achievement. The NCQ was administered over a 10 year period to random samples of female freshmen attending orientation to enter a large, mid-Atlantic university. Cumulative GPA defined academic success in this study at intervals over a period of seven semesters.

Ancis & Sedlacek (1997) reported the reliability and predictive validity of the NCQ as a predictor of female academic achievement. The findings demonstrate that both non-cognitive and academic variables significantly predicted female GPA throughout most of the college experience. Traditional measures of the SAT verbal and mathematical skills scores predicted the academic success of female students in the sample. In addition, for female students in this sample, non-cognitive variables related to predicting grades at all intervals during the seven semesters were demonstrated community service, realistic self-appraisal, and nontraditional knowledge. Additionally, variables identifying successful leadership experience were significantly predictive of grades in the fifth semester, and those identifying the availability of a strong support person emerged as a significant predictor of grades in the seventh semester.

One significant negative relationship between positive self-concept and GPA emerged in the study. Ancis & Sedlacek (1997) attribute this finding to a psychological concept or pattern based on intense, secretive feelings of fraudulence that can occur during high achievement tasks and situations. Individuals who experience this tend to be identified more frequently among high achieving high school students, female college students, and women with strong career orientation (Cromwell, Brown, Sanchez-Hucles, & Adair, 1990). The researchers cautioned that this finding required additional study (Ancis & Sedlacek, 1997).

This study was unique in that it investigated of both traditional and nontraditional predictors of women's academic achievement. The findings support other research efforts that indicate the importance of non-cognitive variables in predicting success, provide additional evidence of the predictive validity of the NCQ, and demonstrate a need for future comprehensive research efforts to understand female achievement in education.

Research has revealed that there are differences in the education experiences of female and male students. Research also demonstrates that there are both cognitive and non-cognitive variables which affect the academic achievement of students. Awareness of non-cognitive variables that affect female students is important to educators who seek to improve academic success and reduce attrition rates among female engineering students.

The literature reveals that both traditional measures of cognitive ability and non-traditional measures of non-cognitive variables can predict the academic achievement of students. The literature suggests that measures of non-cognitive variables may add to the predictive ability of the traditional measures for the academic and persistence of female students. However, little research has been done using the SAT and non-cognitive variables to predict the academic achievement of first year female engineering students. The present study sought to address this gap in the literature.

Chapter Three: Methods

The present study examined the value of the NCQ and the SAT in predicting the academic achievement of first year female engineering students, using the first semester GPA as the dependent variable. The NCQ (Tracey & Sedlacek, 1984) was administered to identify and provide a quantitative measure of non-cognitive variables related to the academic achievement of first-year female engineering students.

This study employed stepwise multiple regressions using the NCQ variable scores and SAT Verbal and Math scores as independent variables. Participants were entering female first-year engineering students. Each student's first semester GPA was used as the dependent variable representing academic achievement. Specifically, the study was designed to explore the following research question: What are the contributions of each NCQ scale score, the SAT Math score, and the SAT Verbal score in explaining the variance in female engineering students' first semester GPAs?

This chapter presents the methods used in the present study. This includes the sample selection process, the instrument employed in the study, and the data collection and analysis procedures used in this study.

Sample Selection

The population from which the sample was drawn included all entering female first-year engineering students at a large Research-Extensive university in the mid-Atlantic region of the United States. I began the sample selection process by contacting the associate dean in the Office of Academic Affairs of the College of Engineering. From this contact I learned the approximate number of entering female engineering students and the best time to administer the questionnaire. The associate dean anticipated that approximately 200 female engineering

students would enter the college during the fall semester and she suggested that the best time to administer the NCQ would be during summer orientation (B. Watford, personal communication, June 25, 2002). In this way the questionnaire could be administered to the female students prior to matriculation, assuring that the NCQ measured pre-college characteristics. Between 80% and 90% of first-year female engineering students attend orientation during the summer preceding their first college semester.

Overall, 92% of entering first-year students in all majors at the institution under study attend summer orientation. These students are randomly assigned to orientation sessions in which their chosen major is advised. The College of Engineering participates in the summer orientation program and advises all entering first-year students who have selected engineering as a major and who have been admitted into the College of Engineering. The associate dean tries to meet personally with all incoming first-year engineering students during orientation.

The NCQ was administered at all orientation sessions advised by the College of Engineering. All female students attending orientation were asked to participate in the study and complete the questionnaire.

Instrument

The instrument used to collect data on non-cognitive variables was the Non-Cognitive Questionnaire or NCQ (Tracey & Sedlacek, 1984). A copy of the NCQ appears in Appendix A, and the message from Sedlacek giving permission for its use appears in Appendix B. The NCQ is designed to predict the academic success of United States college students when used in conjunction with the SAT or other cognitive measures. It is a pencil and paper survey that provides a quantitative assessment of eight non-cognitive variables which are indicative of academic success. Through assessing these eight variables, the NCQ has been shown to correlate

well with the academic success of underrepresented student populations (Tracey & Sedlacek, 1984, 1987).

The NCQ has a total of 29 items. The first six items gather demographic information such as social security number, sex, age, parent's occupation, and race. Then there are 23 items that consist of a combination of two nominal items, three open ended items, and 18 items using a Likert-type scale. Items on the NCQ are designed to assess eight non-cognitive dimensions associated with student academic success. Each of the items is a question which asks participants about attitudes and perceptions prior to attending college. The questions pertain to educational expectations, present goals, educational aspirations, past accomplishments, and involvement in community and leadership activities.

The first non-demographic question is item 7 which asks, "How much education do you expect to get during your lifetime?" There are four possible responses that are each assigned a numeric value. Response options include "College, but less than a bachelor's degree"; "B.A. or equivalent"; "1 or 2 years of graduate or professional study"; "Doctoral degree such as M.D., Ph.D., etc."

This question is followed by item 8 which asks the participant to list three goals that she has for herself. Three lines are provided for open responses.

Item 9 asks what would be the most likely cause if the participant had to leave college before receiving a degree. The participant must choose one of nine possible responses which are assigned a numeric value. Choices include the responses "Absolutely certain that I will obtain a degree"; "To accept a good job"; "To enter military service"; "It would cost more than my family could afford"; "Marriage"; "Disinterest in study"; "Lack of academic ability"; "Insufficient reading or study skills"; "Other".

Item 10 asks the participant: “Please list three things that you are proud of having done.” As in Item 8 above, three lines are provided for response.

Next, items 11 through 28 are 18 Likert-type items which ask questions that pertain to (a) educational expectations regarding college and (b) self-assessment. The participant is asked to indicate the extent to which he or she agrees or disagrees with a specific statement, using the following scale: (1) strongly agree, (2) agree, (3) neutral, (4) disagree, or (5) disagree strongly. Examples of these items are “I get easily discouraged when I try to do something and it doesn’t work”; “I am sometimes looked up to by others”; “If I run into problems in school, I have someone who would listen to me and help me”; “My family has always wanted me to go to college”; and “I want a chance to prove myself academically” (Tracey & Sedlacek, 1984).

The final question on the NCQ is item 29, the third open ended item. This item asks the participant to list any offices held, along with any groups that she belonged to in high school and the community.

Scoring the NCQ. The NCQ is scored by using a scoring key provided by the developers (Tracey & Sedlacek, 1984). A copy of the scoring key can be found in Appendix C. This key is used to score participant responses to every item on the NCQ. I received training in the use of this scoring key from Raymond Ting, Associate Professor of Educational Research and Leadership and Counselor Education at North Carolina State University, who is expert in its use. Individual items are categorized into one of the eight non-cognitive dimensions. Positive Self-Concept or Confidence (I) is scored by items, 7, 9, 10, 23, 20, and 28. Realistic Self-Appraisal (II) is scored by items 9, 12, and 21. Scores from items 11, 18, 22, 26, 27, are used to assess Understands and Deals with Racism (III). Items 8A, 13, and 19 are used to score for Prefers Long-Range Goals to Short-Term or Immediate Needs (IV). A fifth non-cognitive variable is the

Availability of Strong Support (V) and is scored by items 15, 24, and 25. Leadership (VI) is scored using items 14, 17, and 29A. Demonstrated Community Service (VII) is scored by items 16 and 29B. Item 8B and item 29C are used to score Knowledge Acquired in a Field (VIII).

Each item response is assigned a corresponding numerical value. For NCQ questions that have more than one response the mean score is calculated and rounded to the nearest whole number. Scores for each NCQ variable (e.g. “Leadership”) are computed by complex algorithms that are provided in the scoring key. A high score on an NCQ variable indicates a greater strength in that non-cognitive variable. The lowest and highest possible scores for all scales are displayed in Table 2.

I scored all items of every completed questionnaire individually and recorded all participant item scores in a notebook. Every participant received a separate scoring page in the notebook. I reviewed each score a second time to check for any errors or oversights. Then I used the equations from the scales to arrive at a score for each non-cognitive dimension addressed by the NCQ.

To enhance credibility, I sought the assistance of a second expert scorer. This expert is a second-year student in a Higher Education and Student Affairs master’s degree program. First, I reviewed the scoring key provided by the developers of the NCQ and trained the second scorer on the scoring procedure. Then this second expert scored each questionnaire using the same method that I had used. I compared the results of both scoring procedures to ensure that the same score was determined for each participant in all dimensions by both scorers before the data were used in analysis. Where I found differences, I conferred with the other scorer to arrive at a commonly agreed score. Overall, our initial ratings agreed 90% of the time and we were able to come to final agreement on all item scores.

Table 2

Lowest and Highest Possible Scores of the Eight Non-Cognitive Scales Measured by the Non Cognitive Questionnaire

Scale	Possible Scale Scores	
	Lowest	Highest
(I) Positive Self-Concept	7	27
(II) Realistic Self-Appraisal	4	14
(III) Understands and Deals with Racism	5	25
(IV) Prefers Long-Range Goals	3	13
(V) Availability of a Strong Support Person	3	15
(VI) Leadership Experience	3	13
(VII) Demonstrated Community Service	2	8
(VIII) Knowledge Acquired in a Field	2	8

Reliability and Validity

Reliability. Reliability of an instrument can be determined by the consistency of items, the stability in responses over time, and the consistency in the administration of the instrument and its scoring (Gall, Borg, & Gall, 1996). Reliability of the NCQ has been measured using test-retest evaluative methods.

Tracey and Sedlacek (1984) used test-retest methodology in a study of two random sample populations to test the reliability of the NCQ. This study determined the reliability of the NCQ as a predictor of student academic success and persistence in college when used in conjunction with SAT scores. The GPA and persistence of the participants were used as the dependent variables in the study, and each was examined at the end of the first and third college semester.

In this study the NCQ was administered to random samples of entering freshmen at a large eastern state university in 1979 and 1980. Only those students who completed the NCQ and whose SAT scores were available were selected as participants in the study. The number of participants chosen for the 1979 sample totaled 1529 (1339 White and 190 Black). The total number of participants in the 1980 sample was 444 (355 White and 89 Black).

