# INFORMATION TO USERS

This manuscript has been reproduced from the microfilm master. UMI films the text directly from the original or copy submitted. Thus, some thesis and dissertation copies are in typewriter face, while others may be from any type of computer printer.

**The quality of this reproduction is dependent upon the quality of the copy submitted.** Broken or indistinct print, colored or poor quality illustrations and photographs, print bleedthrough, substandard margins, and improper alignment can adversely affect reproduction.

In the unlikely event that the author did not send UMI a complete manuscript and there are missing pages, these will be noted. Also, if unauthorized copyright material had to be removed, a note will indicate the deletion.

Oversize materials (e.g., maps, drawings, charts) are reproduced by sectioning the original, beginning at the upper left-hand corner and continuing from left to right in equal sections with small overlaps.

Photographs included in the original manuscript have been reproduced xerographically in this copy. Higher quality 6" x 9" black and white photographic prints are available for any photographs or illustrations appearing in this copy for an additional charge. Contact UMI directly to order.

Bell & Howell Information and Learning
300 North Zeeb Road, Ann Arbor, MI 48106-1346 USA

UMI®
800-521-0600

# SELF-EFFICACY AND VOCATIONAL INTERESTS IN THE PREDICTION OF ACADEMIC PERFORMANCE OF STUDENTS IN ENGINEERING TECHNOLOGY

by

ASAD YOUSUF

B.S., NED University, 1980

M.S., University of Cincinnati, 1982

A Dissertation Submitted to the Graduate Faculty

Of The University of Georgia in Partial Fulfillment

of the

Requirements for the Degree

DOCTOR OF EDUCATION

ATHENS, GEORGIA

1999

# SELF-EFFICACY AND VOCATIONAL INTERESTS IN THE PREDICTION OF ACADEMIC PERFORMANCE OF STUDENTS IN ENGINEERING TECHNOLOGY

by

ASAD YOUSUF

Approved:

Major Professor

July 25, 1999
Date

Approved:
Graduate Dean

August 4, 1999
Date

ASAD YOUSUF
Self-Efficacy and Vocational Interests in the Prediction of Academic Performance of Students in Engineering Technology
(Under the direction of MYRA WOMBLE)

This study explored the extent to which career self-efficacy beliefs, math-SAT scores, high school GPA and vocational interests could predict academic performance of students enrolled in Computer Science and Engineering Technology programs.

Research was based on social cognitive theory and self-efficacy theory. These theories were used to assess the students' ability to complete the educational requirements of Computer Science and Engineering Technology programs.

The participants (N=125) included in the statistical analyses consisted of 85 males and 40 females. These participants completed measures of self-efficacy and expressed vocational interests in technical fields using a three-part instrument, referred to as the Science and Engineering Career questionnaire (SEC).

Data collected were analyzed using descriptive statistics and multiple linear/stepwise regression. Results of this study supported and extended results from previous studies that showed self-efficacy expectations to be highly correlated to the indices of academic performance behavior (Hackett & Betz, 1984; Lent et al., 1986) as well as vocational interests and a range of perceived career choices. Results of the study also provided a regression model that can assist counselors to guide students in achieving good academic grades.

Findings of the study support the need for further research to involve investigations that compare academic progress and career behavior across racial, ethnic and socioeconomic levels. Such research may serve to expand the knowledge base useful for recruiting, counseling, and advising students.

INDEX WORDS: **Self-efficacy, Vocational interest, Career interest, Academic performance, Engineering technology, Computer science technology**

## ACKNOWLEDGMENTS

First I would like to acknowledge my teacher, mentor, and advisor, Dr. Myra N. Womble for her guidance and support in all phases of this project.

I am also very thankful for the support provided by the committee members; Dr. Helen C. Hall, Dr. Karen H. Jones, Dr. Clifton L. Smith, Dr. John L. Scott, and Mr. Kendall Hill.

Finally, I want to express my special thanks to my wife, Parveez, for her love and support.

TABLE OF CONTENTS

## LIST OF TABLES

# CHAPTER I

# INTRODUCTION

As a result of the eruption of technological advances, careers in the fields of Computer Science and Engineering Technology have become areas of high employment opportunities and this trend is expected to remain strong in the future (National Center for Educational Statistics, 1996). Engineering and Computer Science skills are now considered basic tools for acquiring knowledge, managing systems, and solving complex problems in our society. The influence of these two areas is becoming so universal that almost all areas in the work place seem to be affected in some significant way. Moreover, reports from the College Placement Council (1996) indicate that the demand for computer scientists and engineers far exceeds the supply. However, in order to take advantage of the numerous career opportunities, students must first complete the educational requirements for engineering and it's allied fields (Lent, Brown, & Larkin, 1986).

This chapter presents background information relative to the engineering technology discipline and self-efficacy. The theoretical framework supporting the study, statement of the problem, purpose of the study, research questions, significance of the study and assumptions and limitations are also provided. The chapter concludes with definition of terms.

## Background Information

Cheshier (1998) pointed out that much of this demand for computer scientists and engineers can be fulfilled by engineering technology education which focuses primarily on the applied aspects of science and engineering, aimed at

preparing graduates for industrial practices, and engineering operational functions. The four basic disciplines of the engineering technology field are Computer Engineering Technology, Civil Engineering Technology, Electronics Engineering Technology and Mechanical Engineering. Cheshier summarized each of these disciplines as presented in the following paragraphs.

The Engineering Technology Discipline

Computer Engineering Technologists are involved in the construction, operation, and maintenance of computer systems. They deal with both computer hardware and software problems, although their primary focus is on hardware issues, unlike the computer scientist, whose primary focus is on software design and development, installation and support.

Civil Engineering Technology graduates are primarily involved in planning, designing, supervising, and building the infrastructure and facilities essential to modern life. Their projects range from high-rise buildings to mass transit systems, from airports to water treatment facilities, from space telescopes to offshore drilling platforms.

Electronics Engineering Technologists are concerned with electrical devices and systems and with the use of electrical energy. They deal with the application of transistors, semiconductors, integrated circuits, and microprocessors. Electronics Engineering Technology graduates can also work in the area of computers, communications, controls and instrumentation.

Mechanical Engineering Technologists applies the principles of mechanics and energy to the design of machines and devices. Graduates of this discipline deals with heat transfer, aerospace, materials handling, fluid power systems and solid waste processing.

According to Gardner and Pierce (1998), beliefs about oneself are some of the most powerful motivators of behavior. About two decades ago, Bandura began to explore a belief system, which represents people's assessment of their abilities. Bandura suggests that efficacy expectations at a given point in time determine the initial decision to perform a task, the amount of effort that gets expended, and the level of persistence that emerges in the face of adversity (Bandura, 1977, 1989). The following section presents background information relative to self-efficacy theory, with emphasis on its application to prediction of academic performance.

Self-Efficacy Theory

In 1977, Bandura proposed that individuals' self-efficacy plays a role in determining whether or not they will engage in certain activities, how much effort they place in activities, and how long they will remain engaged. More recently, Bandura (1997) adds "efficacy beliefs affect thought processes, the level of persistency of motivation, and affective states; all of which contribute importantly to the types of performances that are realized" (p. 31). Consequently, the construct of self-efficacy and the relationship of individuals' self-efficacy beliefs to the occurrence, effort, and duration of behavior have been applied to investigations relating to career entry behaviors such as choice of college major and subsequent academic performance (Betz & Hackett, 1981; Betz & Hackett, 1983; Betz & Hackett, 1986; Campbell & Hackett, 1986; Lent & Hackett, 1987).

Self-efficacy has been shown to be an effective predictor of individuals' performance outcomes and has been evidenced in the work of various researchers (Bruch, Chesser, & Meyer, 1989). Lent, Brown & Larkin (1986) also reported that academic self-efficacy was a good predictor of grade point average. Students who are positive about their academic skills (high self-efficacy) expect high grades on exams and expect the quality of their work to accumulate benefits. The opposite is

true for those students who lack such confidence (low self-efficacy). Students who are not sure about their academic abilities envision low grades before they begin an exam.

Early research on career self-efficacy focused on investigations of the relationship of general occupational self-efficacy to students' consideration of a range of career options (Betz & Hackett, 1981). However, researchers have since moved toward examining self-efficacy in relation to educational progress and achievement in specific fields.

Lent et al. (1984) conducted the first studies linking career self-efficacy to academic performance and persistence in engineering fields. Findings of their research are supportive of the utility of the self-efficacy construct. Lent, Brown, and Larkin (1984) found that students' beliefs about their ability to complete the educational requirements of various science and engineering fields were predictive of later academic performance. Students declaring relatively strong self-efficacy, generally achieved higher academic grades, and were much more likely to persist in engineering or scientific majors than those with low self-efficacy.

Lent, Brown and Larkin (1987), following up on their early research with an investigation comparing self-efficacy theory to alternative theoretical paradigms, reported evidence suggesting that self-efficacy is helpful in the prediction of grades and persistence of engineering majors. Brown, Lent, and Larkin (1989) documented the interactions between aptitude and self-efficacy. Brown et al.'s results suggest that strong self-efficacy expectations are especially important to the success of moderate ability students as compared to high-ability students, and are also predictive of persistence and grades in the sciences and engineering.

Hackett, Betz, Casas, and Singh (1992) conducted a study to examine the relationship of social cognitive variables to academic achievement in engineering

programs. A total of 218 students enrolled in the School of Engineering at a midsize West Coast University provided the sample for study. Self-efficacy expectations with regard to engineering were measured in two ways: as overall occupational self-efficacy and as self-efficacy for academic milestones. Hackett et al.'s study suggest that self-efficacy for academic milestones, in combination with other academic and support variables, was found to be the strongest predictor of academic achievement.

The previously mentioned researchers have used the Science and Engineering Career questionnaire (SEC) to measure expectations or self-perceptions of personal efficacy in science and engineering areas. It was reported that those students who had significantly higher scores on the Science and Engineering Career scale would be more likely to achieve academic progress than those with lower scores.

## Theoretical Framework

Social cognitive theory and self-efficacy theory guided the research. These theories were used to assess students' ability to complete educational requirements of various science and engineering fields. Self-efficacy theory, as derived from social cognitive theory, is believed to contribute positively towards student career counseling and guidance resulting in improved academic performance of students in engineering and computer science technology (Brown, Lent and Larkin, 1989).

### Social Cognitive Theory

About a decade ago, the prominent Stanford psychologist Albert Bandura (1989) translated his years of basic research using a behavioral and social learning framework into what he called social cognitive theory (SCT). This new theory offered several major advances for the field of psychology. The scope of SCT is much broader and more comprehensive than behavioral theory and social learning theory, the foundations on which researchers had been basing their approach to

behavioral management. SCT includes cognitive constructs such as self-regulatory mechanisms, which extend beyond issues of learning or modifying behavior (Stadjkovic & Luthans, 1998).

In SCT, learning is viewed as knowledge acquisition through cognitive processing of information. In other words, the social part acknowledges the social origins of much of human thought and action, where as the cognitive portion recognizes the influential contribution of thought processes to human motivation, attitudes and action (Stadjkovic & Luthans, 1998).

Drawing from SCT and a considerable stream of basic research, Bandura and others have advanced the concept of self-efficacy. This increasingly recognized psychological construct deals specifically with how people's beliefs in their capabilities to affect the environment control their actions in ways that produce desired outcomes. Unless individuals believe that they can gather up necessary behavioral, cognitive, and motivational resources to successfully execute the task in question, they will dwell on the formidable aspects of the project, exert insufficient effort, and fail (Bandura, 1997).

This aspect of self-efficacy plays an important role in SCT. In his latest book, Self-efficacy: The Exercise of Control, Bandura (1997) suggested that self-efficacy operates in concert with sociocognitive determinants represented by SCT in influencing human action, adaptation, and change. The literature clearly indicates that traditional motivational and behavioral approaches are still relevant but according to Bandura (1997) social cognitive theory (SCT) and its derivative of self-efficacy are needed to extend understanding and help improve performance of students in academia and the workplace.

Social cognitive theory and self-efficacy provide an innovative extension of traditional, motivational and behavioral approaches to career choice and career

development. Social cognitive theory and self-efficacy have been shown to have both explanatory and predictive powers and to be quite different from related psychological constructs such as self-esteem, expectancy, and locus of control. Most importantly, not only does SCT provide a more comprehensive understanding of academic behavior than either motivation or reinforcement theories, but self-efficacy, a derivative of SCT, with its clearly demonstrated strong relationship to career and academic performance, seems to have considerable implications for improving student performance. For example, Lent, Brown and Larkin, (1983), investigated the relationship of self-efficacy beliefs to persistence and success in pursuing science and engineering programs. The results indicated that those students who reported high self-efficacy expectations in being able to complete technical tasks earned higher grades and persisted longer in these programs than those students with lower self-efficacy expectations.

Self-Efficacy Theory

Bandura's (1977) self-efficacy theory focused on how beliefs about one's ability to successfully function in a task can increase an individual's confidence. This concept has been applied to a variety of domains, ranging from the treatment of individuals with phobic problems (Bandura and Adams, 1977) to areas such as career decision-making (Hackett & Betz, 1983); academic achievement and persistence (Lent, Brown and Larkin, 1983).

In their study of vocational behaviors, Hackett and Betz (1983) examined the utility of self-efficacy expectations in understanding the behaviors of men and women in perceiving the range of career options and career decisions related to pursuing desired goals and objectives. Results indicated that women generally failed to fully utilize their capabilities, talents and interests in pursuing careers compatible with their potential.

Lent, Brown and Larkin, (1983) investigated the relationship of self-efficacy beliefs to persistence and success in pursuing science and engineering programs. During a 10-week career-planning course in science and engineering careers, they administered a self-efficacy measure to 28 males and 14 females. Results indicated that those students who reported high self-efficacy expectations in their ability to complete technically related tasks earned higher grades and were able to persist longer in the programs as compared to those students with lower self-efficacy expectations.

According to Bandura's (1986) social cognitive theory, individuals possess a self-system that enables them to exercise a measure of control over their thoughts, feelings, motivation, and actions. Self-efficacy, a derivative of social cognitive theory, is strongly related to the individual's perceived capabilities to produce results and to attain designated types of performance. In the present study, self-efficacy beliefs were explored to predict academic performance of students in engineering technology.

## Statement of the Problem

Campbell (1990) pointed out that Computer Science and engineering technologists are more and more in demand, however, the supply of academically prepared graduates is inadequate to meet the needs of industry. Many students who enter computer and engineering technology programs are unable to sustain a satisfactory level of achievement required for program completion. There is need for a counseling tool that will be useful in selection and preparation of students who enter computer and engineering technology programs. However, an extensive review of the literature has failed to identify an effective, comprehensive counseling tool that will enable more students to graduate and become productive technologists in business and industry. This study was designed to extend the findings of Lent,

Brown and Larkin (1986) and the applicability of Bandura's self-efficacy theory to the process of students' ability to complete the educational requirements of various science and engineering fields.

In particular, results of this study were intended to determine what factors were useful in predicting academic performance (college GPA) of upper-level students in Engineering and Computer Science Technology programs, based on measurable parameters (career-related self-efficacy beliefs, math SAT scores, high school GPA, vocational interests). The resulting model, based on possible importance of career-related self-efficacy beliefs and other career-related variables, was expected to contribute to the process of translating self-efficacy theory into a practical approach for career counseling of upper level students enrolled in Computer Science and Engineering Technology Programs.

## Purpose of the Study

The purpose of this study was to determine what factors were useful in predicting academic performance (college GPA) of upper-level students in Engineering and Computer Science Technology programs, based on measurable parameters (career-related self-efficacy beliefs, math SAT scores, high school GPA, vocational interests). The resulting model, based on possible importance of career-related self-efficacy beliefs and other career-related variables, was expected to contribute to the process of translating self-efficacy theory into a practical approach for career counseling of upper-level students enrolled in Computer Science and Engineering Technology programs.

Therefore, this study assessed the strength of career related self-efficacy beliefs of upper-level students enrolled in Computer Science and Engineering Technology programs to determine the extent to which measurable parameters (career-related self-efficacy beliefs, math SAT scores, high school GPA, vocational

interests) could predict academic performance (college GPA) of upper-level students enrolled in Computer Science and Engineering Technology programs. Information gained from this study was expected to allow improvement of advisor effectiveness and career counseling for students.

## Research Questions

The following research questions were investigated as a means of gaining useful information for educators and counselors to assist students in completing their undergraduate programs in Computer Science and Engineering Technology:

1. Is there a relationship between the academic performance (college GPA) of undergraduates enrolled in Computer Science and Engineering Technology programs and math SAT scores or high school grade point average (GPA)?

2. Is there a relationship between the academic performance (college GPA) of undergraduates enrolled in Computer Science and Engineering Technology programs and self-efficacy (scores) or vocational interests (scores) as measured by the Science and Engineering Questionnaire?

3. Is there a relationship between the academic performance (college GPA) of undergraduates enrolled in Computer Science and Engineering Technology programs and math SAT scores, high school GPA, self-efficacy (scores), or vocational interests (scores), based on gender?

## Significance of Study

This study was expected to contribute to the process of translating self-efficacy theory into a practical approach to career counseling and guidance of students enrolled in Computer Science and Engineering Technology programs. With information about students' occupational interest, extent of interest in science and engineering careers, types of occupations and activities in which students would likely engage, counselors and teachers will be better able to advise students who are

considering careers in Computer Science and Engineering Technology fields. Such information will also be useful for recruitment of students interested in careers in the varying engineering fields.

## Assumptions and Limitations

The following assumptions were made in this study:

1. It was assumed that students enrolled in Computer Science and Engineering Technology programs responded to the survey instrument honestly, thus reflecting their true perceptions.

2. It was assumed that the Science and Engineering Career Questionnaire (SEC) developed by Lent, et al (1986) accurately measured self-perceptions of personal efficacy and vocational interest in science and engineering areas.

The limitations of this study were:

1. The study was limited to students who were enrolled in Computer Science and Engineering Technology programs at Savannah State University during the Spring semester of the 1998-1999 academic year.

2. Response bias may have occurred because some students may have been acquainted with the researcher, which may simulate a demand effect.

3. The results were limited to expectations of career, which are merely expectations, not actual practice.

4. Certain demographic variables, such as socioeconomic status, were not considered in the analyses.

## Definition of Terms

For the purposes of this study, the following terms were utilized:

Self-efficacy

Self-efficacy refers to beliefs about one's ability to successfully perform a given task or behavior, which may be important mediators of behavior and

behavior change. Efficacy beliefs predict the range of career options people consider viable for themselves when variations in actual ability, prior level of academic achievement, and vocational interests are controlled. Self-efficacy, as measured by the Science and Engineering Career Questionnaire (SEC) (Lent et al., 1983), refers to an individual's beliefs regarding the ability to perform a particular task or behavior unique to science and engineering fields (Bandura, 1977). Self-efficacy is defined in terms of two scores, educational requirement and academic milestone. Educational requirements (ER) and academic milestones (AM) are both further divided into two components indicating level and strength of self-efficacy. For this study, only strength of self-efficacy was needed because it effectively subsumes information contained in the level measures. Therefore, only scores for ER-S and AM-S were obtained.

ER-S (Educational Requirement)

Educational requirement is a score derived from the SEC questionnaire that indicates whether or not a participants perceives he/she can complete the educational requirements or job duties of fifteen science and engineering occupations.

AM-S (Academic Milestone)

Academic milestone is a score derived from the SEC questionnaire that indicates whether or not a participant perceives he/she can successfully complete scientific core course requirements in engineering and computer science technology. Participants are asked to rate their degree of confidence in their ability to perform specific accomplishments critical to academic success in science and engineering majors (e.g. "complete the mathematics requirements for most engineering majors").

Vocational Interest

Vocational interest is a score derived from the SEC questionnaire that indicates a participant's perceived degree of interest in each of the 15 science and engineering occupations.

Academic Performance

Each student's most recent overall quarterly college grade point average (GPA) will serve as an indicator of academic performance. GPA will be presented on a scale of 4.0, the higher GPA will reflect good academic performance.

Upper-Level Students

In this study, upper-level students are defined as undergraduate students enrolled in Computer Science and Engineering Technology programs that have completed four or more semesters of course work at Savannah State University.

# CHAPTER II

## REVIEW OF LITERATURE

This chapter is divided into three sections beginning with a review of self-efficacy theory and related concepts. Discussion about fundamental cognitive capacities, types of expectancies, sources of self-efficacy beliefs, self-efficacy and self-confidence, self-efficacy and motivation, self-efficacy and learning outcomes, self-efficacy and career-related concepts, and self-efficacy and gender are central to the discussion in the first section. The second section introduces related major theories including decision theory and decision making paradigms. Expectancy, behavioral, developmental and trait and factor theories are also discussed in the second section, along with presentation of sociological, contextual, and psychological approaches to career decision making. The final section reviews several measures used to assess self-efficacy and vocational interest.

### Self-Efficacy Theory

Two decades have passed since Bandura (1977) first identified self-efficacy theory as a belief of one's ability to successfully perform a given task. By the end of his first decade of study, Bandura (1986) had determined that human functioning might be dependent on cognitive capacities.

#### Fundamental Cognitive Capacities

According to Bandura (1997), human cognitive capacities that can predict individual's performance include ability to use symbols, learning through observation,

planning, self-regulation, and self-reflection. A brief description of each of these human cognitive capacities, as described by Bandura.