As a result of this study, Tracey and Sedlacek reported test-retest reliabilities of .70 to .94 for each of the 18 Likert-type items and the 2 nominal questions. The test-retest reliability median was reported to be .85. Additionally, inter-rater reliabilities of .83 to 1.00 were reported for the 3 open ended items. These item variables were rated by three judges and the range was reported with academic relatedness of goals ($r = .83$), degree of difficulty of the listed accomplishments ($r = .88$), long-range goals ($r = .89$), leadership ($r = .89$), community

involvement ($r = .94$), academic relatedness of activities ($r = .98$), and overall number of outside activities ($r = 1.00$), (Tracey & Sedlacek, 1984).

Validity. The validity of an instrument refers to whether it actually measures what it is intended to measure (Gall et al., 1996). Validity of the NCQ was determined in two ways. The first analysis examined the construct validity of the NCQ, and the second set examined predictive validity.

Examination of construct validity used principle components factor analysis to determine if the NCQ items were measuring the proposed non-cognitive variables. Then separate factor analyses were performed to test for similar results. The results of the factor analysis showed that the NCQ contained similar structures for each racial group and the items were congruent with the non-cognitive variables being measured.

The developers conducted a second analysis to establish the NCQ as a valid predictor of academic success for college students. Two measures of academic success, college GPA and continued college enrollment were used in the study. The cumulative college GPA of the participants was examined during the first and third semesters of study. Using the GPA as the dependent variable, stepwise multiple regressions were used to determine the predictive validity of the NCQ and SAT scores. The NCQ was found to have good predictive validity for GPA of all participants in the study. The NCQ was found to be a valid predictor of college GPA when used alone or in conjunction with SAT scores (Tracey & Sedlacek, 1984).

The same study used stepwise discriminant analysis to determine the predictive validity of the NCQ along with SAT scores in regard to student persistence. The NCQ was found to be highly predictive of college persistence for minority students only. The SAT scores were found not to be predictive of persistence for any student population (Tracey & Sedlacek, 1984).

Data Collection Procedures

Prior to the start of this study, I submitted a Request for Exemption of Research Involving Human Subjects to the Institutional Review Board Office of Research Compliance. The reviewer concurred that there was minimal risk involved to the participants in this study and the exemption request was granted (See Appendix D). Once approval was granted, the sample was selected and the data collection began.

The associate dean of the College of Engineering at the institution under study administered the questionnaire during freshmen orientation. All entering female engineering students attending the academic engineering orientation sessions were asked to participate.

During the orientation session, the female students were handed a packet, asked to read the packet instructions, and complete the questionnaire. The packet contained an information sheet explaining the purpose of the study, instructions for participating in the study, two copies of an informed consent form, and the NCQ (See Appendix E). Packet information instructed the participants to sign both copies of the informed consent form and keep one copy for themselves prior to completing the questionnaire. Once the questionnaire was completed, the participants were instructed to place the questionnaire into a collection envelope. The completed questionnaires were collected by the associate dean and given to me at the end of freshmen orientation.

After receiving the completed questionnaires, I verified that the informed consent form had been signed, that the social security number had been provided by the participant, and that the participant had responded to all items on the NCQ. Any questionnaires that were incomplete or completed by a male participant were discarded and not included in the sample. I counted the usable questionnaires and placed them in a secure file box.

Next, I obtained a list of the names and social security numbers of all entering female freshmen engineering students from the associate dean of the College of Engineering. Based on the social security numbers provided, I compiled a list of those female students who submitted completed questionnaires. This list contained the names and social security numbers of the female students that I could identify as participants in this study.

To ensure that I had obtained a representative sample I counted the number of completed questionnaires and compared this with the number of entering female engineering students. Then I merged the list of social security numbers with the demographic information from the university's student census file. I used chi-square analysis to compare the participant group to eligible non-participants on the variables of race/ethnicity and age, and I used an independent samples *t*-test to compare the participants and eligibility of non-participants by SAT total score.

I scored each questionnaire following the scoring key provided by the developers of the NCQ (Tracey & Sedlacek, 1984). For each participant I entered the scale score for each NCQ variable into a spreadsheet using the Statistical Package for the Social Sciences (SPSS) Version 11.0. I merged my spreadsheet of NCQ scale scores with SAT math and verbal scores from the university's student census files, discarding any cases for which SAT scores were not available.

Data Analysis Procedures

Once the data entry was complete for each participant, I saved the data file and stored it for future analysis. After fall semester grades were available I merged the data file with data from the university's grade file and computed grades for each participant, discarding any cases where participants failed to complete the fall semester.

To answer my research question I performed a step-wise regression analysis. Multiple regression analyses provide a prediction equation, indicate whether or not the equation is

significant, and whether the direction of the relationship is positive or negative (Cronk, 1999). Additionally, step-wise regression allowed me to consider the significance level of each independent variable. I used NCQ scale scores, and SAT Verbal and Math scores as independent variables and Fall GPA as the dependent variable.

Previous NCQ research has also used stepwise regression analysis. In almost all previous NCQ studies, the researchers have entered the NCQ scale scores into the regression analysis as first block variables, forcing the statistical analysis package to analyze their predictive ability before considering whether the SAT scores or other cognitive variables significantly explain the remainder of the variation in the dependent variable. I chose not to follow this model. Instead I allowed the NCQ scale scores and the SAT scores to compete equally within the regression analysis, so that their relative predictive value would be determined by the regression procedure itself. The importance of this difference in method is discussed in the final chapter.

In conclusion, the purpose of this study was to examine the value of the NCQ and the SAT in predicting the academic achievement of first year female engineering students, using the first semester GPA as the dependent variable. The methods described in this section allowed me to answer the research question posed in the study.

Chapter Four: Results

This chapter summarizes the results of this study. The purpose of the study is reviewed first. Next, a description of the sample is presented in the following section. Then the demographic characteristics of participants and non-participants are examined. Finally, the chapter concludes with the results of the data analysis, which are arranged to answer the research question posed in this study.

The purpose of this study was to determine the value of the NCQ and SAT in predicting the academic achievement of first year female engineering students. The participants' first semester GPA was used as the dependent variable. Previous research documents the value of using non-cognitive variables in addition to traditional measures of cognitive ability to predict academic success for certain groups. This study extends that literature by focusing on the variables of the NCQ that may be used as non-cognitive predictors for female engineering students.

Sample Description

The sample used in this study was comprised of 100 first year female engineering students enrolled in the fall semester of 2002. Several steps were taken to obtain the sample. First, the NCQ was distributed at all orientation sessions to all first year female engineering students during the summer prior to their first year of college. Only those female students who completed the questionnaire by answering all questions on the survey were chosen as participants. One hundred four students completed the NCQ. Four of the participants were removed from the sample after university records revealed that these students had no SAT scores recorded, leaving 100 eligible participants. All 100 participants completed fall semester, so they comprised the final analyzed sample.

Data Analysis

I began the data analysis by merging the list of social security numbers of the participants with the demographic information from the university's census file. I wanted to compare participants to eligible non-participants on the variables of race/ethnicity and SAT scores, to learn whether my sample was representative of the whole.

I used a chi-square test of independence to assess the distribution of race/ethnicity and independent samples *t*-tests to compare SAT Verbal and SAT Math score means between the two groups. To compare participants to eligible non-participants by race/ethnicity, I regrouped the data into White vs. all other race/ethnicity categories. Small cell sizes made other comparisons inappropriate. Table 3 shows the distribution of participants and non-participants in all race/ethnicity categories. Table 4 displays the chi-square analysis race and ethnicity using the two categories of White and all other races or ethnicities. I found that White students were significantly overrepresented in the participant group (chi-square = 5.09, $df = 1$, $p = .02$).

Independent samples *t*-tests found no significant difference in the means of either the SATV ($t = 1.72$, $df = 168$, $p = .09$) or the SATM ($t = -.33$, $df = 168$, $p = .74$) between the participants and non-participants. Two-tailed tests and an alpha of .05 were used for these and all other analyses. The results of these analyses are summarized in Table 5.

I used step-wise regression analysis to examine the predictive value of the eight NCQ scale scores and SATV and SATM scores, with Fall GPA as the dependent variable. Table 6 presents the means and standard deviations for the dependent variable and each of the independent variables.

Table 7 displays the results of the regression analysis. Significant predictors were SATM and SATV. R^2 for Step 1 was .26, meaning that 26% of the variance in GPA was predicted by

Table 3

Number and Percent of Participants and Non-Participants by Race/Ethnicity

	Participants (N=100)	Non-Participants (N=74)
	N (%)	N (%)
White, Non-Hispanic	81 (81)	48 (65)
African American	9 (9)	4 (5)
Asian or Pacific Islander	4 (4)	7 (9)
Foreign	1 (1)	8 (11)
Hispanic or Latino	1 (1)	5 (7)
Unknown	4 (4)	2 (3)
Total	100 (100)	74 (100)

Table 4

Chi-Square Analysis of Distribution of Race/Ethnicity between Participants and Non-Participants

	Participants (N=100)	Non-Participants (N=74)			
Race/Ethnicity	N (%)	N (%)	χ^2	df	p
White/Non-Hispanic	81 (81%)	48 (66%)	6.00	1	.01
All Other Race/Ethnicities	19 (19%)	26 (34%)			

Table 5

T-test Results for SAT Verbal and SAT Math Scores between Participants and Non-Participants

Group	SAT Verbal					SAT Math				
	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	<i>p</i>	<i>M</i>	<i>SD</i>	<i>t</i>	<i>df</i>	<i>p</i>
Participants (<i>N</i> =100)	611	75.4	1.72	168	.09	642	64.5	-.33	168	.74
Non- Participants (<i>N</i> =74)	590	78.4				645	56.2			

Table 6

Means and Standard Deviations of Dependent and Independent Variables

Variable	Mean	Standard Deviation
GPA	2.98	.71
(I) Positive Self-Concept	17.23	2.38
(II) Realistic Self-Appraisal	8.25	1.46
(III) Understands and Deals with Racism	12.77	2.60
(IV) Prefers Long Range Goals	7.09	1.09
(V) Availability of Strong Support Person	7.68	1.12
(VI) Leadership Experience	6.59	1.22
(VII) Demonstrated Community Service	5.61	.94
(VIII) Knowledge Acquired in a Field	4.41	.83
SAT Verbal	61.05	7.53
SAT Math	64.20	6.45

Note. SAT Verbal and SAT Math scores are presented and analyzed using the university's student data base code for these variables, which is one-tenth of the original SAT score.

Table 7

Results of Step-Wise Multiple Regression Predicting Grade Point Average Using SAT Verbal, SAT Math, and Non Cognitive Questionnaire Scale Scores

Variable	<i>B</i>	<i>SE B</i>	β	<i>t</i>	<i>p</i>
Step 1 (Constant)	.03	.51		.05	.96
SATV	0.05	.01	.51	5.80	.00
Step 2 (Constant)	-1.40	.63		-2.21	.03
SATV	0.03	.01	.36	3.92	.00
SATM	0.04	.01	.32	3.46	.00

Note. $R^2 = .26$ for Step1; $\Delta R^2 = .08$ for Step 2.

variance in SATV alone. The addition of SATM at Step 2 raised the R^2 value by .08, meaning that the SATV and SATM together explain 34% of the variance in GPA. All NCQ scale scores were excluded from the regression equation, meaning that they added no significant explanatory value to SATV and SATM for this group.