Ability to Use Symbols. By the use of symbols, humans transform immediate visual experiences into internal cognitive models that, in turn, serve as guides for their actions. Through symbolizing, people also ascribe meaning, form, and duration to their past experiences.

Learning Through Observations. Learning can also occur indirectly by observing other people's behavior and its outcomes. Individuals' capacity to learn by observation enables them to obtain and accumulate rules for initiating and controlling different behavioral patterns without having to acquire these behaviors by risk or trail and error.

Planning. People not only react immediately to their environments through a symbolic process, but also self-regulate their future behaviors by planning. In particular, people plan courses of action for the near future, anticipate the likely consequences of their future actions, and set goals for themselves.

Self-Regulation. Through self-regulatory functions, human behavior is motivated and regulated by internal standards and self-evident reactions. The ability of self-regulation enables people to analyze their experience and to think about their own thought processes (Bandura, 1986).

Self-Reflection. The self-reflective capability also called self-reflective consciousness, enables people to think and analyze their experiences and thought processes. By reflecting on their different personal experiences, individuals can generate a specific knowledge about their environment and about themselves.

Types of Expectancies

Self-efficacy is based on the two types of expectancies, which exert powerful influences on behavior of individuals; efficacy expectation and outcome expectation.

Efficacy Expectation. An individual's perceived ability to perform a behavior Bandura (1977, 1986) is referred to as efficacy expectation. Efficacy expectation can help predict (a) whether or not to engage in the behavior, (b) how much effort will be expended, and (c) how long behavior will last despite possible hurdles.

Outcome Expectation. The belief that outcomes may result from engaging in a specific behavior is referred to as outcome expectation (Bandura, 1977; Bandura, 1986). There is not enough evidence, to clearly demonstrate a relationship between outcome expectation and behavior choices, therefore, efficacy expectation appears to be a better predictor of individual actions.

Sources of Self-Efficacy Beliefs

In his research, Bandura (1982) suggested that beliefs about self-efficacy are based on four major sources: performance, vicarious experiences, verbal persuasions, and physiological feedback. The most influential source of these beliefs is the result of one's performance. Repeated failure will lower perceived self-efficacy while success will increase it. Vicarious experiences influence personal beliefs by comparing one's situation with that of others. When individuals are introduced to persons who have similar talents in successfully performing that behavior, their efficacy expectation increases. Verbal persuasion is the influence of other suggestions on efficacy beliefs and is a weaker source of efficacy information than performance or vicarious experiences, but persuaders can play an important role in the development of an individual's self-beliefs (Zeldin & Pajares, 1997).

Lastly, physiological states such as anxiety, stress, and fatigue also provide added information about efficacy beliefs. Bandura (1997) has observed that people live with psychic environments that are basically of their own making. When individuals experience unpleasant thoughts and fears about their capabilities, those negative affective reactions can themselves further lower perceptions of capability and trigger the stress, which can ensure the negative performance they fear.

Self-Efficacy and Self-Confidence

Two constructs, academic self-efficacy and academic self-confidence, have demonstrated a great deal of influence on academic performance and persistence of students in science and engineering (Lent et al., 1986). Self-confidence and self-efficacy have received attention both as outcomes of college attendance, and a mediating influence on students' academic achievement (Brown, Lent & Larkin, 1989; Hacket et al., 1992; Lent, Brown & Larkin, 1986; Pascarella, Smart, Ethington & Nettles, 1987). Some researchers have identified self-confidence as another component in the development of efficacy. Self-confidence is generated by the amount of knowledge possessed concerning a specified task and by the level of skill needed to successfully fulfill the desired outcome (DeMoulin et., 1993).

Various researchers have employed the terms academic self-confidence (Berg & Ferber, 1983; Felder et al., 1995; Horning, 1987), academic self-concept (House, 1993; Hurtado, 1994; Sax, 1994) and self-esteem (Brush, 1991; Windall, 1988), sometimes even within the same study to refer to students' self-perceptions of their academic abilities. Academic self-confidence has been measured by asking students to rate their academic abilities, separated into discrete scale items such as math, writing, overall academics, and computer skills relative to the abilities of their peers (Austin & Sax, 1994; Pascarella et al., 1987).

Relative to academic self-confidence, the conceptualization and measurement of academic self-efficacy is more complex. While academic self-confidence refers to students' self-perceptions about the amount of knowledge possessed concerning a specified task and by the level of skill needed to successfully fulfill a desired outcome, academic self-efficacy refers to an individual's expectations of attainment in relation to the completion of specific academic tasks (Lent, Brown & Larkin, 1986). Derived from Bandura's (1977, 1982) social cognitive theory, self-efficacy consists of self-expectations about efficacy and outcomes. Efficacy expectations refer to an individual's belief about his/her ability to perform any task successfully. When the term academic self-efficacy is used in the literature, this is the element of self-efficacy theory that is specifically tailored to the educational environment (Brown et al., 1989).

A review of the academic persistence literature identifies several variables that exist in support of academic persistence and performance at different levels in any program of study. These variables may also function in conjunction with academic self-confidence and academic self-efficacy. Such variables include parental socioeconomic status, as indicated by educational accomplishment and job status (Austin & Sax, 1994; Isaac, Malaney & Karras, 1992; Hurtado, 1994); foregoing academic accomplishments (Girves & Wemmerus, 1988; Tinto 1993), and students' perceptions of the extent to which their previous education has prepared them for their current program of study (Astin & Sax, 1994).

Self-Efficacy and Motivation

According to Bandura (1997), motivation is a general construct that encompasses a system of self-regulatory mechanisms. It is considered to be an individual's driving force or the factor that makes one complete a certain task. Some researchers believe motivation is only linked to performance (Landy &

Becker, 1988; Knowlton, 1990), others have identified motivation as part of a need theory (Alderfer, 1969; Maslow, 1943), and still others have linked motivation to job satisfaction (Herzberg, 1966; Sergiovann, 1967).

In some way, perceptions of capability play a noticeable role in most theories of motivation. For example, according to expectancy theory, motivation is primarily a result of individuals' beliefs about the likely outcomes of their actions and of the incentive value they place on those outcomes (McClelland, 1985; Rotter, 1982). Most recent theories of motivation can be realized as variations of expectancy-value models of motivation.

According to De Moulin (1993) motivation, confidence, and stress comprise the key elements in determining efficacy. The relationship is further expressed in the equation *Self * (Motivation * Confidence)/Stress = Efficacy*, and is designated as the effectiveness model (DeMoulin, 1993). This theory rests with the evidence that self-efficacy is determined by the product of self-motivation and self-confidence (numerator) and is divided by functional components of stress (denominator) producing an efficacy fraction. This resulting fraction represents the magnitude of significance displayed by motivation, confidence, and stress in generating an individual's level of self-efficacy. As the fraction changes, self-efficacy is changed. This change in efficacy is referred to as efficacy shift.

DeMoulin (1993) has suggested that the level of motivation is a significant factor in determining self-efficacy. Whether the level of motivation was derived primarily through intrinsic means, through extrinsic means, or through some combination of both, is insignificant. However, according to the literature, motivation is generated in one of three ways: (1) through internal desire to excel, such a motivation is also identified as intrinsic motivation; (2) through external

factors such as money, job, recognition, and advancement, (also referred to as extrinsic motivation), and (3) some combination of both.

The relationship between self-efficacy and learning outcomes can be explained by relating self-efficacy to its influence on motivation. An individual's perception of self-efficacy is the major component of any expectancy, especially those that pertain to academic tasks. This relationship between self-efficacy, expectancies, motivation, and eventually learning or achievement outcomes has become more and more accepted (Bandura, 1986; Schunk, 1990). Individuals will be motivated to engage in tasks when they value the outcome expected; they will be less willing to perform tasks whose outcomes they do not value.

Expectancy value theorists agree that judgments of skill play an interactive role with valued outcomes in determining the tasks in which individuals will engage (Wigfield & Eccles, 1992), but they emphasize the more prominent role of a construct similar to which Bandura (1986) called outcome expectations in influencing motivation and predicting behavior. The effectiveness model clearly indicates that individuals with high motivation and high confidence generally possess a high degree of self-efficacy. These individuals like what they do and have the capability to accomplish required tasks. However, a deficiency in either or both may have adverse outcomes.

Self-Efficacy and Learning Outcomes

Learning outcomes can be broadly labeled into two categories: cognitive and affective. The cognitive outcome is the actual knowledge and skills acquired. The affective outcome is the self-concept changes. The application of self-efficacy beliefs has positive effects on both the outcomes. Bandura (1986) suggested that individuals with high self-efficacy exhibit low anxiety, better working styles, and better focus.

He also suggested that self-efficacy theory combined with behavioral analysis of student performance could improve learning outcomes.

Bandura (1984) argued that the outcome people expect are largely dependent on their judgments of what they can achieve. Students may recognize that strong mathematics skills are important for a good score on the Graduate Record Examination (GRE) and admission to graduate school, which in turn, may guarantee a great career and prosperous lifestyle, but if they have low confidence (low self-efficacy) in their math abilities they may shy away from certain courses and may not bother to take the GRE or apply to graduate school. However, high self-efficacy and negative outcome expectations are likewise possible. For example, a student reasonably confident (high self-efficacy) in her/his physics capabilities may elect not to enroll in a physics course because the professor's grading curve is such as to discourage all but the daring. Several theorists have acknowledged the importance of self-efficacy theory to the understanding and prediction of career relevant behaviors, such as vocational choices and academic outcomes. Self-efficacy theory has been found to be more vigorous than alternative theoretical systems in explaining and predicting academic performance variables among college students (Lent et al., 1987; Siegel, Galassi, & Ware, 1985).

Various researchers have assessed general academic self-perceptions of competence. The basic problem with such assessments is that students must generate these judgments without a clear academic activity or task in mind. Pajares (1996) has suggested that domain-specific assessments, such as asking students to identify their confidence to learn mathematics or writing, are more explanatory and predictive than excluded measures and preferable to general academic judgments. Thus, a growing body of research relating self-efficacy beliefs to academic outcomes

has been generated. The differing role played by beliefs of personal skills versus self-efficacy about likely outcomes continues to be an area of study.

Self-efficacy and Career-Related Concepts

Viewed outwardly, self-efficacy appears very similar to self-concept, self-esteem, and career identity. However, there are sometimes subtle, but important differences that allow researchers to more clearly understand and apply self-efficacy theory. The following paragraphs discuss some of the subtle differences between the related concepts of self-concept, self-esteem, and career identity.

Self-Concept. Self-concept is derived from self-efficacy, but the two concepts are different in application and execution of the concept. Self-concept is a person's self-perceptions, formed through experiences with his or her environment (Shavelson, Hubner, & Stanton, 1976). It is a relational term that is used to denote students' judgments of their competence or skills relative to those of other students. It refers to the determination of one's comparative standing in any given area of competence or skill. Gresham, Ellion, and Evans (1993) defined self-concept as a complex, interactive network of self-perceptions a person holds about his or her confidence in enacting certain behaviors and in having certain culturally valued personal attributes in relation to the other individuals. The research on college students typically examines their self-concept in either or both academic and social areas.

However, as previously noted, self-efficacy suggests that psychological intervention strategies serve as a means of creating, strengthening, and maintaining expectations of personal competence (Bandura, 1977, 1982, 1986). In self-efficacy theory, individuals base their expectations of personal competence or efficacy on four major sources of information: performance accomplishments, vicarious experiences, verbal persuasion, and emotional arousal. Two of these sources,

performance accomplishments and vicarious experiences, are most relevant for designing intervention to enhance self-concept.

Performance (accomplishments) of an individual can provide an excellent gage for self-efficacy. Repeated failure will lower perceived self-efficacy while success will increase it. This performance criterion could assist individuals in improving the self-concept when the performance is compared to other individual in similar domains (Bandura, 1982). The other source of information on which individuals base their expectations of efficacy, vicarious experiences, influences personal beliefs by comparing
one's situation with that of others. When individuals are introduced to persons who have similar talents in successfully performing that behavior, their efficacy increases. The concept of vicarious experience has a direct influence on self-concept because it compares the individuals with same talents to evaluate performance (Bandura, 1982).

Self-Esteem. Although conceptually similar, self-esteem and self-efficacy are quite different. The first difference is in the domains that self-esteem and self-efficacy cover. Self-esteem is often portrayed as a global construct that represents a person's self-evaluations across a wide variety of different situations. In contrast, self-efficacy is the individual's conviction about a task and context specific capability (Franks & Marolla, 1976; Gecas & Schwalbe, 1986). Second, self-esteem tends to be more stable, an almost trait like variable, whereas self-efficacy is a dynamic construct that changes over time as new information and task experiences are obtained.

Finally, self-esteem is based on a reflection of the self (e.g., feelings and self-worth) that is usually derived from perceptions about several personal characteristics (e.g., intelligence, integrity). By contrast, some people might have

high self-efficacy for some tasks (e.g., technically based problem solving) and, at the same time, very low self-efficacy about other tasks (e.g., writing technical reports). However, neither of these results in an increase in overall self-esteem (Branden, 1983; Franks & Marolla, 1976; Gecas & Schwalbe, 1983).

Self-esteem and self-efficacy, although distinct, are also related, both theoretically and empirically. A reasonable assumption is that people who have come to perceive
themselves as highly capable, significant, successful, and worthy (high global self-esteem) will generally predict higher possibilities of task success (high self-efficacy) than
will those who see themselves as less capable, significant, successful, and worthy (low global self-esteem).

Career Identity. According to Pascarella (1991), students have a career identity if they have: (a) a concept of themselves as a worker with the ability and self-esteem to carry out work-related tasks; (b) an awareness of the necessary skills and responsibilities for a career; (c) an awareness of the educational and training demands of work; (d) taken steps to become competent; and (e) begun career planning and exploration.

Traditionally, career counseling has been viewed by many critics as either "test or tell" (Crises, 1981). Much of this criticism is linked to the historical emphasis that was placed upon the assessment of interests and values and the identification of *goodness of fit* in terms of occupational environments. Although these endeavors have merit, and will continue to have merit in the delivery of career counseling interventions, Sonnenfield (1984) believes people will continue to expect more from their careers in terms of general satisfaction and that careers will play a more integral role in the overall identity of people. As a result, career counselors

will be channeled to assist individuals in developing a greater appreciation for some of the emotional components that contribute to the selection or avoidance of career options, and finally how these emotional components can have an impact on overall performance.

Personal Flexibility. According to Herr (1990), the behavior, skills, and attitudes sought by industrialized societies for their workforce, can be summarized under the term personal flexibility. More recently, in 1996, Herr suggested that there are categories of skills subsumed under the broad rubric of personal flexibility that seem relevant to the context of: global economic transformations, shifts in the organization of work, and career opportunities that are chosen from a larger pool of globally defined career possibilities.

Danish, Galambos, and Laquatra, (1983) suggest that the concept of personal flexibility in not unlike that of personal competence or life development skills. In each of these perspectives, personal flexibility or competence can be defined as a series of skills or forms of knowledge that an individual acquires either through process of socialization or training.

Herr (1996) suggests that personal flexibility represents an alternative set of cultural competencies that people need to learn about and possess, as these skills relate to their ability to master and change career dimensions influenced by the global economy. He further suggests that personal flexibility is an essential element of career counseling and guidance for persons involved in the global economy of the present and future.

Self-Efficacy and Gender

Derived from Bandura's (1977) self-efficacy theory, in which self-efficacy expectations are defined as a person's beliefs about his or her ability to successfully perform specific behaviors, Hackett and Betz (1981) proposed a model that applied

self-efficacy theory to the career behavior of women. Hackett and Betz theorized that, due to women's early socialization experiences, women lack the confidence to perform many career-related tasks and in turn, are not able to recognize their strengths and capabilities in career areas. The authors emphasized that the under-representation of women in many non-traditional, male dominated professions was due largely to the effects of gender socialization and the resulting internalized beliefs about one's ability to achieve in certain career areas.

Hackett and Betz (1981) expanded Bandura's (1977) four bases upon which women perceive lower career-related self-efficacy expectations than men. The four influences of self-efficacy expectations proposed in their model were performance accomplishments, vicarious learning, emotional arousal, and verbal persuasion. In terms of performance accomplishments, a woman was expected to perform more stereotypical female tasks such as housework, and thus have lower self-efficacy about non-traditional tasks. The second influence of self-efficacy expectations, vicarious learning was thought to negatively affect women's levels of self-efficacy because the lack of female role models in non-traditional occupational areas decreased the likelihood of a woman entering these types of career fields. The third influence of self-efficacy expectations proposed in the Hacket and Betz (1981) model, emotional arousal, was believed to play a role in negatively affecting the level of self-efficacy of women because more feminine-typed people are socialized to experience more anxiety and higher stress regarding tasks. The final source of information in which women developed lower levels of self-efficacy regarding career-related behavior was verbal persuasion, a situation in which a woman would experience lack of encouragement and even active discouragement from nontraditional occupational fields, and thus, have lowered self-efficacy expectations toward these options.

With these four sources in which a woman would have lower self-efficacy expectations than a man, Hackett and Betz (1981) proposed questions regarding the implications of these beliefs affecting women's ability to make effective career decisions and confidently perform career-related tasks. The authors theorized that women who experience lower self-efficacy expectations due to the four sources of information would be less confident in their career decision-making abilities.

When analyzing how career self-efficacy expectations affected perceived career options in college students, Betz and Hackett (1981) found that a woman's beliefs about her ability to succeed in a career influenced the traditionality of her career choice. While the study found that undergraduate college women scored higher on ability than the college men, the women had lower self-efficacy expectations for occupations nontraditional for women. Betz and Hackett (1981) suggested that women were socialized to select occupations that were traditional for their gender and not to select occupational choices that were nontraditional, including those in math and science areas.

Stitt-Gohdes (1997) suggested that environment and circumstances may affect *an individual's* efficacy expectations as well as *an individual's* outcome expectation*s*. If a woman with low self-efficacy finds herself in *a* sextyped situation, she may well not be willing to attempt to challenge *the* status quo because of her perceptions of the consequences of that behavior. According to Betz and Hackett (cited in Stitt-Gohdes, 1997), "strength of a woman's personal or self-efficacy is directly related to the pursuit and achievement of a career that is compatible with her abilities. A weak or strong self-efficacy will determine how a woman copes with and manages internal and external career-related barriers "(p. 27).

## Career Development Theories

At present, there are several theoretical foundations for decision theories that focus on career choice and career development. This section provides a discussion of decision and expectancy theories, behavioral, developmental, and trait and factor theories.

### Decision Theory and Decision Making Paradigms

Herr (1996) states " Decisions are not simply benign, independent behaviors that persons emit impulsively. Rather, decisions are the conjunctions between self and environment" (p 185). Decision making theory is based on the Keynesian economic theory, in that an individual chooses a career goal or an occupation that will maximize gain and minimize loss. The gain or loss is not necessarily monetary but can be anything that is of great importance to the individual. The career path or an occupation that an individual decides to pursue might be considered as a means of achieving certain perceived rewards such as greater prestige, security, social mobility or a spouse. The person will choose the path that promises to provide the most reward for his or her investment with the least chance of failure (Herr, 1996).

The concept of maximizing gain and minimizing loss facilitates the processes of career guidance, career counseling, and career choice. For example, Herr (1996) suggested that students will decide on a career or occupation that will maximize gain, and thus, provide counselors with models and concepts to help them discuss the process of decision making directly with the students.

When investigating career decision-making behavior, it is important to utilize a self-efficacy measure that will indicate levels of career decision making. Taylor and Betz (1983) designed a scale to measure factors such as indecisiveness, choice anxiety, and avoidance in deciding on an occupational choice as a way to assess the degree of a person's own self-efficacy expectation related to career

decisions. Career decision-making self-efficacy refers to the level of confidence that an individual has in making a career-related decision. Their measure, the Career Decision Making Self-efficacy Scale (Taylor & Betz, 1983), is derived from Bandura's (1977) theory on self-efficacy expectations and is intended to assess an individual's level of self-efficacy in a career path. Certain variables, such as external barriers, lack of confidence in decision-making skills, and lack of immediacy to make a decision were cited as variables contributing to a person's self-efficacy.

Many paradigms exist that describe the decision making process. Pitz and Harren (1980), have suggested that a decision making process can be classified in terms of four elements: set of objectives that the decision maker seeks to accomplish; set of choices or alternative courses of action, among which the decision maker must make a choice; set of possible outcomes that are linked with each choice; and the ways that each outcome might be assessed with respect to how well it meets the decision maker's objectives.

Gati, Shenhav, and Givon (1993) suggest that decision making is theory dependent and identified the following seven stages of decision making:

> (a) defining or structuring the decision problem, (e.g. selecting a major or choosing a career); (b) selecting a set of aspects or criteria relevant to the decision (e.g. yearly income, prestige); (c) ranking or rating by importance the various aspects identified as relevant to the specific decision; (d) explicating the individual's preferences regarding the various levels of those aspects identified as the more important ones; (e) identifying occupational alternatives the characteristics of which are compatible with the career decision-maker's preferences; (f) ranking alternatives from most to least

preferred based on all information; and (g) implementing the most preferred alternative (p. 53).