A predictive equation can be derived from a multiple regression analysis as follows:

$$Y' = B_0 + B_1X_1 + B_2X_2 \dots B_nX_n$$

In this equation Y is the dependent variable, the X s represent the independent variables, and the B 's are derived from the first column in Table 7, and n is the number of independent variables (Cronk, 1999). In my study, GPA is the dependent variable and is the Y in the equation. The independent variable, SATV is X_1 and SATM is X_2 . Based on the results of the regression analysis, B_0 was found to be -1.40, while B_1 and B_2 can be located in the table and are .03 and .04, respectively.

Based on the results of this study, the following prediction equation emerged:

$$\text{GPA} = -1.40 + (.03) (\text{SATV}) + (.04) (\text{SATM})$$

The standard error of the estimate for this Step 2 equation is .63, which means 68% of all GPA values for this group are within +/- .63 from the value of this equation. Readers should note that the SAT scores used in this study are university central code values that are actually one tenth of the absolute SAT score. Since each SAT score ranges from 200 to 800, (or 20 to 80 in the university's central coding system), this means that the SATV score explains up to 2.40 of

the total 4.00 GPA (.03 x 80) and the SATM score explains up to 3.20 of the overall 4.00 GPA (.04 x 80). These findings and their implications for future practice and research are discussed in the final chapter of this study.

Chapter Five: Discussion

The purpose of this study was to determine the value of the NCQ and SAT in predicting the academic achievement of first year female engineering students. The participants' first semester GPAs were used as the dependent variable. I analyzed the data using step-wise regression to determine any statistically significant predictive value of the NCQ when used with SAT scores for this population.

This chapter discusses the study's results, limitations, and implications. The first section addresses the research question, reviews the research process, and discusses the major finding. The next section lists possible limitations in the research process and how the results of this study may have been affected by those limitations. Implications for research, future practice, and policy are examined in the final section.

Major Finding

The study was guided by the following research question: what are the contributions of each NCQ scale score, the SAT Math score, and the SAT Verbal score in explaining the variance in female engineering student's first semester GPA? To answer the question I administered the NCQ to 100 first year female engineering students prior to the start of the fall semester. SAT Math and SAT Verbal scores and GPA were derived from the university's central files.

The major finding in this study is that the NCQ did not add to the predictive value of SAT scores in determining the first semester GPA of female engineering students. The cognitive measures of the SAT Math score and the SAT Verbal score significantly predicted the academic achievement of first year female engineering students. The scale scores of the NCQ that measure eight non-cognitive variables showed no significant predictive ability in relation to first semester GPA of these female engineering students.

As Chapter Two demonstrated, previous researchers have documented a positive relationship between traditional measures of cognitive ability, such as the SAT, and the academic success of female engineering students (Astin, 1993). However, findings from other researchers have reported a variety of problems associated with the predictive value of the SAT (Burton & Ramist, 2001). Some have shown that even with high SAT scores many female students enrolled in engineering programs are not academically successful and frequently leave the major (Levin & Wyckoff, 1994).

Another body of literature documents the effect of non-cognitive variables on the academic achievement of female engineering students (Hanson, 1996; Hewitt & Seymour, 1991; Huang & Brainard; 2001; Oakes, 1990; Sax, 1994). The NCQ was designed as a tool to assess eight non-cognitive variables that are related to the academic achievement of students from minority groups. A gap in the literature exists on the value of using both cognitive and non-cognitive variables to predict the academic success of women who are the minority student population in engineering programs. This study was designed to add to this body of literature.

This study was undertaken with the hope of identifying specific non-cognitive variables that could be added to the admission equation to benefit women interested in pursuing an engineering major or career. I was surprised to find that only the traditional cognitive measures of SATV and SATM were significantly predictive of GPA for this population. Based on the results of Ancis and Sedlacek (1997) who studied a general population of women students, I expected to find at least one NCQ scale score to have significant predictive value for my sample. Because the results of this study are at odds with a large body of previous NCQ research the most important implications of this study relate to understanding this difference.

Dependent Variable. There are several possible explanations for the unexpected finding in this study. First, previous studies have used a variety of dependent variables and have examined GPA for more than one semester. My study defined academic success as first semester GPA and used this single dependent variable to examine how measures of pre-college non-cognitive and cognitive variables may predict academic achievement.

Ancis and Sedlacek (1997) designed their study using a variety of dependent variables to measure the academic achievement of female students over a seven semester period. Their study reflects data collected over 10 years. The results of their study determined that the predictive ability of the NCQ scale scores differed by semester. They reported that the NCQ variables Demonstrated Community Service (VII), Realistic Self-Appraisal (II), and Knowledge Acquired in a Field (VIII) emerged as significant predictors of GPA in semesters 1, 3, 5, and 7. In semester 5 an additional non-cognitive variable, Successful Leadership Experience (VI), was significantly predictive of GPA. The researchers caution that the results of their study assume that the academic experience of women did not change over time.

In his study of the academic success of Asian American students, Ting (2000) also used NCQ scale scores and SAT scores as the independent variables, but more than one dependent variable was used in the study. His study examined first and second semester GPA as well as retention in those semesters.

When defining academic success by GPA during fall and spring semesters, the multiple regression analysis in the Ting (2000) study showed that different NCQ scales predicted success in those semesters. Regression analysis explained 26.2% of the variance of fall semester GPA and 31.3% of the variance in the spring. Fall semester GPA was predicted by SATM, Realistic Self-Appraisal (II), and Successful Leadership Experience (VI). SATM, Realistic Self-Appraisal

(II), and Demonstrated Community Service (VII) were the significant predictors of spring semester GPA for the sample of Asian American students.

My study focused on the first semester of freshman year. First year college GPA is most often used in research on student academic success due to the availability of this measure, comparable grading standards in the first year courses, and similarity in required first year courses. (Burton & Ramist, 2000). Researchers have reported that academic success during the first semester of college is highly predictive of future achievement (Astin, 1993; Pascarella & Terenzini, 1991). Furthermore, SAT scores are designed to predict only the first semester GPA (Willingham, 1985) and so this study did not go beyond that semester. It is possible that my study did not find predictive value for the NCQ because unlike previous researchers, I only examined this one dependent variable.

Population. A second possible explanation for the difference between the findings of this study and previous research may be the population of interest. Previous research found that the NCQ adds to the predictive value of SAT scores for female students from the general population at a single institution (Ancis & Sedlacek, 1997). However, predicting female success and persistence in an engineering program is much more difficult than predicting female academic performance in general, and this has led researchers to conclude that studying non-cognitive variables might improve prediction of both academic success and persistence (Levin & Wyckoff, 1994, 1995; Oakes, 1990; Solomon, 1985). While certain non-cognitive variables of the NCQ may have significant relevance for determining the academic success of female students from the general population, the NCQ may not be a good predictive measure for female engineering students. That is, women who choose to major in engineering may be different from other women students in ways that are relevant to this study.

For example, Ancis and Sedlacek reported a positive correlation between Demonstrated Community Service (VII), Knowledge Acquired in a Field (VIII), and the academic success of female students in their sample. In contrast, Sax (1994) reported a negative relationship between student altruism, volunteering, having a wide variety of experiences outside of the field of science, and student academic success in science and engineering. According to Sax (1994) the academically successful female engineering student possesses non-cognitive characteristics that are different from women who are successful in non-scientific fields.

Campus climate. Another explanation for why the major finding of this study did not support previous research using the NCQ may be due to the campus climate of the particular institution where the research was conducted. Any population of students that experiences bias or differences in education may develop a variety of non-cognitive characteristics that allow them to achieve (Tinto, 1993). Sternberg (1985) explains a relationship that exists between traditional or non-traditional experiences and non-cognitive variables. His theory describes the existence of three types of intelligence which explain differences in basic abilities that a person may possess as a result of life experiences. A large body of literature exists on the subject of gender bias and educational differences experienced by female students. Due to gender differences encountered through socialization and education, women learn various ways of obtaining and utilizing knowledge (Belinky et al., 1986).

The NCQ was developed to identify the non-cognitive variables that are associated with academic achievement for students from minority populations who may have experienced bias or discrimination and developed certain characteristics that differ from those in the traditional majority. Previous research has demonstrated that the academic success of students from minority groups who experience inequalities in a college environment can be predicted by the

eight non-cognitive variables measured by the NCQ (Ancis & Sedlacek, 1997; Boyer & Sedlacek, 1988; Fuertes & Sedlacek, 1994; Sedlacek & Adams Gaston, 1989; Ting, 2000; Tracey & Sedlacek, 1984).

Although female engineering students exist as a minority population within their major, and women comprise only 40% of the student body at the institution in this study, they may not perceive discrimination in their program or on campus. Results of recent research conducted at the institution where this present study took place contribute to this conclusion. In fall 2000 an institutional survey on the campus climate was conducted at that university.

The results of this survey revealed that female undergraduates do not perceive themselves as discriminated against at this particular institution (Hutchinson, Hyer, & Collins, 2000).

Hutchinson, Hyer, and Collins (2000) reported that female undergraduate students believe that they are treated the same as their male peers by faculty and staff on campus in terms of fairness. Generally, undergraduate women on this campus report that they encounter similar occurrences of insensitive or offensive comments and materials related to gender as do the male undergraduate students at this institution.

Importantly, women graduate students and faculty at this institution do not share this positive view of the campus climate. The perception of undergraduate women at this institution is that they are not treated unfairly. This may be different from the perception of women, and women engineering students in particular, at other institutions. This difference could explain the contrast between results of this study and the results of previous NCQ research.

Methodology. The most notable explanation for the major finding in this study is the difference in methodology that I used and the method employed by researchers in earlier studies. My methodology differs from virtually all previous studies with the NCQ in the order of entry

for independent variables. Two specific studies, Ancis and Sedlacek (1997) and Ting (2000), serve as examples of these differences.

In research conducted by Ancis and Sedlacek (1997) and Ting (2000), the researchers entered NCQ scale scores *first* in a step-wise procedure before entering the SATV and SATM scores. This is the procedure recommended for use in the professional literature published by Tracey and Sedlacek (1980) which reports that the NCQ is effective in predicting academic achievement. The previous researchers explained that this method allowed them to explore the relationships between the non-cognitive variables first before combining with SAT scores. Tracy and Sedlacek (1980) suggest that this is the most effective method for comparing two different measures.

Tracey and Sedlacek (1980) cite two different bodies of literature that prompted their research. First they discuss the research that shows a significant correlation between traditional measures of cognitive ability followed by other studies that show the value of non-traditional measures of non-cognitive ability that predict student success in college. They created the NCQ as a measure of the non-cognitive variables associated with student success. Their study (1980) was designed to increase the level of understanding of the value of using both cognitive and non cognitive measures that may affect grades and retention. The independent variables in the study are the scores from the SAT and the NCQ scores, and the dependent variable is student GPA, similar to my study.

Their research design (1980) explores this relationship by using a method that they say takes into account the previously established significant relationship between traditional cognitive measures and student academic achievement. Since the relationship is so strong the researchers advise that “cognitive and non-cognitive areas must be studied separately, and only

when we have relatively reliable and valid measures in each area should we combine them in a research study” (Tracey & Sedlacek, p. 2, 1980). Research has determined that both the SAT and the NCQ have proven reliability and validity for predicting academic achievement of students from a variety of populations since Tracey and Sedlacek (1980) first recommended the methodology used in their study.

In contrast to the recommended methodology, I chose *not* to enter the NCQ scale scores as first block variables in my analysis. I wanted to understand the value that NCQ scores would *add* to an admission process that already contains SAT scores. Therefore, I allowed all 10 independent variables to compete equally within the step-wise regression analysis. If NCQ scale scores had better predictive value than SAT scores, they would enter the equation first. If they had less predictive value than SAT scores, but still added significantly to the predictive value of the SAT, then they would enter the regression equation after the SAT scores.

Neither of these results, in fact, occurred. Had I used the method employed in previous research, forcing NCQ scores into the equation ahead of the SAT scores, I would have obscured the actual, practical, and relative value of the two measures for this population. It is my belief, based on the results of this study, that the methodology used in previous NCQ research may exaggerate the value that NCQ scores add to an admission process that already relies on SAT scores. This observation calls for the further discussion among scholars on the whole body of NCQ research.

Limitations and Implications for Research

Each of the discussion points outlined above suggests important areas for new research. For example, future researchers could examine the predictive value of SAT and NCQ scores using different dependent variables for women engineering students. My finding also supports

further research on the ways that female engineering students differ from other women students. The interaction of perceived campus climate and non-cognitive variables should also be examined. Most importantly, previous studies NCQ studies should now be replicated using the two data analysis methodologies and the difference in results should be compared and discussed. In addition, some of the limitations of my study pose suggestions for future research.

Sample size and composition. An additional limitation is also related to the size of the sample. Participation in this study was voluntary. While I took steps to encourage participation, the results may be affected by a difference between those who agreed to participate in the study and those who did not choose to participate. About 50% of first year female engineering students chose to complete the survey. The results of this study may have been different if the participation rate was 100% of the entering female engineering students.

Previous NCQ studies collected data in different ways. One method obtained data from several cohorts over a 10 year period. Ancis and Sedlacek (1997) administered the NCQ at freshmen orientation for a 10 year period and analyzed data from a total sample of 1,930 entering female students. Other studies used a sample drawn from one single entering class of freshmen students. I collected data from one entering class of female engineering students that resulted in a total sample of 100. In comparison, the size of the sample used in my study was similar to previous research that included participants from one cohort of freshmen. For example, Ting (2000) reported a sample size of 96 participants and Sedlacek and Adams-Gaston (1989) had 105 participants in their study.

Results found in this study may also be limited due to the high percentage of White, Non-Hispanic women who participated in the study. The sample consisted mainly of participants who are White, Non-Hispanic and not students from other racial or ethnic groups. The results of this

study should be viewed with caution as to how they pertain to women who are not White. Future research could test this limitation by studying the NCQ and SAT as predictors of academic success among a more racially and ethnically diverse group of female engineering students.

Single institution. The most important limitation of this study is that all of the participants were from a single institution. It is possible that students on this campus were different from students on other campuses in some important way. If this was so, then the results might have been influenced by these differences.

For example, the selective nature of the engineering program at this institution may have contributed to the unexpected findings in this study. At this institution, engineering students face a highly competitive and selective process for admission. Results could be different at an institution whose engineering program is less selective.

As explained above, the undergraduate women at this institution do not generally perceive themselves to be treated unfairly. At other institutions this may not be the case and the results at those institutions could be different from mine. The findings of this study call into question the results of single studies, performed at single institutions that use the NCQ to predict the GPA of students from minority populations.

All previous research that reported on the predictive value of the NCQ and the SAT collected data from samples at single institutions and most were conducted at the same institution (Ancis & Sedlacek, 1997; Boyer & Sedlacek, 1988; Fuertes & Sedlacek, 1995; Sedlacek & Adams-Gaston, 1989; Tracey & Sedlacek, 1984, 1985, 1987). All of these studies were conducted at a large, predominantly White, state university in the Eastern region of the United States. It is possible that previous results reflect the institutional character of this single university, and similar studies at other types of institutions would yield findings that are more

like mine and less like the previous studies. Any single-institution study should be replicated in other settings and applied generally to the broader population. This is true for my study as it is for previous NCQ research, and this fact alone provides a rich field of exploration for future research.

To extend my study to other settings, data could be collected from samples of first year female engineering students entering other public colleges and research oriented universities located in other regions of the United States. Such a study would provide further insight into determining the relative value of the NCQ and SAT as predictors of academic achievement for these populations. Additional research that extends this study to private institutions, including women's colleges, liberal arts colleges, and colleges that are racially or ethnically oriented, would add significantly to the literature on female engineering majors.

Like most previous research comparing the SAT and NCQ as predictors of academic success, my study was only able to explain about one third of the variance in GPA; two thirds remains unexplained. Future researchers may find that this remaining variance in GPA cannot be explained by pre-college characteristics, even when first semester GPA is the dependent variable.

Despite these limitations, the study was important. It yielded useful and surprising information that addressed a significant gap in the literature on the use of both cognitive and non-cognitive variables as predictors of first year academic success of female engineering students. It examined the value of the NCQ and SAT as measures of non-cognitive and cognitive variables in predicting the academic success of female engineering students during the first year, and it uncovered a serious question of methodology for this whole body of research.

Implications

Assuming the findings here can be replicated elsewhere, they have implications for policy and practice. These implications extend to personnel involved in university administration, financial aid and admissions officers, engineering college officials, secondary education teachers and counselors, and female students themselves. Additionally, the findings of this study hold implications for persons involved in setting federal and state policy as well.

University administrators. This study has significance for many university constituencies in areas of practice and policy. In higher education, the results of standardized tests affect access to an institution, institutional choice, financial aid, and placement in a particular course of study (Perna, 1998). Since higher education provides opportunity for increased earning potential and elevated socioeconomic status, the number of spaces available for entering students within educational institutions are highly competitive (Gurin, 1999).

University administrators, educators, and student affairs professionals who provide funding and programming to increase the academic success and retention of female engineers may benefit from this study. Results of this research emphasize the need to examine ways to develop the cognitive variables reported by previous research that are related to the academic success of female engineering students and to support women in their cognitive studies.

Since non-cognitive characteristics are an integral part of student success many universities provide significant funds, time, and energy for the development of educational support programs for female engineers. University administrators may benefit from this study when deciding which programs to fund. Programmatic efforts at this technical university are often based on meeting the non-cognitive developmental needs of female engineering students. The results of this study indicate that development of pre-college non-cognitive characteristics

do not predict success at this institution for female engineering students. Professionals involved in this area of program development may want to direct their funding and programming toward programs that develop cognitive characteristics that are important for female engineering retention during the college experience.

Financial aid officers. The results of this study give staff in the financial aid and scholarship office a better understanding of how to promote academic achievement for female engineering students. Student test scores also determine the type or amount of financial aid received. Scholarships and other forms of financial aid promote student access to higher education and increase retention (Perna, 1998). Staff in the financial aid office could provide a list of scholarships and other financial aid opportunities that are based on cognitive ability assessed by the SAT to all entering female engineering students. Office personnel could also work to develop funding for additional scholarship opportunities based on aptitude for women seeking admission to the engineering major.

Admission office personnel and officials in the engineering college. Assessment of student achievement and aptitude has become very widespread in the U.S. and is generally thought to be necessary to determine ability and success of both the student and the institution. Opportunity for advancement and access to higher education is dependent upon the results of the standardized tests (Camera, & Echternacht, 2000). Appropriate or inappropriate use and interpretation of test results has the potential to promote good or to harm (Bertrand & Cebula, 1980; Vaughn, 2002).

Personnel in the admission office and officials in engineering colleges spend many hours evaluating student applications to determine which students are most likely to succeed at the institution and in the engineering major. Increased awareness that pre-college cognitive measures

provide the best predictors of first year success for female engineering students may provide clearer insight and direction in the admissions process. Based on these findings, college administrators may feel more confident continuing to use the SAT as an evaluative measure in their admission criteria, and not direct time or funding toward non-cognitive factors in the admissions evaluation.

Secondary school personnel. Administrators, advisors, and teachers who work in secondary schools may also benefit from this study. College admission criteria often guide and determine the curriculum of primary and secondary schools. Every year over a million high school students in the U.S. take the SAT or the ACT to determine their potential for success at a particular institution (Atkinson, 2002). Standardized testing at the secondary level seeks to determine achievement and student performance to produce students capable of succeeding in colleges (Vaughn, 2002). The results of this study provide an increased awareness of the continued importance of developing the cognitive ability of female students.

Educators in the secondary schools can require or encourage female students to take higher level math and science courses, participate in science fairs and projects, offer learning activities in science and technology that involve women, and encourage female students to pursue future education and careers in science or engineering. Such efforts may educate the young women and their parents on the importance of science and technology in today's job market for both genders and for future academic and employment success.

Female students. The results of this study can be useful to women interested in pursuing engineering as a major or career. The knowledge provided by the research might be used to better understand the best way for a female to prepare for ultimate success in this field.

They may gain a better understanding of how their education may differ from that of male peers and how these differences impact their high school experience education and college success. The results of this study demonstrate to female students the significant correlation between cognitive variables and academic achievement in engineering. Women interested in science or engineering can use the information provided in this study to help prepare for future study by selecting upper level math and science courses and by participating in math and science fairs, clubs, and competitions.

Federal government policy. The results of this study may increase the level of understanding of state and federal government officials who are involved in court decisions to determine acceptable admission criteria. The results of standardized testing determine future opportunity of students and court decisions provide a guide for practice and implementation. Changes required by the courts in admissions criteria in higher education have prompted states and local communities to reform their educational standards. Higher education needs to determine if traditional methods of standardized testing adequately measure and evaluate students from a variety of backgrounds to provide a guideline for the primary and secondary schools (Burton & Ramist, 2001). If replicated in other settings the results would support the use of the SAT as an adequate measure of predicted success for female engineering students.

Founders of this nation believed that a well informed and educated citizenry would insure the existence of a strong, stable democracy. The federal government has placed an emphasis on providing education to qualified citizens as the most important way to achieve optimal learning for all and equal opportunity in society (Trowe, 1997). Federal interests have led to the implementation of policies that intend to provide access, increase retention, and insure quality education at all levels of the educational system. These interests also include the expansion of

opportunities to learn, the issue of promoting choice and access to educational institutions, and the protection of the rights and interests of certain groups of citizens (Blanchette, 1994; Gladieux & King, 1999). If the finding of this study can be replicated, policies that intend to increase access, increase retention, and insure quality education should focus on the development of cognitive skills for female students.

State government policy. State policymakers may use the results of this study to support public funding of programs at state institutions that promote the development of cognitive ability. State government interests are similar to the interests of the federal government on education, but include additional goals that require additional legislative policy on the state and local levels. State government is interested in promoting access and success in the institutions that exist within their state borders. The results of this study demonstrate the SAT is a significant predictive measure of female student success in engineering programs.