Studies show a strong correlation between decision theory and career choice. For example, (Vondracek , Hostetler, Schulenberg & Schmizu, 1990) used the Career Decision Scale (CDS) developed by (Osipow, 1980), to describe career decision behavior among 266 junior high school and 199 senior high school students, consisting of 222 boys and 243 girls. Using the CDS, the researchers were able to identify students who were undecided because they were confused and lacked information about occupations. They were also able to identify those students who were undecided because they had an attraction to several occupations; and those who could not reach a decision because they perceived either internal or external barriers to decision making.

Expectancy Theory

Student motivation has long been considered an important factor in the determination of academic performance. The nature and extent of links between motivation and performance have been explored in a number of ways. One way in which the nature and extent of links between motivation and performance has been explored is through expectancy theory, as developed by Vroom (1964).

According to this theory, motivation to act is a combination of the perceived attractiveness of future outcomes and the likelihood one's actions will lead to those outcomes. Thus, motivating students to put forth-academic effort depends on students' perceptions of the benefit of academic performance and their belief that exerting effort will actually lead to higher performance.

As originally developed by Vroom (1964), expectancy theory is made up of two related models, the valence model and the force model (Herr, 1996). The valence model attempts to capture the perceived attractiveness, or valence, of an outcome by aggregating the attractiveness of all the associated resultant outcomes. More

specifically, the valence model suggests that the valence of first level outcome is equal to the summation of the products from all associated second level outcome valences, with the perceived belief that the first level outcome will result in the second level outcome. In the context of academic performance and career development, we expect the valence model to accurately explain a student's assessment of the attractiveness of academic success in terms of course grade. The second level outcome related to academic success is in terms of increasing one's overall grade point average, allowing one to perform at a superior level in one's initial post college job, and obtaining a strong feeling of personal satisfaction.

The force model of expectancy theory attempts to capture motivational force to act by associating the expectancy of resultant outcomes and their individual valences. The force model more formally suggests that the motivational force influencing a person to perform an act is equal to the sum of the products of the valences of first-level outcomes multiplied by the expectancy that the act will result in those outcomes. In the context of academic performance prediction, the force model implies that a student's motivational force to achieve academic success (e.g. earn a grade of A) is explained by the attractiveness of academic success and the expected probability that increased effort will lead to academic success. Of interest is the fact that several recent findings regarding the force model of expectancy theory have indicated that significant numbers of individuals use a simpler additive processing model rather than the multiplicative form (Butler & Womer 1985; Rynes & Lawlet, 1983; Snead, 1991).

Several researchers have examined the relationship between Vroom's expectancy theory and student academic performance. Vollmer (1986) found that, even after controlling student preparation time, past grades, and perceived ability, expectancy was still positively associated with subsequent grades. Similarly,

Malloch and Micheal (1981) used a multiple regression approach and found that college students' GPAs could be predicted from ability and expectancy measures.

Behavioral Theory

Schultz (1994) suggested that Skinner's approach to behavior is simple in its essential concept, which is that all behavior can be controlled by its consequences. Schultz stated that Skinner believed that humans could be trained to perform virtually any act by the extent and nature of the reinforcement that followed the behavior. Also, according to Skinner (1953), behavior theory relies only on observable behavior, discounting mental activities. Consequently, many behavior theorists define learning as nothing more than the acquisition of new behavior (Phillips, 1996). These views possibly explain why behavior theory's positive and negative reinforcement techniques can be very effective in treatments for human disorders such as autism and antisocial behavior.

According to Schultz (1994) the basic tenet of Skinner's approach is that behavior is controlled and modified by variables external to the organism. External sources are the shapers of behavior, and individuals have the power to act to change them. Skinner proposed the idea of self-control, however, he did not mean control of the self, but rather control of the external variables that determine human behavior. For example, if the music from a neighbor's stereo is annoying and interferes with ability to concentrate on a book, one could leave the room and go to the library and study, thereby removing oneself from an external variable that affects and controls one's behavior.

How well people meet their standards of behavior determines their sense of self-efficacy. In Bandura's (1982) view, self-efficacy refers to feelings of adequacy, efficiency, and competence in coping with life. He described it as a person's perception of the ability "to produce and regulate" life events (p.122). Later,

Bandura (1986) suggested that most human behavior is learned through example, either intentionally or accidentally. He stated that people learn by observing other people and patterning their behavior after the people they observe. Bandura applied his behavior models to enhance self-efficacy in a variety of situations, including academic performance.

Developmental Theory

Pascarella (1991) suggested that, theorists vary in the degree to which they subscribe to certain characteristics or features of the development process. Development theory in general is viewed as a general movement toward greater differentiation, integration, and complexity in the ways that individuals think, value and behave. This movement is typically seen as orderly, sequential, and hierarchical, passing through ever-higher levels or stages of development, and to some extent as age related.

Theory and practice in career development have been increasingly characterized in recent decades as a lifelong series of choices that individuals make to express their changing needs (Super, 1984). This understanding of career development has replaced
the rigid conception that had been a legacy of the trait-factor dominated counseling approach (Issacson, 1985). In psychological terms, career development can be considered to be an act of meaning construction. In theoretical terms, Super's study (as cited in Carlsen, 1988, p. 185) described the centrality of *meaning making* in career development when he proposed that the *cement* that holds career development theory together is self-concept theory, which treats the individual as the socialized organizer of his or her experience.

Kegan (1982) described development as a function of the "process of evolution as a meaning-constitutive activity" (p. 42). According to Epstein (1983),

Kegan's constructive development theory is perhaps the most inclusive of the cognitive development theories, explaining how the *self* constructs meaning across the affective, cognitive, and moral domains.

Herr (1996) suggested that career counseling could be considered as a development enhancing activity, one that helps individuals to achieve greater flexibility. He further recommended that the individual occupations, as described by the career development concepts, can be understood, anticipated, and influenced by systematic programs of career counseling, career guidance, or career education.

Trait and Factor Theory

In trait and factor theory, the individual is a pattern of traits and factors such as interests, aptitudes, achievement, personality characteristics that can be identified through objective means, usually psychological tests or inventories, and then analyzed to represent the individual's potential Herr (1996). Through trait and factor theory, predictions can be made using individual traits as predictors, and the degree to which these traits are possessed by successful persons in different occupations as the criteria. The techniques and results of the numerous studies combining different traits and different occupational requirements also provide a means of assessing an individual's potentials.

In his review of trait and factor theory, Brown (1984) suggested the following: (a) each individual has a unique set of traits that can be measured reliably and validly; (b) occupations require that workers possess certain traits for success, although a worker with wide range of characteristics can be successful in given job; (c) the choice of an

occupation is a rather straightforward process, and matching is possible; and (d) the closer the match between personal characteristics and job requirements, the greater the likelihood for success (p. 12) .

Sociological, Contextual, and Psychological Approaches

Sociological or situational approaches to career choice and/or career development represent change from place to place and from time to time. The situational or sociological outlook on career development approaches is a reminder that decision-making, the development of self-identity, and life changes do not occur in a vacuum. They occur within political, economic, and social conditions that influence the achievement images and belief systems on which individuals base their actions (Watts, 1981).

Contextual perspectives emphasize the nature of social, physical, and cultural aspects. The context in which career behavior evolves is different across nations,

communities, and families. It is different from one socioeconomic group to another. The career context is also different across time. As social, economic, and technological conditions change at a national or global level, they reflect the decrease of some types of work opportunities and lifestyles and the emergence of the others Herr (1996).

A psychological approach to career development emphasizes individuals' motivation. The major assumption of the psychological approach is that because of differences in personality structure, individuals develop certain needs or drives and seek satisfaction of those needs or drives through occupational choices (Herr, 1996). These differences in personality occupational can lead to different choices. Silver and Spilerman (1990) suggested that psychological approaches consistently develop a classification of personality or need, and then relate it to gratification available in occupational or educational environments.

## Assessing Self-Efficacy and Vocational Interest

There are several measures used to assess self-efficacy and vocational interest. The measure selected for use in this study and five additional measures often used in educational environments are presented in the following paragraphs.

### Science and Engineering Career Questionnaire (SEC)

The Science and Engineering Career Questionnaire (SEC) is based on Bandura's (1977) self-efficacy theory. According to Bandura (1977), self-efficacy expectations refer to beliefs about one's ability to successfully perform a given task or behavior, which may be important mediators of behavior and behavior change. Efficacy beliefs predict the range of career options people consider viable for themselves when variations in actual ability, prior level of academic achievement, and vocational interests are controlled.

Application of Bandura's theory to academic performance and career options is based on the criteria that students reporting relatively strong self-efficacy generally achieve higher grades and are much more likely to persist in technical or scientific majors. In their use of the SEC questionnaire, Lent, Brown and Larkin (1984) found that students' beliefs about their ability to complete the educational requirements of various science and engineering fields were predictive of academic performance and career options.

The Science and Engineering Career questionnaire (Lent et al., 1983) is used to measure participants' self-perceptions (expectations) of personal efficacy. Specifically, this instrument is designed to measure an individual's self-efficacy beliefs regarding ability to perform a particular task or behavior (Bandura, 1977) unique to science and engineering fields. The questionnaire consists of two components, one measures the *level* of self-efficacy by asking the participant to assess whether she/he could successfully complete the educational requirements

(ER) or training requirements of fifteen science and engineering occupations. The other component evaluates the *strength* of self-efficacy expectations by asking participants to estimate her/his degree of confidence in being able to perform the job duties of fifteen science and engineering occupations.

Scores on the first index, educational requirements (ER), are obtained for both strength and level of self efficacy. First, level of self-efficacy (ER-L) scores are obtained by summing the number of fields participants believe they can complete. Next, strength of self-efficacy (ER-S) is assessed by having participants rate their degree of confidence in their ability to complete these educational requirements or job duties. Strength is indicated on a 5-point scale ranging from completely unsure-1 to completely sure-5. Strength score for each subject are calculated by dividing the summed strength estimates by 15, the total number of major/career fields.

Hackett and Betz (1984) have argued whether task specific measures might be superior to the more global approaches to self-efficacy assessment represented by ER. Thus in contrast to ER-S, scores on the second index, academic milestones, are obtained for strength of self-efficacy (AM-S). Participants are asked to rate their degree of confidence in their ability to perform specific accomplishments critical to academic success in science and engineering majors (e.g. "complete the mathematics requirements for most engineering majors"). Confidence ratings made on a 5-point scale identical to ER-S, are summed across items and divided by the total number of items (11), yielding a measure termed as strength of self-efficacy for academic milestones (AM-S).

The interest measure, also part of the ER self-efficacy index, requires participants to indicate their degree of interest in each of the 15 fields contained in ER-S. Responses of "like", "indifferent", and "dislike" with scores of 3, 2, and 1

respectively, are obtained. Summed ratings are used to reflect the extent of interest in science and engineering careers.