The ability for the state funded educational institutions to thrive is of great interest at a time of fiscal austerity. Efficient and effective use of funds, the survival of the institutions, and the learning outcomes of students are extremely important at the state level. Legislators have a vital interest in assessments that demonstrate learning and quality education (McGuinness, 1999). This study provided an assessment of the value of the NCQ and the SAT in predicting female academic success at a state land grant university. The results determined that cognitive ability alone predicts the academic achievement of female engineering students and state policymakers may want to use the information to direct state funds.

Conclusion

As the face of the nation's population continues to change, the demands upon higher education will increase to produce a widely diverse and well developed citizenry. National economic success in a global market requires a workforce of individuals who can compete in major scientific endeavors of international importance. Colleges and universities must educate and train individuals who are capable of high achievement and have the flexibility to use technological and scientific skills in a variety of different contexts.

Increasing the academic success and retention of women in engineering continues to be a challenge for those in higher education. This study offered valuable information to educators, researchers, and women interested in pursuing the study of engineering. The major finding suggests that for this population of female engineering students only cognitive predictors of academic ability are significant.

These results are surprising in light of previous research and existing literature that demonstrates the powerful impact of non-cognitive variables on the academic success of college students. My finding does not call into question the whole body of research on non-cognitive variables. Rather, it calls into question the usefulness of the NCQ instrument as a measure of academic success for these students, and it challenges the common methodology used in previous research on the NCQ.

References

- Altbach, P. H., Berdahl, R. O., & Gumport, P. J. (Eds.). (1999). *American higher education in the Twenty-First Century: Social, political, and economic challenges*. Baltimore, MD: The Johns Hopkins University Press.
- American Association of State Colleges and Universities. (1999). *Enrollment trends at public four year colleges and universities fall 1990-1997*. Washington, DC: Author.
- American Association of University Women. (1992). *How schools shortchange girls*. Washington, DC: AAUW Educational Foundation and the National Education Association.
- Ancis, J. R., & Sedlacek, W. E. (1997). Predicting the academic achievement of female students using the SAT and non cognitive variables. *College and University*, 72(3), 2-8.
- Astin, A. W. (1993). *What matters in college: Four critical years revisited*. San Francisco: Jossey-Bass.
- Astin, H. S., & Sax, L. J. (1996). Developing scientific talent in undergraduate women. In C. Davis, A. B. Ginorio, C. S. Hollenshead, B. Lazarus, P. Rayman, & Associates (Eds.), *The equity equation: Fostering the advancement of women in the sciences, mathematics, and engineering* (pp. 96-121). San Francisco: Jossey-Bass.
- Atkinson, R. C. (Winter 2001-2002). Achievement versus aptitude in college admissions. *Issues in Science and Technology*, 18(2), 31-36.
- Barber, L. A. (1995). U. S. women in science and engineering, 1960-1990: Progress toward equity? *Journal of Higher Education*, 66, 213-234.
- Barker, A. M. (2001). Effects of gender on engineering career commitment. *Journal of Women and Minorities in Science and Engineering*, 7, 125-152.

- Baxter Magolda, M. B. (1992). *Knowing and reasoning in college: Gender related patterns in students' intellectual development*. San Francisco: Jossey-Bass.
- Belinky, M. F., Clinchy, B. M., Goldberger, N. R., Tarule, J. M. (1986). *Women's ways of knowing: The development of self, voice, and mind*. New York: Basic Books.
- Bertrand, A., & Cebula, J. P. (1980). *Tests, measurement, and evaluation: A developmental approach*. Reading, MA: Addison-Wesley Publishing Company.
- Blaisdell, S. (1995). Factors in the underrepresentation of women in science and engineering: A review of the literature. Working Paper 91-1 (December), 31pp. WEPAN: Women in Engineering Program Advocates Network, West Lafayette IN.
- Blanchette, C. M. (1994). Higher Education. *Grants effective at increasing minorities' chances on graduating*. Testimony before the Sub-committee on Education, Arts, and Humanities, Committee on Labor and Human Resources, U. S. Senate. (Report No. GAO/T-HEIS-94-168). Washington, DC: General Accounting Office. (ERIC Document Reproduction Service No. ED 370 505).
- Boyer, S. P., & Sedlacek, W. E. (1988). Non cognitive predictors of academic success for international students: A longitudinal study. *Journal of College Student Development*, 29, 218-223.
- Brainard, S. G., & Carlin, L. (2001). A six-year study of undergraduate women in engineering and science. In M. Lederman & I. Bartsch (Eds.), *The gender and science reader*. New York: Routledge.
- Burton, N. W., & Ramist, L. (2001). *Predicting success in college: SAT studies of classes graduating since 1980* (College Board Research Report No. 2001-02). New York: College Entrance Examination Board.

- Camara, W. J., & Echternacht, G. (2000). *The SAT I and high school grades: Utility in predicting success in college*. (Research Notes 10). New York: College Entrance Examination Board.
- Cromwell, B., Brown, N., Sanchez-Hucles, J., & Adair, F. L. (1990). The imposter phenomenon and personality characteristics of high school honor students. *Journal of Social Behavior and Personality, 5*, 563-573.
- Cronk, B. C. (1999). *How to use SPSS: A step-by-step guide to analysis and interpretation*. Los Angeles, CA: Pyrczac.
- Eccles, J. S. (1992). *Girls and mathematics: A decade of research*. (Report to the Committee on Equal Opportunities in Science and Engineering). Arlington, VA: National Science Foundation.
- Eccles, J. S., & Jacobs, J. E. (1986). Social forces shape math attitudes and performance. *Signs: Journal of Women in Culture and Society, 11*, 367-380.
- Eccles, J. S., Jacobs, J. E., & Harold, R. D. (1990). Gender role stereotypes, expectancy effects, and parents' socialization on gender differences. *Journal of Social Issues, 46*, 183-201.
- Eisenhart, M. A., & Finkel, E. (2001). Women (still) need not apply. In M. Lederman, & I. Bartsch (Eds.), *The gender and science reader* (pp. 13-23). New York: Routledge.
- Etzkowitz, H., Kemelgor, C., & Uzzi, B. (2000). *Athena unbound*. Cambridge: UK. Cambridge University Press.
- Fass, P. (1991). The female paradox: Higher education for women, 1945-1963. In L. F. Goodchild & H. S. Wechsler (Eds.), *The history of higher education* (2nd ed., pp. 699-723). Needham Heights, MA: Simon & Schuster.

- Felder, R. M., Forrest, K. D., Baker-Warf, L., Dietz, E. J., & Mohr, P. H. (1994). *Gender differences in student performance attitudes: A longitudinal study of engineering student performance and retention*. (ERIC Higher Education Report No. NCSU-94A)
- Fennema, E. (1990). Justice, equity, and mathematics education. In E. Fennema & G. C. Leder (Eds.), *Mathematics and gender* (pp. 1-9). New York: Teachers College Press.
- Fisler, J. L., Young, J. W., Hein, J. L. (2000). Retaining women in the sciences: Evidence from Douglas College's Project Super. *Journal of Women and Minorities in Science and Engineering*, 6, 349-372.
- Fleming, J. (1984). *Blacks in college: A comparative study of students' success in Black and White institutions*. San Francisco: Jossey-Bass.
- Fleming, J., & Garcia, N. (1998). Are standardized tests fair to African-Americans: Predictive validity of the SAT in Black & White institutions. *The Journal of Higher Education*, 69, 471-495.
- Ford, S. F., & Campos, S. (1977). *Summary of validity data from the admissions testing program validity study service*. New York: The College Entrance Examination Board.
- Fox, M. F. (1995). Women and scientific careers. In S. Jasanoff, J. Markle, J. Peterson, & T. Pinch (Eds.), *Handbook of science and technology studies* (pp. 205-223). Newbury Park, CA: Sage.
- Fox, M. F. (1997). Women in higher education: Gender differences in the status of students and scholars. In J. Freeman (Ed.), *Women: A feminist perspective*, (5th ed., pp. 220-235). Mountain View, CA: Mayfield.
- Fuertes, J. N., & Sedlacek, W. E. (1995). Using non-cognitive variables to predict the grades and retention of Hispanic students. *College Student Affairs Journal*, 14(2), 30-36.

- Gall, M. D., Borg, W. R., & Gall, J. P. (1996). *Educational research: An introduction* (6th ed.). White Plains, NY: Longman.
- Gehring, D. D. (1998). The frog in the pot: External influences on higher education. In D. Cooper & J. Lancaster (Eds.), *Beyond law and policy: Reaffirming the role of student affairs. New directions for student services* (pp. 3-13). San Francisco: Jossey-Bass.
- Gilligan, C. (1982). *In a different voice: Psychological theory and women's development*. Cambridge, MA: Harvard University Press.
- Gilligan, C., Lyons, N., & Hammer, T. (Eds.) (1990). *Making connections: The relational world of adolescent girls at Emma Willard School*. Cambridge, MA: Harvard University Press.
- Gladieux, L. E., & King, J. E. (1999). The federal government and higher education. In P. G. Altbach, R. O. Berdahl, & P. J. Gumpert (Eds.), *American higher education in the Twenty First Century* (pp. 151-182). Baltimore, MD: The Johns Hopkins University Press.
- Goree, C. T. (1993). *Steps toward redefinition: Coeducation at Mississippi State College, 1930-1945*. Unpublished doctoral dissertation, Mississippi State University.
- Gurin, P. (1999). [Expert report.] Gratz et al. v. Bollinger, et al. No. 97-75321 (E.D. Mich.); Grutter, et al. v. Bollinger, et al. No. 97-75928 (E.D. Mich.). *Equity and Excellence in Education*, 32, 36-62.
- Gutmann, A. (1987). Distributing higher education. In A. Gutman (Ed.), *Democratic education*. (pp. 194-223). Princeton, NJ: Princeton University Press.
- Hall, R. M., & Sandler, B. R. (1982). *The classroom climate: A chilly one for women?* Washington, DC: Association of American Colleges.
- Hanson, S. L. (1996). *Lost talent: Women in the sciences*. Philadelphia, PA: Temple University Press.

- Hathaway, R. S., Sharp, S., & Davis, C. (2001). Programmatic efforts affect retention of women in science and engineering. *Journal of Women and Minorities in Science and Engineering*, 7, 107-124.
- Henes, R., Bland, M. M., Darby, J., & MacDonald, K. (1995). Improving the academic environment for women engineering students through faculty workshops. *Journal of Engineering Education*, 84(1), 59-68.
- Hewitt, N. M., & Seymour, E. (1991). *Factors contributing to high attrition rates among science, mathematics, and engineering undergraduate majors*. Boulder, CO: University of Colorado.
- Heyman, G. D., Martyna, B., & Bhatia, S. (2002). Gender and achievement related beliefs among engineering students. *Journal of Women and Minorities in Science and Engineering*, 8, 41-52.
- Holland, D., & Eisenhart, M. (1990). *Educated in romance: Women, achievement and college culture*. Chicago: University of Chicago Press.
- Huang, P. M., & Brainard, S. G. (2001). Identifying determinants of academic self-confidence among science, math, engineering, and technology students. *Journal of Women and Minorities in Science and Engineering*, 7, 315-337.
- Hughes, W. J. (2002). Gender attributions of science and academic attributes: An examination of undergraduate science, mathematics, and technology majors. *Journal of Women and Minorities in Science and Engineering*, 8, 53-65.
- Hutchinson, S. B., Hyer, P., & Collins, D. (2000). *The campus climate for diversity: Student perceptions*. Blacksburg, VA: Virginia Polytechnic Institute and State University.