Occupational Self-Efficacy Scale

Application of Bandura's self-efficacy theory to the Occupational Self-efficacy Scale (OSES) is based on the concept that low levels of occupational self-efficacy will result in avoidance of career decisions and behaviors, whereas high levels of occupational self-efficacy will result in increased involvement in career decision behaviors.

In an effort to measure students' perceptions of self-efficacy, Betz and Hackett (1981) developed the 20-item occupational self-efficacy scale with respect to the educational requirements and job duties of twenty commonly known occupations. The instrument format is such that participants respond first to the questions about educational requirements for all 20 occupations. The second part presents the job duties questions with reference to all 20 occupations.

Two response formats have been used for this instrument. The original response format used in Betz and Hackett (1981), required subjects to provide a Yes/No response and indicate a confidence rating in response to each occupational title. Because the yes/no response indicated *level*, a 1-10 confidence rating (completely unsure to completely sure) indicated *strength*. A second format uses only a confidence rating (0 to 9).

Both response formats was reported to be acceptable by Betz and Hackett (1981) in assessing self-efficacy expectations with respect to specific occupations. The first format retains Bandura's original notion of the *level* (Yes/No) versus the *strength* (confidence) of self-efficacy. The second format has the advantage, however, of requiring only one versus two scores. In this latter format a response of "No

confidence at all" (0) is assumed to be equivalent to a "No" response to the "Yes/No" section in the first format.

Several different scores are available from the OSES. First, self-efficacy scores with respect to each occupation alone, summing across educational requirements and job duties. Sub-scale scores can be calculated for educational requirements and job duties

separately and within each of these, separately for ten traditionally female and ten traditionally male options. Total level scores for traditional occupations may be computed as the sum of "Yes" responses to both educational requirements and job duties across traditional occupations.

If the second format is used, self-efficacy scores are the sum of the confidence rating across the following desired sub-scale items: educational requirements versus job duties and traditional occupations versus non-traditional occupations. Total scores for educational requirements and job duties across all twenty occupations can be calculated as a simple sum.

Kuder Task Self-Efficacy Scale (KTSES)

Application of Bandura's self-efficacy theory to the Kuder Task Self-Efficacy Scale (KTSES) is based on a career task self-efficacy measure that assesses a person's self-efficacy for occupational tasks instead of occupational titles. The Kuder Task Self-efficacy Scale is a 30-item scale measuring a person's self-efficacy for tasks corresponding to Kuder's 10 occupational interest areas (Kuder & Zytowski, 1991). The preliminary KTSES was a 100- item scale measuring career task self-efficacy using Kuder's 10 occupational areas: Artistic, Musical, Mechanical, Scientific, Outdoor, Clerical, Computational, Literary, Social Service, and Persuasive. According to DeVellis (1991), when developing an instrument, it is a good idea to start with a pool of items three times as large as the final scale.

Therefore, Since the researcher wanted the final version of the KTSES to consist of 30 items, using 100 items was considered appropriate. Vocational Preference Inventory (VPI)

According to Bruch and Krieshok's (1981) application of interest models to the Vocational Preference Inventory (VPI) was based on the notion that, students who selected a major program on the basis of how well their interests matched a particular educational field, had a better chance of achieving academic success. According to Holland (1978), the VPI was based on the premise that preferences for occupations were expressions of personality. Interest inventories were personality inventories and vocational preferences represented a major part of an individual's personality. Like personality inventories, interest inventories describe how an individual perceives himself/herself in his/her environment in relation to an occupation (Walsh, 1978).

The VPI index has been used in a variety of settings, both clinical and non-clinical, and has been administered to a wide range of subjects. It is composed of 160 occupational items. To respond, a subject indicates which occupations she/he likes, dislikes or is indifferent towards. The items are grouped as part of eleven (11) scales. Six of the scales related to interests categorized as Realistic, Investigative, Conventional, Social, Enterprising and Artistic themes. The five other scales pertain to personality assessment and are identified as Self-control, Masculinity, Status, Infrequency and Acquiescence scales (Holland, 1978).

Ohio Vocational Interest Survey (OVIS)

According to Bruch and Krieshok (1981), research-based evidence suggests that students who select a major program based on how well their interests match a particular educational field, have a better chance of achieving academic success. Specifically, a high level of interest should result in more satisfaction, more

persistence, and better achievement in students' educational programs (Lent, Brown and Larkin, 1987). Similarly, application of interest models to the Ohio Vocational Interest Survey (OVIS) is based on findings that show when students select a major program as a factor of how well their interests match with an educational field, those same students have a better chance of achieving academic success (Bruch and Krieshok, 1981).

The OVIS can been seen as a career education program that aims to help students: gain better a understanding of themselves; develop an awareness of careers; explore educational and occupational alternatives, and make decisions about their future careers (Domino, 1982). It is a 253 item psychometric instrument requiring 30 to 45 minutes to complete, and yielding scores on 23 occupational scales, each composed of 11 items. Therefore, it can be considered a vocational interest inventory (Domino, 1982).

# CHAPTER III

# METHODOLOGY

The purpose of this study was to determine what factors were useful in predicting academic performance (college GPA) of upper-level students in Engineering and Computer Science Technology programs, based on measurable parameters (career-related self-efficacy beliefs, math SAT scores, high school GPA, vocational interests). The resulting model, based on possible importance of career-related self-efficacy beliefs and other career-related variables, was expected to contribute to the process of translating self-efficacy theory into a practical approach for career counseling of upper-level students enrolled in Computer Science and Engineering Technology programs.

This study assessed the strength of career related self-efficacy beliefs of upper-level students enrolled in Computer Science and Engineering Technology programs to determine the extent to which measurable parameters (career-related self-efficacy beliefs, math SAT scores, high school GPA, vocational interests) could predict academic performance (college GPA) of upper-level students enrolled in Computer Science and Engineering Technology programs. Information gained from this study was expected to allow improvement of advisor effectiveness and career counseling for students. Bandura's self-efficacy theory served as the theoretical foundation for this study.

## Statement of the Problem

Campbell (1990) pointed out that Computer Science and engineering technologists are more and more in demand, however, the supply of academically

prepared graduates is inadequate to meet the needs of industry. Many students who enter computer and engineering technology programs are unable to sustain a satisfactory level of achievement required for program completion. There is need for a counseling tool that will be useful in selection and preparation of students who enter computer and engineering technology programs. However, an extensive review of the literature has failed to identify an effective, comprehensive counseling tool that will enable more students to graduate and become productive technologists in business and industry. This study was designed to extend the findings of Lent, Brown and Larkin (1986) and the applicability of Bandura's self-efficacy theory to the process of students' ability to complete the educational requirements of various science and engineering fields.

In particular, results of this study were intended to determine what factors were useful in predicting academic performance (college GPA) of upper-level students in Engineering and Computer Science Technology programs, based on measurable parameters (career-related self-efficacy beliefs, math SAT scores, high school GPA, vocational interests). The resulting model, based on possible importance of career-related self-efficacy beliefs and other career-related variables, was expected to contribute to the process of translating self-efficacy theory into a practical approach for career counseling of upper-level students enrolled in Computer Science and Engineering Technology programs.

## Research Questions

The following research questions were investigated as a means of gaining useful information for educators and counselors to assist students in completing their undergraduate programs in Computer Science and Engineering Technology:

1. Is there a relationship between the academic performance (college GPA) of undergraduates enrolled in Computer Science and Engineering Technology programs and math SAT scores or high school GPA?

2. Is there a relationship between the academic performance (college GPA) of undergraduates enrolled in Computer Science and Engineering Technology programs and self-efficacy (scores) or vocational interests (scores) as measured by the Science and Engineering Questionnaire?

3. Is there a relationship between the academic performance (college GPA) of undergraduates enrolled in Computer Science and Engineering Technology programs and math SAT scores, high school GPA, self-efficacy (scores), or vocational interests (scores), based on gender?

## Research Setting and Participants

The following section provides a brief description of the research setting, including the university and department, of the students invited to participate in this study during Spring, 1999. A description of participants is also included.

### Savannah State University

Savannah State University, located in Savannah, Georgia, was founded in 1890, and is the oldest public historically black college in Georgia. Formerly known as Savannah State College, in1996, the Board of Regents of the University System of Georgia granted the college university status and the institution was renamed Savannah State University. The University served approximately 3,000 students in Spring, 1999. Approximately 90 percent of students enrolled were from Georgia, 56 percent were women, and 95 percent were African American. The University offers 24 undergraduate and 2 graduate degree programs through its three colleges: Business Administration, Liberal Arts and Social Sciences, and Sciences and Technology.

Department of Engineering and Technology

The Department of Engineering and Technology is one of four academic departments within the College of Sciences and Technology at Savannah State University. The Department of Engineering and Technology offers courses leading to the degree of Bachelor of Science, with majors in Chemical Engineering Technology, Civil Engineering Technology, Electronics Engineering Technology, Electronics Engineering Technology with a Computer Engineering Technology option, and Mechanical Engineering Technology. Students must have a combined SAT score of at least 850 and a high school GPA of at least 2.2 (effective Fall 2000) to gain admission to the Department of Engineering and Technology.

## Participants

The participants for this study were upper-level students enrolled in courses offered through the Department of Engineering and Technology, in the College of Science and Technology at Savannah State University. There was a combined total of 300 students enrolled in the degree areas offered through the Department of Engineering and Technology in Spring, 1999. Over forty percent (42.4%) of the students were enrolled in Computer Science Technology, 21.6% male, 20.8% female. Almost 21% (20.8) of the 300 students were enrolled in Electronics Engineering Technology, 17.6% male, 3.2% female. A smaller percentage (6.4%) of the students were enrolled in Electronics Engineering Technology with a Computer Engineering Technology option, 4% male, 2.4% female.

The largest numbers of students (20%) were enrolled in the Electrical Circuit course and the Digital Systems I course (16%). The next largest numbers of students were enrolled in the Digital Systems II course (14.4%) and the Engineering Economy course (11.2%). Over half of the students (53.6%) had been enrolled at the University four semesters, and another 24.8% had been enrolled five semesters.

These data and enrollment data for other courses within the department are presented in Table G1-G3 in Appendix G.

Of the 300 students enrolled in the various engineering technology courses, only 175 were initially identified as upper-level (a criteria for the study), having completed four or more semesters of undergraduate course work. Therefore, a total of 175 upper-level students enrolled in courses offered by the Department of Engineering Technology met criteria for participation in the study. One hundred seventy five data collection instruments were distributed and 148 were returned. Twenty-three students were eliminated because 8 were foreign students who had no reported SAT score, and 15 were transfer students, also with no reported SAT score. Seven of the participants (5.6%) had completed fewer than four semesters (2-3), but were retained for data analysis. Therefore, a total of 125 participants (N = 125) were included in the statistical analyses, 85 males and 40 females.

## Instrumentation

According to Lent and Hackett (1987) specific self-efficacy must be employed when studying distinct aspects of psychosocial functioning. Therefore, when investigating career-decision-making behavior, it is important to utilize a self-efficacy measure that will indicate levels of career decision-making self-efficacy. Consequently, this study utilized a self-efficacy measure that explored efficacy expectations of task specific behaviors.

### Psychometric Characteristics

Participants in this study completed measures of self-efficacy and expressed vocational interests in technical fields using a three-part instrument referred to as the Science and Engineering Career questionnaire (SEC). The SEC questionnaire (Lent et al., 1983) is designed to measure an individual's self-efficacy beliefs

regarding ability to perform a particular task or behavior unique to science and engineering fields (Bandura, 1977).

The first part of the questionnaire focuses on self-efficacy and is referred to as the *educational requirements* (ER) scale employed by (Lent et al, 1983). It consists of two self-efficacy components, one measures the *level* of self-efficacy by asking the participant to assess whether she/he could successfully complete the educational requirements (ER) or training requirements of fifteen science and engineering occupations. The other component evaluates the *strength* of self-efficacy expectations by asking the participant to estimate her/his degree of confidence in being able to perform the job duties of the fifteen science and engineering occupations.

Scores on the first part of the index, educational requirements (ER), are obtained for both strength and level of self efficacy. First, level of self-efficacy (ER-L) scores are obtained by summing the number of fields participants believe they can complete. Next, strength of self-efficacy (ER-S) is assessed by having participants rate their degree of confidence in their ability to complete these educational requirements or job duties. Strength is indicated on a 5-point scale ranging from completely unsure-1 to completely sure-5. Strength scores for each subject are calculated by dividing the summed strength estimates by 15, the total number of major/career fields. Only ER-S was used in the study because of its conceptual relevance to the academic criteria of interest and because it effectively subsumes information contained in the level measure.

The second part of the questionnaire is a newer measure focusing on more specific academic behaviors, referred to as *academic milestones* (AM) (Lent et al, 1986). Hackett and Betz (1984) have argued whether task specific measures might be superior to the more global approaches to self-efficacy assessment represented by

ER. Thus, in contrast to ER-S, scores on the second part of the questionnaire, *academic milestones*, are obtained for strength of self-efficacy (AM-S). Participants were asked to rate their degree of confidence in their ability to perform specific accomplishments critical to academic success in science and engineering majors (e.g., complete the mathematics requirements for most engineering majors). Confidence ratings made on a 5-point scale identical to ER-S, were summed across items and divided by the total number of items (8), yielding a measure termed as *strength of self-efficacy for academic milestones* (AM-S).

The third part of the questionnaire, adapted from Betz and Hackett (1983), and later included as part of the instrument, was used to assess students' expressed vocational interests relative to science and engineering fields. This part of the SEC questionnaire, the vocational interest measure, requires participants to indicate their degree of interest in each of the 15 fields contained in ER-S. Responses of "like", "indifferent", and "dislike" with scores of 3, 2, and 1 respectively, are obtained. Summed ratings are used to reflect the extent of interest in science and engineering careers.

Validity and Reliability

Nunnally (1978) indicated that a coefficient alpha of r = 0.80 was necessary to justify using an instrument for basic research. According to Lent et al (1983), coefficient alpha values for internal consistency reliability of the Science and Engineering Career Questionnaire have ranged from r = 0.79 to 0.85. The validity of the questionnaire is r = 0.30 which is modest, yet, well within the acceptable range for research (Lent et al., 1983).

## Data Collection Procedures

Prior to collection of data, the researcher requested and received written approval from Dr. Robert W. Lent, Professor, Counseling Psychology at the

University of Maryland at College Park to use the Science and Engineering Career (SEC) questionnaire (see Appendix B). Permission to conduct the study at Savannah State University was requested and written permission was received from Dr. Raghavan Nair, Professor and Chair, Institutional Review Board (see Appendix E). The researcher also requested and received approval to conduct the study from the University of Georgia, Institutional Review Board, Human Subjects Office (see Appendix F).

Once all necessary approvals were received, a colleague and professor in the department was approached and asked to serve as one of the administrators of the instrument. The researcher was the other administrator of the instrument. Upon agreement, the colleague was provided all forms and instructions necessary to assist in administering the questionnaire. With permission of the Engineering Technology Department and individual course instructors, the administrators visited classes and invited all upper-level students enrolled in Computer Science and Engineering Technology programs to participate in the study. During these visits, the administrators briefly described the nature and purpose of the study. Participants were informed that the information they provided would be treated as confidential and that they would be allowed to respond anonymously. The administrators stressed that the questionnaire would only take 20-30 minutes to complete, and that it was not a test and, therefore, had no right or wrong answers. The administrators then distributed coded packets containing a cover letter, instructions, an authorization form (for obtaining SAT scores), and the instrument to all students who agreed to participate. Students were asked to sign the authorization form as an indication that they agreed to participate in the study and authorized the researcher to obtain their SAT scores. For management and control purposes, all instruments and data sheets were coded.

The questionnaire was administered to three classes each day during the first week of the 1999 Spring semester. This process continued until all students enrolled in Computer Science and Engineering Technology courses in the Spring of 1999 had been invited to participate. Of the 175 upper-level students invited, 148 agreed to participate, 27 did not. Administrative staff in the Registrar's Office provided the researcher with data related to math-SAT, high School GPA and college GPA.

## Data Analysis

After completion of the data collection process, data were entered into the computer and statistical analyses were performed using SPSS 8.0. Through data analysis, the effects of the correlational variables, self-efficacy (educational requirements, academic milestones), vocational interests, math SAT scores, and high school GPA, in prediction of academic performance of students enrolled in Computer Science and Engineering Technology courses at Savannah State University were determined.

Data collected relative to research questions one and three were analyzed using descriptive statistics (means scores and standard deviations), multiple regression and stepwise regression analyses. Stepwise regression analysis was used to exclude the variables that were not significant in predicting academic performance. Pearson correlation analyses were used to assess the relationship between the scores on academic performance and self-efficacy as well as between scores on academic performance and vocational interests. Summed ratings were used to reflect the extent of interest in science and engineering careers (Betz & Hackett, 1981).

Data collected relative to the second research question were analyzed using descriptive statistics and multiple linear regression analyses. Stepwise regression analysis was not necessary since all the variables were statistically significant in

predicting academic performance. The following section provides a summary of the multiple linear and stepwise regression analyses used in analyzing the data for the three research questions.

Multiple Linear/Stepwise Regression Analyses

Multiple linear/stepwise regression analyses were conducted to assess what self-efficacy added to the prediction of academic performance (college GPA) of students enrolled in Computer Science and Engineering Technology courses, above and beyond the measures of math SAT scores, high school GPA, and vocational interests. Specifically, multiple linear/stepwise regression analysis was used in analysis of data pertaining to research questions one and three to predict academic performance (college GPA) of the students enrolled in Computer Science and Engineering Technology programs at Savannah State University based on the following variables:

| Variable | Refers to |
|---|---|
| y | Academic performance (college GPA) |
| x1 | Math SAT scores |
| x2 | Vocational Interests |
| x3 | AM-S* |
| x4 | ER-S** |
| x5 | High School GPA |

**Academic milestones-strength/self efficacy ** Educational requirement-strength/self efficacy*

The multiple linear regression equation y = m1*x1 + m2*x2 + m3*x3 + m4*x4 + m5* x5 + b was used to predict academic performance of students in the Computer Science and Engineering Technology programs at Savannah State University. Coefficient m1, m2, m3, m4, and m5 were obtained from the computer program. The F statistics were used to determine whether the results, with high a coefficient of determination, occurred by chance. The t-statistic was used to determine whether each slope coefficient was useful in predicting academic performance. Each independent variable was tested for statistical significance at the

0.05 level. If the observed t- value, was greater than the critical value for all the variables used in the regression equation, then all the variables used in the equation were determined to be useful in predicting academic performance of the students enrolled in Computer Science and Engineering Technology programs at Savannah State University.

Multiple linear regression was used in analysis of data for research question two. However, it was not necessary to use stepwise regression in analysis of data obtained regarding research question two, since all the variables were statistically significant in predicting academic performance.

# CHAPTER IV

## RESULTS

The purpose of this study was to assess the extent to which the independent variables, career-related self-efficacy (educational requirements score), math SAT scores, high school GPA, and vocational interests predicted academic performance (college GPA-dependent variable) of students enrolled in Computer Science and Engineering Technology programs. This study was designed to extend the findings of Lent, Brown and Larkin (1986) and the applicability of Bandura's self-efficacy theory to the process of students' ability to complete the educational requirements of various science and engineering fields. A total of 148 students from a Computer Science and Engineering Technology program were volunteer participants in the study. Useable responses were received from 125 participants, 85 males and 40 females, for a return rate of 85.7 percent. The research questions of this study served as a guide for presenting the results.

Results from the analysis of data are presented in this chapter. Data for research questions one and three were analyzed using a four-step process that included using descriptive statistics (mean scores and standard deviations), multiple regression and stepwise regression analyses. Data for research question two were also analyzed using descriptive statistics and multiple linear regression, however stepwise regression analyses were not necessary. The analyses were performed at the .05 level of significance.

The sections in this chapter include the statement of the problem and the research questions. Results of data analyses are also presented, beginning with presentation of descriptive data.

## Statement of the Problem

Campbell (1990) pointed out that Computer Science and Engineering Technologists are more and more in demand, however, the supply of academically prepared graduates is inadequate to meet the needs of industry. Many students who enter computer and engineering technology programs are unable to sustain a satisfactory level of achievement required for program completion. There is need for a counseling tool that will be useful in the selection and preparation of students who enter computer and engineering technology programs. However, an extensive review of the literature has failed to identify an effective, comprehensive counseling tool that will enable more students to graduate and become productive technologists in business and industry. This study was designed to extend the findings of Lent, Brown and Larkin (1986) and the applicability of Bandura's self-efficacy theory to the process of students' ability to complete the educational requirements of various science and engineering fields.

In particular, results of this study were intended to determine what factors were useful in predicting academic performance (college GPA) of upper-level students in Computer Science and Engineering Technology programs, based on measurable parameters (career-related self-efficacy beliefs, math SAT scores, high school GPA, vocational interests). The resulting model, based on possible importance of career-related self-efficacy beliefs and other career-related variables, was expected to contribute to the process of translating self-efficacy theory into a practical approach for career counseling of upper-level students enrolled in Computer Science and Engineering Technology programs.

## Results Related to Research Question 1

Research question one was designed to determine if there is a relationship between the academic performance (college GPA) of undergraduates enrolled in Computer Science and Engineering Technology programs and math SAT scores or high school grade point average (GPA). The analyses used to answer this question and presentation of results are provided in the following four sections.