- Jacobs, J. (1986). The sex-segregation of fields of study: Trends during the college years. *Journal of Higher Education, 57*, 134-154.
- Jacobs, J. E., Finkin, L. L., Griffin, N. L., & Wright, J. D. (1998). The career plans of science talented rural adolescent girls. *American Educational Research Journal, 35*, 681-704.
- Kahle, J. B. (1990). Real students take chemistry and physics. In K. Tobin, J. B. Kahle, & B. J. Fraser (Eds.), *Windows into science classrooms: Problems associated with higher level cognitive learning* (pp. 92-134). New York: Falmer Press.
- Kahle, J. B. (1996). Opportunities and obstacles: Science education in the schools. In C. S. Davis, A. B. Ginorio, C. S. Hollenshed, B. B. Lazarus, P. M. Rayman, and Associates (Eds.), *The equity equation: Fostering the advancement of women in the sciences, mathematics, and engineering* (pp. 57-95). San Francisco: Jossey-Bass.
- Kobrin, J. L., & Milewski, G. B. (2002). Students with discrepant high school GPA and SAT I scores. (Research Notes 15). New York: College Entrance Examination Board.
- Koehler, M. S. (1990). Classrooms, teachers, and gender differences in mathematics. In E. Fennema & G. C. Leder (Eds.), *Mathematics and gender* (pp. 1-9). New York: Teachers College Press.
- Larose, S., & Roy, R. (1995). Test of Reactions and Adaptation in College (TRAC): A new measure of learning propensity for college students. *Journal of Educational Psychology, 87*, 293-305.
- Levin, J., & Wyckoff, J. H. (1994). Predicting persistence and success in baccalaureate engineering. *Education, 111*, 461-468.
- Levin, J., & Wyckoff, J. H. (1995). Predictors of persistence in an engineering program. *NACADA Journal, 15*(1), 15-21.

- Linn, R. L., & Wetrs, C. E. (1971). Consideration for studies of test bias. *Journal of Educational Measurement* 8, 1-4.
- Lucena, J. C. (2000). Making women and minorities in science and engineering for national purposes in the United States. *Journal of Women and Minorities in Science and Engineering*, 6, 1-31.
- Ludwig, D. D. (1995). An overview of freshmen enrollment data and departmental admission practices in engineering colleges. *Proceedings of the ASEE Annual Conference*, 228-233.
- McGuinness, Jr., A. C. (1999). The states and higher education. In P. G. Altbach, R. O. Berdahl, & P. J. Gumport (Eds.), *American higher education in the Twenty First Century* (pp. 151-182). Baltimore, MD: The Johns Hopkins University Press.
- McIlwee, J. S., & Robinson, J. G. (1992). *Women in engineering: Gender, power, and workplace culture*. Albany, NY: State University of New York Press.
- Mickelson, R., & Smith, S. (1995). Education and the struggle against race, class, and gender inequality. In Anderson & Collins (Eds.), *Race, class, and gender: An anthology*, (2nd ed., pp. 289-303). Belmont, CA: Wadsworth.
- Moller-Wong, C. & Eide, A. (1997). An engineering student retention study. *Journal of Engineering Education*, 86, 7-15.
- Mouw, J. T., & Khanna, R. K. (1993). Prediction of academic success: A review of the literature and some recommendations. *The College Student Journal*, 27, 328-336.
- National Science Board of the National Science Foundation. (2000). *Science and engineering indicators 2000*. Washington DC: U. S. Government Printing Office

- National Science Foundation. (1998). *Women, minorities, and persons with disabilities in science and engineering*. Washington, DC: Government Printing Office.
- National Science Foundation. (2002). *Science and engineering indicators*. Retrieved August 10, 2002 from <http://www.nsf.gov/sbe/srs/nsf99338/forward.htm>
- National Center for Educational Statistics. (1997a). *NAEP 1996 mathematics report card for the nation and the states*. NCES 97-488. Washington DC: U.S. Government Printing Office. Retrieved April 6, 2003 from <http://nces.ed.gov/nationsreportcard/pdf/main1996/97488.pdf>
- National Center for Educational Statistics. (1997b). *NAEP 1996 science report card for the nation and the states*. NCES 97-497. Washington DC: U.S. Government Printing Office. Retrieved April 6, 2003 from <http://nces.ed.gov/nationsreportcard/pdf/main1996/97497.pdf>
- Noble, K. D., & Smyth, R. K. (1995). Keeping their talents alive: Young women's assessment of radical, post-secondary acceleration. *Roeper Review*, 18, 49-53.
- Oakes, J. (1990). *Lost talent: The under representation of women, minorities, and disabled persons in science*. Santa Monica, CA: RAND.
- Office of Institutional Research and Planning Analysis. (2003). *2001 Common Data Set*. Retrieved February 18, 2003 from http://www.irpa.vt.edu/Common%20Data%20Set/cds_2001_B.xls
- Pascarella, E. T. (1985). Students' affective development within the college environment. *Journal of Higher Education*, 56, 640-663
- Pascarella, E., & Terenzini, P. (1991). *How college affects students*. San Francisco: Jossey-Bass.

- Perna, L. W. (1998). The contribution of financial aid to undergraduate persistence. *Journal of Student Financial Aid*, 28(3), 25-40.
- Ramist, L., Lewis, C., & McCamley-Jenkins, L. (1994). *Student group differences in predicting college grades: Sex, language, and ethnic groups* (College Board Report No. 93-1). New York: College Entrance Examination Board.
- Reichert, M., & Absher, M. (1997). Taking another look at educating African American engineers: The importance of undergraduate retention. *Journal of Engineering Education*, 86(3), 241-253.
- Rosser, S. V., & Zieseniss, M. (2000). Career issues and laboratory climates: Different challenges and opportunities for women engineers and scientists (Survey of fiscal year 1997 POWRE awardees). *Journal of Women and Minorities in Science and Engineering*, 6, 95-114.
- Rosser, M. W. (1995). *Women scientists in America: Before affirmative action 1940-1972*. Baltimore: Johns Hopkins University Press.
- Sadker, M., & Sadker, D. (1994). *Failing at fairness: How America's schools cheat girls*. New York: Charles Scribner & Sons.
- Sanford, N. (1966). *Self and society*. New York: Atherton Press.
- Sax, L. J. (1992, April). *Predicting persistence of science career aspirations: A comparative study of male and female college students*. Paper presented at the American Educational Research Association Conference, San Francisco, CA.
- Sax, L. J. (1994). Retaining tomorrow's scientists: Exploring the factors that keep male and female college students interested in science careers. *Journal of Women in Science and Engineering*, 1, 45-62.

- Schmuck, R., & Schmuck, P. (1992). *Small districts, big problems: Making schools everybody's house*. Newbury Park, CA: Corwin Press.
- Sedlacek, W. E. (1987). Black students on White campuses: 20 years of research. *Journal of College Student Personnel*, 28, 484-495.
- Sedlacek, W. E. (1989). Non-cognitive indicators of student success. *The Journal of College Admissions*, 125(1), 2-10.
- Sedlacek, W. E. (1993). Employing non-cognitive variables in the admission and retention of nontraditional students. *National Association of College Admission Counselors*, 33-39.
- Sedlacek, W. E., & Adams-Gaston, J. (1989). *Predicting the academic success of student athletes using SAT and non-cognitive variables* (Research Report No. 20-89). College Park, MD: University of Maryland. (ERIC Document Reproduction Service No. ED314501)
- Seymour, E. (1995). The loss of women from science, mathematics, and engineering undergraduate majors: An explanatory account. *Science Education*, 79, 437-473.
- Seymour, E., & Hewitt, N. (1997). *Talking about leaving: Why undergraduates leave the sciences*. Boulder, CO: Westview.
- Shalom, S. R. (1996). Teaching affirmative action. In E. G. Friedman, W. K. Kolmar, C. B. Flint, & P. Rothenberg (Eds.), *Creating an inclusive college curriculum*. New York: Teachers College Press.
- Solomon, B. M. (1985). *In the company of educated women*. New Haven, CT: Yale University Press.
- Steele, C. M. (1997). Changes in women's majors from entrance to graduation at women's and coeducational colleges. *Industrial and Labor Relations Review*, 48, 505-514.

- Stern, D., & Briggs, D. (2001, January-February). Changing admissions policies. *Change*, 33, 34-41.
- Sternberg, R. J. (1985). *Beyond IQ: A triarchic theory of human intelligence*. New York: Cambridge University Press.
- Tidball, M. E., Smith, D. G., Tidball, C. S., & Wolf-Wendel, L. E. (1999). *Taking women seriously: Lessons and legacies for educating the majority*. Washington, DC: American Council on Education, Oryx Press.
- Ting, S. R. (2000). Predicting Asian Americans' academic performance in the first year of college: An approach combining SAT scores and non-cognitive variables. *Journal of College Student Development*, 41, 442-449.
- Tinto, V. (1993). *Leaving college: Rethinking the causes and cures of student attrition*. Chicago: The University of Chicago Press.
- Tracey, T. J., & Sedlacek, W. E. (1980). *A description and illustration of a model for conducting student retention research* (Research Report No. 13-80). College Park, MD: University of Maryland. (ERIC Document Reproduction Service No. ED208745)
- Tracey, T. J., & Sedlacek, W. E. (1984). Non-cognitive variables in predicting academic success by race. *Measurement and Evaluation in Guidance*, 16(4), 171-178.
- Tracey, T. J., & Sedlacek, W. E. (1985). The relationship of non-cognitive variables to academic success: A longitudinal comparison by race. *Journal of College Student Personnel*, 26, 405-410.
- Tracey, T. J., & Sedlacek, W. E. (1987). Prediction of college graduation using non-cognitive variables by race. *Measurement and Evaluation in Counseling and Development*, 19, 177-184.

- Tracey, T. J., & Sedlacek, W. E. (1989). Factor structure of the Non-Cognitive Questionnaire-Revised across samples of Black and White college students. *Educational and Psychological Measurement, 49*, 637-648.
- Trowe, M. A. (1997). American higher education: Past, present, and future. In L. F. Goodchild, & H. S. Wechsler (Eds.), *The history of higher education*, 2nd ed., 571-586. MA: Simon & Schuster.
- Vaughn, A. C. (2002). Standards, accountability, and the determination of school success. *The Educational Forum, 66*, 206-213.
- Volet, S. E. (1997). Cognitive and affective variables in academic learning: The significance of direction and effort in students' goals. *Learning and Instruction, 7*, 235-254.
- Weidlein, E. R. (Ed.). (2001). [Almanac Issue]. *The Chronicle of Higher Education, XLVII*(1), 118-125.
- White, P. H. (Ed.). (2000). *Undergraduate course catalogue and academic policies 2000-2001*. Blacksburg, VA: Virginia Polytechnic Institute and State University.
- Willingham, W. W. (1985). *Success in college: The role of personal qualities and academic ability*. New York: The College Board.
- Willingham, W., Lewis, C., Morgan, R. & Ramist, L. (1990). *Predicting college grades: An analysis of institutional trends over two decades*. New York: Educational Testing Service.

Appendix A

The Non Cognitive Questionnaire

Please fill in the blank or circle the appropriate answers.

1. Your social security number _____

2. Your sex is:

1. Male
2. Female

3. Your age is _____ years

4. Your father's occupation: _____

5. Your mother's occupation: _____

6. Your race is:

1. Black (African-American)
2. White (not of Hispanic origin)
3. Asian (Pacific Islander)
4. Hispanic (Latin American)
5. American Indian (Alaskan native)
6. Other

7. How much education do you expect to get during your lifetime?

1. College, but less than a bachelor's degree
2. B.A. or equivalent
3. 1 or 2 years of graduate or professional study (Master's degree)
4. Doctoral degree such as M.D., Ph.D., etc.

8. Please list three goals that you have for yourself right now:

- 1.
- 2.
- 3.

9. About 50% of university students typically leave before receiving a degree. If this should happen to you, what would be the most likely cause?

1. Absolutely certain that I will obtain a degree
2. To accept a good job
3. To enter military service
4. It would cost more than my family could afford
5. Marriage
6. Disinterest in study
7. Lack of academic ability
8. Insufficient reading or study skills
9. Other

10. Please list three things that you are proud of having done.

- 1.
- 2.
- 3.

Please indicate the extent to which you agree or disagree with each of the following items. Respond to the statements below with your feelings at present or with your expectations of how things will be. Write in your answer to the left of each item.

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Disagree Strongly

- ____ 11. The University should use its influence to improve social conditions in the State.
 - ____ 12. It should not be very hard to get a B (3.0) average at Virginia Tech.
 - ____ 13. I get easily discouraged when I try to do something and it doesn't work.
 - ____ 14. I am sometimes looked up to by others.
 - ____ 15. If I run into problems concerning school, I have someone who would listen to me and help me.
 - ____ 16. There is no use in doing things for people; you only find that you get it in the neck in the long run.
 - ____ 17. In groups where I am comfortable, I am often looked to as leader.
 - ____ 18. I expect to have a harder time than most students at Virginia Tech.
 - ____ 19. Once I start something, I finish it.
 - ____ 20. When I believe strongly in something, I act on it.
 - ____ 21. I am as skilled academically as the average applicant to Virginia Tech.
 - ____ 22. I expect I will encounter racism at Virginia Tech.
 - ____ 23. People can pretty easily change me even though I thought my mind was already made up on the subject.
 - ____ 24. My friends and relatives don't feel I should go to college.
 - ____ 25. My family has always wanted me to go to college.
 - ____ 26. If course tutoring is made available on campus at no cost, I would attend regularly.
 - ____ 27. I want a chance to prove myself academically.
 - ____ 28. My high school grades don't really reflect what I can do.
 - 29. Please list offices held and/or groups belonged to in high school or in your community.
-
-
-

Appendix B

Permission to Use the Non Cognitive Questionnaire

Subj: **RE: Permission Requested**
Date: Mon, 24 Jun 2002 10:53:03 AM Eastern Standard Time
From: William Sedlacek <ws12@umail.umd.edu>
To: hawaii99 <hawaii99@vt.edu>
Sent from the Internet (Details)

Therese- You have my permission to use the NCQ in your research. I would appreciate receiving a copy of your results- good luck on your study.

William E. Sedlacek
Professor of Education
Assistant Director, Counseling Center
Adjunct Professor of Pharmacy
1101B Shoemaker Bldg.
University of Maryland
College Park, MD. 20742-8111
Phone 301-314-7687
Fax 301-314-9206
Website
<http://www.inform.umd.edu/EdRes/Topic/Diversity/General/Reading/Sedlacek/>

"You can't solve a problem on the same level that you created it" Albert Einstein

-----Original Message-----
From: hawaii99 [<mailto:hawaii99@vt.edu>]
Sent: Monday, June 24, 2002 11:26 AM
To: ws12@umail.umd.edu
Subject: Permission Requested

Dear Dr. Sedlacek,
I am writing to ask for your permission to use the Non-Cognitive Questionnaire in my thesis study. For purposes of this study, I would like to administer the NCQ to incoming freshmen, female engineering students during orientation this summer. I am a Masters student in the Higher Education and Student Affairs program at Virginia Tech. I have the support of my committee and the Academic Dean of the College of Engineering to administer the NCQ as early as July 7th as long as I have your permission in time. Your response through email would be appreciated and acceptable to the University. I look forward to hearing from you. I appreciate your time in this matter, and your research, which assists me in my work with academic support programs and my professional preparation.

Therese Lovegreen
Masters Student, Higher Education and Student Affairs
Virginia Polytechnic Institute and State University

Appendix C

Scoring Key

COUNSELING CENTER
UNIVERSITY OF MARYLAND
COLLEGE PARK, MARYLAND 20742

SCORING KEY FOR SUPPLEMENTARY ADMISSIONS QUESTIONNAIRE II

William E. Sedlacek

QUESTIONNAIRE ITEMS	VARIABLE NAME	(NUMBER)
= 2		Use to score for Self-Concept (I) Option 1 = 1; 2 = 2; 3 = 3; 4 = 4; No response
8	A.	Options for Long Range Goals (IV) Each goal is coded according to this scheme:
(e.g., "to meet people," confidence")	1 =	a vague and/or immediate, short-term goal "to get a good schedule," "to gain self
orientation which could be "to join a sorority schedule so I can get government office")	2 =	a specific goal with a stated future accomplished during undergraduate study (e.g., so I can meet more people," "to get a good good grades in the fall," "to run for a student
orientation which would occur schedule so I can get become president of	3 =	a specific goal with a stated future after undergraduate study (e.g., "to get a good the classes I need for graduate school;" "to a Fortune 500 company")
(VIII)	B.	Options for Knowledge Acquired in a Field Each goal is coded according to this scheme:
vague or unclear (e.g., better person")	1 =	not at all academically or school related; "to get married," "to do better," "to become a
primarily educationally become student body	2 =	school related, but not necessarily or oriented (e.g., "to join a fraternity," "to president")
3.5 GPA," "to get	3 =	directly related to education (e.g., "to get a

to know my teachers")

Goals) and round to the
Find the mean for each dimension (e.g. Long Range
nearest whole number.

QUESTIONNAIRE
ITEMS

VARIABLE NAME (NUMBER)

9 Use to score for Self-Concept (I) and Self-Appraisal
(II)

Option 1 = 4; 2 through 9 = 2; No response = 2

10

Use to score for Self Concept (I)
Each accomplishment is coded according to this scheme:

1 = at least 75% of applicants to your school could
have accomplished it (e.g., "graduated from high school," "held a
part-time summer job")

2 = at least 50% of applicants to your school could
have accomplished it (e.g., played on an intramural sports team,"
"was a member of a school club")

3 = only top 25% of applicants to your school could
have accomplished it (e.g., "won an academic award," "was captain
of football team")

Find the mean code for this dimension and round to the
nearest whole number.

For items 11 through 28, positive (+) items are scored
as is. Negative (-) items
are reversed, so that 1 = 5, 2 = 4, 3 = 3, 4 = 2, and 5
= 1. A shortcut is

to subtract all negative item responses from 6.

QUESTIONNAIRE
ITEMS

DIRECTION

VARIABLE NAME (NUMBER)

11	-	Use to score for Racism (III)
12	-	Use to score for Realistic Self-
Appraisal (II)		
13	+	Use to score for Long-Range Goals (IV)
14	-	Use to score for Leadership (VI)
15	-	Use to score for Availability of Strong
Support (V)		
16	+	Use to score for Community
Service (VII)		

17	-	Use to score for Leadership (VI)
18	+	Use to score for Racism (III)
19	-	Use to score for Long-Range Goals (IV)
20	-	Use to score for Positive Self-Concept
(I)		
21	-	Use to score for Realistic Self-
Appraisal (II)		
22	-	Use to score for Racism (III)
23	+	Use to score for Positive Self Concept
(I)		
24	+	Use to score for Availability of Strong
Support (V)		
25	-	Use to score for Availability of Strong Support (V)
26	-	Use to score for Racism (III)
27	-	Use to score for Racism (III)
28	-	Use to score for Positive Self Concept
(I)		

29 Use to score for Leadership (VI), Community Service (VII) and Knowledge Acquired in a Field (VIII). Each organization is given a code for A, B, and C below. Find the mean for each dimension (e.g. Leadership) and round to the nearest whole number.

A. Leadership (VI)

1 = ambiguous group or no clear reference to activity performed (e.g., "helped in school")

2 = indicates membership but no formal or implied leadership role; it has to be clear that it's a functioning group and, unless the criteria are met for a score of "3" as described below, all groups should be coded as "2" even if you, as the rater, are not familiar with the group (e.g., "Fashionettes, " "was part of a group that worked on community service projects through my church")

3 = leadership was required to fulfill role in group (e.g., officer or implied initiator, organizer, or founder) or entrance into the group was dependent upon prior leadership (e.g., "organized a tutoring group for underprivileged children in my community," "student council")

B. Community Service Relatedness (VII)

- 1 = no community service performed by group, or vague or unclear in relation to community service (e.g., "basketball team").
- 2 = some community service involved but it is not the primary purpose of the group (e.g., "Scouts")
- 3 = group's main purpose is community service (e.g., "Big Brothers/Big Sisters")

C. Knowledge Acquired in a Field (VIII) (same coding criteria as used for item 8B.)

SUPPLEMENTARY ADMISSIONS QUESTIONNAIRE II
Worksheet for Scoring

1. POSITIVE SELF-CONCEPT OR CONFIDENCE
item7* + item9* + item10* + (6 - item20)
+ item23 + (6 - item28)
2. REALISTIC SELF-APPRAISAL
item9* + (6 - item12) + (6 - item21)
3. UNDERSTANDS and DEALS with RACISM
item26) + (6 - item11) + item18 + (6 - item22) + (6 -
(6 - item27)
4. PREFERS LONG-RANGE GOALS to SHORT-TERM or IMMEDIATE
NEEDS
item8A* + item13 + (6 - item19)
5. AVAILABILITY of a STRONG SUPPORT PERSON
(6 - item15) + item24 + (6 - item25)
6. SUCCESSFUL LEADERSHIP EXPERIENCE
(6 - item14) + (6 - item17) + item29A*
7. DEMONSTRATED COMMUNITY SERVICE
item16 + item29B*
8. KNOWLEDGE ACQUIRED in a FIELD
item8B* + item29C*

* Recoded item. See scoring instructions for these items on pages 1-3 herein.

Appendix D
Exemption Approval

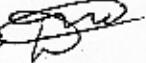
Institutional Review Board

Dr. David M. Moore
IRB (Human Subjects) Chair
Assistant Vice Provost for Research Compliance
CVM Phase II - Duckpond Dr., Blacksburg, VA 24061-0442
Office: 540/231-4991; FAX: 540/231-6033
e-mail: moored@vt.edu

Date: June 28, 2002

MEMORANDUM

TO: Therese Lovegreen ELPS 0302
Don Creamer ELPS 0302

FROM: David M. Moore 

SUBJECT: IRB EXEMPTION APPROVAL – “Predicting Academic Success of
Female Engineering Students” – IRB #02-348

I have reviewed your request to the IRB for exemption for the above referenced project. I concur that the research falls within the exempt status. Approval is granted effective as of June 28, 2002.

cc: file
Department Reviewer: M. D. Alexander

Appendix E
Questionnaire Packet

This Questionnaire is provided by the Higher Education and Student Affairs Program in the Department of Educational Leadership and Policy Studies at Virginia Tech.

Some things you should know before you respond:

- We are conducting this questionnaire to find out what factors best predict the **academic success of female engineering students**.
- It should take you only a few minutes to complete this questionnaire, so you can quickly resume your orientation activity.
- We are confident that responding to this questionnaire has very minimal risks to you. It is similar to the information needed to grade an exam or home work assignment, only you will not be graded.
- There are possible benefits to you and to future female engineering students. The results of this questionnaire will be used to help predict academic achievement and improve support programs for female engineering students.
- Your responses will be completely **confidential**. Only the researcher and two faculty members of the Department of Educational Leadership and Policy Studies will see your responses.
- We ask that you complete the consent form to let us know that you agree to respond to the questionnaire. **Please sign both consent forms and keep one for yourself** by removing this information sheet from the packet.
- Your response to the questionnaire is completely voluntary. You do not need to respond at all, but we really hope that you will. There is no right or wrong answer to the questions, and no penalty for not responding. But we really need your response to complete this research!
- If you have any questions about this research you are welcome to call 231-6272 and ask for Cathy Turrentine or 231-9705 and ask for Don Creamer.
- This research has been approved by the Virginia Tech Institutional Research Review Board for your protection.

Best wishes for your academic success!

Participant Informed Consent

I have read and understand the information regarding my participation in this study. I hereby acknowledge the above and give my voluntary consent for participation in this study. If I participate, I may withdraw at any time without penalty. I agree to abide by the rules of this project.

PRINTED NAME OF PARTICIPANT

DATE

SIGNATURE OF PARTICIPANT

Should I have any questions about this research or its conduct, I may contact:

Therese A. Lovegreen
Investigator

hawaii99@vt.edu
e-mail

Cathryn Turrentine, Ph.D.
Faculty Advisor

231-6272/turc@vt.edu
Telephone/e-mail

David M. Moore
Chair, IRB

231-4991/moored@vt.edu
Telephone/e-mail

Please fill in the blank or circle the appropriate answers.

1. Your social security number _____

2. Your sex is:

1. Male
2. Female

3. Your age is _____ years

4. Your father's occupation: _____

5. Your mother's occupation: _____

6. Your race is:

1. Black (African-American)
2. White (not of Hispanic origin)
3. Asian (Pacific Islander)
4. Hispanic (Latin American)
5. American Indian (Alaskan native)
6. Other

7. How much education do you expect to get during your lifetime?

1. College, but less than a bachelor's degree
2. B.A. or equivalent
3. 1 or 2 years of graduate or professional study (Master's degree)
4. Doctoral degree such as M.D., Ph.D., etc.

8. Please list three goals that you have for yourself right now:

- 1.
- 2.
- 3.

9. About 50% of university students typically leave before receiving a degree. If this should happen to you, what would be the most likely cause?

1. Absolutely certain that I will obtain a degree
2. To accept a good job
3. To enter military service
4. It would cost more than my family could afford
5. Marriage
6. Disinterest in study
7. Lack of academic ability
8. Insufficient reading or study skills
9. Other

10. Please list three things that you are proud of having done.

- 1.
- 2.
- 3.

Please indicate the extent to which you agree or disagree with each of the following items. Respond to the statements below with your feelings at present or with your expectations of how things will be. Write in your answer to the left of each item.

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Disagree Strongly

- ___ 11. The University should use its influence to improve social conditions in the State.
- ___ 12. It should not be very hard to get a B (3.0) average at Virginia Tech.
- ___ 13. I get easily discouraged when I try to do something and it doesn't work.
- ___ 14. I am sometimes looked up to by others.
- ___ 15. If I run into problems concerning school, I have someone who would listen to me and help me.
- ___ 16. There is no use in doing things for people; you only find that you get it in the neck in the long run.
- ___ 17. In groups where I am comfortable, I am often looked to as leader.
- ___ 18. I expect to have a harder time than most students at Virginia Tech.
- ___ 19. Once I start something, I finish it.
- ___ 20. When I believe strongly in something, I act on it.
- ___ 21. I am as skilled academically as the average applicant to Virginia Tech.
- ___ 22. I expect I will encounter racism at Virginia Tech.
- ___ 23. People can pretty easily change me even though I thought my mind was already made up on the subject.
- ___ 24. My friends and relatives don't feel I should go to college.
- ___ 25. My family has always wanted me to go to college.
- ___ 26. If course tutoring is made available on campus at no cost, I would attend regularly.
- ___ 27. I want a chance to prove myself academically.
- ___ 28. My high school grades don't really reflect what I can do.

29. Please list offices held and/or groups belonged to in high school or in your community.

THERESE A. LOVEGREEN

EDUCATION

M.A. Ed., Higher Education and Student Affairs Administration, May 2003
Virginia Polytechnic Institute and State University (Virginia Tech), Blacksburg, VA

Certificates in Crisis Counseling and Brief Counseling, June 2001
James Madison University, Harrisonburg, VA

B.S., Speech and Communications; B.S., Psychology; Minor in Sociology; December 1980
University of Pittsburgh, Pittsburgh, PA

EXPERIENCE

Graduate Assistant, Career Services,
Virginia Tech, Blacksburg, VA, August 2002-May 2003

- Served as member of Career Services staff
- Advised students and alumni on decision making in terms of major selection, careers, and job search strategies
- Co-instructor for two major selection and career decision-making courses (3-credits each) includes syllabus creation and implementation, classroom instruction, and grading assignments
- Created and conducted educational programs and presentations on various major/career job search topics and self-assessment strategies
- Instructed students on use of self-assessment and job search resources such as FOCUS
- Assisted with development and implementation of marketing strategies
- Wrote and edited periodic newsletter for university faculty with focus on programs and services
- Developed web site for university graduate students to assist with career discernment and job search
- Led team responsible for programming in relation to student preparation for job fairs and interviewing
- Critiqued and created resumes, professional correspondence letters, and interview style to improve student competitiveness and opportunity in the job market

Academic Advising Office Practicum, College of Interdisciplinary Studies,
Virginia Tech, Blacksburg, VA, January 2003-May 2003

- Advised students on major and career decision-making, academic course selection, curriculum and graduation requirements
- Co-instructed 3-credit, semester long, senior seminar course including planning, syllabus creation, classroom instruction, career planning, resume writing, interviewing techniques, and job search strategies
- Developed and wrote an advising manual for use and training of new advising professionals
- Assessed and evaluated student needs and perception of the college degree program

Graduate Assistant, Project Success, Center for Academic Enrichment & Excellence,
Virginia Tech, Blacksburg, VA, August 2001-August 2002

- Served as assistant to program director of Project Success, a support program for probationary students
- Provided information and instruction on college transition topics such as goal setting, time management, self-assessment, study skills, and academic success strategies
- Contributed to program design and direction of student group activity
- Conducted monthly meetings for faculty, administrative, and peer facilitators
- Re-designed and compiled facilitator program training manual
- Trained and provided support for program facilitators
- Secured guest speakers for student group instruction
- Monitored program participation, activity, and compliance
- Facilitated Project Success student group
- Re-designed and administered program survey evaluation survey
- Compiled and reported assessment results using quantitative and qualitative methods

Alumni Association Practicum,

Virginia Tech, Blacksburg, VA, May 2002–August 2002

- Served as assistant to Alumni Relations staff
- Assisted with planning and implementation of the Summer Escape program for university alumni
- Formulated program cost data base and monitored program budget
- Created and maintained data base for program guest registration information
- Planned and conducted historical campus tour
- Assessed program evaluation responses using quantitative and qualitative methods; reported the results

Scholarship Coordinator and Office Services Specialist, College of Natural Resources,
Virginia Tech, Blacksburg, VA, December 1999-July 2001

- Provided administrative support to the Associate Dean, Academic Advisor, and the Program and Diversity Coordinators in the college Academic Programs Office
- Worked with all college faculty and departments, and the offices of Financial Aid, Student Accounts, Sponsored Programs, Development Office, and Virginia Tech Foundation
- Advised students on academic requirements, course selection, and career opportunities
- Assisted with planning and implementation of Orientation, Fall and Spring Graduation, and other college events
- Marketed College and department programs to prospective students, parents, and high school personnel
- Contacted scholarship donors to solicit award pledges and provide recipient information
- Determined amount of scholarship funding available and monitored accounts
- Assisted Associate Dean with scholarship award compliance and planning of scholarship awards
- Created and maintained payout schedule of awards
- Revised, planned, and coordinated schedule of classes for all college departments

Service Representative, Chase Manhattan Bank,

Manlius, NY, September 1996–August 1999

- Assessed customers financial situation, needs, and provided financial information and advice
- Marketed products and services through personal and telephone contact
- Planned and designed innovative product and service promotions, campaigns, and events
- Coordinated and hosted events for valued customers
- Directed clients through various banking transactions and procedures
- Resolved customer problems and conflict
- Implemented security procedures and directives

Representative to Parish Council, Ascension Church,

Hurricane, WV, May 1994–June 1995

- Managed church administration to accomplish mission and goals
- Planned church programs, events, and budget
- Formulated, monitored, and participated in capitol campaign
- Designed fund raising campaigns for new community worship center and community activities
- Assessed community present and future needs
- Assisted with development and implementation of religious education instruction

Office Manager, Amputee and Brace Center,

Lakeland, FL, August 1990–July 1992

- Managed medical office to accomplish administrative and clerical activities, and provide patient services
- Maintained accurate and concise communication between physicians, office practitioners, satellites and main offices, hospitals, care facilities, and insurance companies
- Supervised and directed contract compliance with Medicare, Medicaid, HMO, and private insurance carriers
- Managed and projected accounts receivable and accounts payable
- Verified and maintained accuracy of patient, employee, and office accounts and records
- Supervised and trained secretarial employees
- Contracted office cleaning services, grounds maintenance, and purchase of supplies
- Coordinated orders for medical supplies and devices with medical suppliers
- Balanced ledger on a monthly and annual basis

PROFESSIONAL SERVICE AND MEMBERSHIP

- Treasurer and Founder, Chi Sigma Alpha, National Honor Society, 2002–2003 (CSA)
- Conference Chair, Association for Student Development, 2002 (ASD)
- Virginia Tech On Call Crisis Intervention Team, 2000–Present
- Sexual Assault Task Force of Virginia Tech, 2001–Present
- Virginia Tech Orientation Team, 2000–2001
- National Association of Student Personnel Administrators (NASPA)
- American Association for Higher Education (AAHE)
- Virginia Association of Colleges and Employers (VACE)
- National Association of Female Executives (NAFE)