First, descriptive data relative to each participant was compiled. Summary of this data reveals that participants had a mean college grade-point average of 2.66. Participants' mean high school GPA of 2.97 was higher as compared to the college grade-point average. The participants' mean math SAT score was reported as 462, a score more than 50% of the possible maximum score of 800. These data are presented in Table 1.

Table 1

Means and Standard Deviations for MSAT, HSGPA, and (CGPA)

| Source | N | M | SD |
|---|---|---|---|
| MSAT | 125 | 462 | 86 |
| HSGPA | 125 | 2.97 | .47 |
| CGPA | 125 | 2.66 | .59 |

Second, Pearson correlations were calculated to assess relationship among variables. These analyses showed HSGPA had a highly significant correlation with MSAT (r = .46). The analyses also showed that the HSGPA had a modest, but significant correlation with CGPA (r = .31). The MSAT showed a slightly higher

correlation factor with CGPA (r = .47) as compared to the HSGPA and MSAT. These data are presented in Table 2.

Table 2

Correlational Matrix of MSAT and HSGPA Used in Regression Analysis of CGPA

| VARIABLES | MSAT | HSGPA | CGPA |
|---|---|---|---|
| MSAT | | .46 | .47 |
| HSGPA | .46 | | .31 |
| CGPA | .47 | .31 | |

Third, multiple linear regression analysis was applied to predict the academic performance of the students based on HSGPA and MSAT scores. The following model was applied:

Y = a + m1x1 + m2x2, where

x1 = MSAT (Math-SAT score)

x2 = HSGPA (High school GPA)

Y = College GPA (CGPA)

a = Constant or the intercept

m1 and m2 are slopes

The multiple Pearson correlation was used to measure the magnitude of the relationship between the dependent variable and the combined independent variables. The coefficient of determination ($R^{2)}$ was used to express the amount of variance in academic performance (CGPA) that was explained by MSAT and HSGPA. The squared multiple regression coefficient was computed by taking the ratio of the sum of squares of the model to the sum of squares total: $R^2$ = Ssreg/Sstotal. For this research question: $R^2$ = 10.22/44.02 = .232. Therefore almost 23% of the total variability in the dependent variable, college GPA (CGPA) or

academic performance, is explained by MSAT and HSGPA. The data presented in the ANOVA table (Table 3) show that statistical significance is found at the .05 alpha level ($\alpha$ >.000), therefore, the regression model is useful in predicting the academic performance (CGPA) of students enrolled in Computer Science and Engineering Technology programs.

Table 3

ANOVA With CGPA as the Dependent Variable, MSAT and HSGPA as Independent Variables

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig of F |
|---|---|---|---|---|---|
| Regression | 10.22 | 2 | 5.112 | 18.447 | .000* |
| Residual | 33.8 | 122 | .277 | | |
| Total | 44.02 | 124 | | | |

* p<.05 level.

Fourth, parameter estimates for the values a, m1, and m2 identified in the original model, and the results of *t* tests indicating the contribution of MSAT score and HSGPA are presented in Table 4. Inferences can be drawn about individual terms in the model (MSAT and HSGPA) by analyzing the Sig T column. Specifically, we can reject a = 0 at any $\alpha$ > .008, reject m1 = 0 at any $\alpha$ > .000, and reject m2 = 0 at any $\alpha$ >.179. If $\alpha$ is set at .05 then reject a = 0, reject m1 = 0, and do not reject m2 = 0. According to the analysis, a suitable model to predict academic performance (CGPA) is represented by the following regression equation: Y = m1x1 + a = .0028 x1 + .889. The beta value of .113 indicates small effect of high school GPA in predicting academic performance (CGPA) of the students enrolled in Computer Science and Engineering Technology programs.

Table 4

Parameter estimates of MSAT and HSGPA

| Independent Variable | b | Beta | t | Sig T |
|---|---|---|---|---|
| MSAT (m1) | .0028 | .413 | 4.599 | .000* |
| HSGPA (m2) | .152 | .113 | 1.352 | .179 |
| Constant (a) | .889 | | 2.719 | .008 |

* p<.05

To find the appropriate coefficient of the variable MSAT score, stepwise regression analysis was used, excluding the variable, high school GPA, because it was not significant in predicting academic performance. The analysis of variance table for the stepwise regression is shown in Table 5. Results indicate a change in the F value from 18.447 to 34.833, therefore, statistical significance is found at the .05 ($\alpha > .000$) level.

Table 5

Analysis of Variance With CGPA as the Dependent Variable

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig of F |
|---|---|---|---|---|---|
| Regression | 9.718 | 1 | 9.718 | 34.833 | .000* |
| Residual | 34.315 | 123 | .279 | | |
| Total | 44.033 | 124 | | | |

*p<.05

Parameter estimates for the values a, m1 identified in the original model, and the results of *t* tests indicating the contribution of each individual term are presented in Table 6. The beta coefficient changed from .41 to .47, which indicates a larger effect of MSAT score in predicting the CGPA. Based upon the stepwise regression analysis, a suitable model to predict the academic performance is represented by the following regression equation: $Y = .003\ x1 + 1.159$.

Table 6

Parameter estimates of MSAT

| Independent Variable | b | Beta | t | Sig T |
|---|---|---|---|---|
| MSAT | .003 | .470 | 5.902 | .000* |
| Constant | 1.159 | | 4.469 | .000 |

Note(*) Indicates statistical significance at p<.05

## Results Related to Research Question 2

The second research question was designed to determine if there is a relationship between the academic performance (college GPA) of undergraduates enrolled in Computer Science and Engineering Technology programs and self-efficacy (scores) or vocational interests (scores) as measured by the Science and Engineering Questionnaire. The analyses used to answer this question and presentation of results are provided in the following four sections.

First, descriptive data relative to each participant was computed. Data indicates that participants' mean educational requirement (ERS) score was 3.02, which was equivalent to 60% of the maximum possible score on a 5 point scale. The participants' mean score on vocational interest (VI) was reported as 1.71, which was 57% of the maximum possible score on a 3 point scale. These data, including participants' mean college GPA are presented in Table 7.

Table 7

Means and Standard Deviations for the ERS, VI and CGPA

| Source | N | M | SD |
|---|---|---|---|
| ERS | 125 | 3.02 | .78 |
| VI | 125 | 1.71 | .65 |
| CGPA | 125 | 2.66 | .59 |

Second, Pearson correlations were calculated to assess relationship among variables. These analyses showed ERS had a highly significant correlation with CGPA (r = .73). The analyses also indicate that the VI had a highly significant relationship with CGPA (r = .68). The interaction between the independent variables ERS and VI was (r = .71), almost as high as the ERS. These data are presented in Table 8.

Table 8

Correlational Matrix of ERS and VI used in Regression Analysis of CGPA

| VARIABLES | CGPA | ERS | VI |
|---|---|---|---|
| ERS | .73 | | .71 |
| VI | .68 | .71 | |
| CGPA | | .73 | .68 |

Third, multiple linear regression analysis was applied to predict the academic performance of the students based on ERS and VI scores. The following model was applied:

Y = a + m1x1 + m2x2, where

x1 = ERS (Educational Requirements score-self efficacy)

x2 = VI (Vocational Interest score)

Y = College GPA (CGPA)

a = Constant or the intercept

m1 and m2 are slopes

The multiple Pearson correlation was used to measure the magnitude of the relationship between the dependent variable and the combined independent variables. The coefficient of determination $R^2$ was used to express the amount of

variance in academic performance (CGPA) that was explained by ERS and VI. The squared multiple regression coefficient was computed by taking the ratio of the sum of squares of the model to the sum of squares total: $R^2$ = Ssreg/Sstotal. For this research question: $R^2$ = 25.859/44.033 = .587. The value of $R^2$ indicates that almost 58.7% of the total variability in the dependent variable, academic performance (CGPA) is explained by ERS and VI. The data presented in the ANOVA table (Table 9) show statistical significance at the .05 alpha level ($\alpha > .000$), hence, the regression model is useful in predicting academic performance (CGPA) of students enrolled in Computer Science and Engineering Technology programs.

Table 9

ANOVA With CGPA as the Dependent Variable, ERS and VI as Independent Variables

| Source of Variation | Sum of Squares | DF | Mean Square | F | Sig of F |
|---|---|---|---|---|---|
| Regression | 25.859 | 2 | 12.929 | 86.79 | .000* |
| Residual | 18.174 | 122 | .149 | | |
| Total | 44.003 | 124 | | | |

*p<.05

Fourth, parameter estimates for the values of a, m1, and m2 identified in the original model, and the results of the *t* tests indicating the contribution of ERS and VI are presented in Table 10. Inferences can be drawn about the individual terms in the model (ERS and VI) by analyzing the Sig T column. Specifically we can reject a = 0 at any $\alpha > .000$, reject m1 = 0 at any $\alpha > .000$, and m2 = 0 at any $\alpha > .000$ can be rejected. The parameter estimates presented in Table 10 indicate $\alpha > .000$ for all the variables in the regression model presented. Therefore, with $\alpha$ set at .05, a = 0, m1= 0, and m2 = 0 are rejected. According to the analysis, a suitable model to

predict academic performance (CGPA) is represented by the following regression equation:

Y = m1x1 + m2x2 + a = .381x1 + .298x2 + 1.004. The beta value of almost 50% (.499) indicates that ERS has large effect in predicting academic performance (CGPA). The beta value of 32.6% for the VI also represents a significant contribution in predicting the academic performance (CGPA) of students enrolled in Computer Science and Engineering Technology program. However, it is not as high as the ERS effect.

Table 10

Parameter Estimates of ERS and VI

| Independent Variable | b | Beta | t | Sig T |
|---|---|---|---|---|
| ERS | .381 | .499 | 6.032 | .000* |
| VI | .298 | .326 | 3.944 | .000* |
| Constant | 1.004 | | 7.247 | .000 |

*p<.05

Both ERS and VI are statistically significant as indicated by Table 10; therefore all the variables used in the regression equation are useful in predicting the academic performance. Stepwise regression analyses was not performed because both ERS and VI were statistically significant in predicting academic performance.

## Results Related to Research Question 3

The third research question was designed to determine if there is a relationship between the academic performance (college GPA) of undergraduates enrolled in Computer Science and Engineering Technology programs and math SAT scores, high school GPA, self-efficacy (scores), or vocational interests (scores), based on gender. Table 11 provides data for male and female participants' mean scores on math SAT scores (MSAT), high school GPA (HSGPA), educational

requirements scores (ERS), academic milestones scores (AMS), and vocational interest (VI) .

First, the MSAT score for male students is 15 points higher than the female students, HSGPA, ERS, AMS and VI are almost the same for male and female students. However, it must be noted that the mean score of VI for male students is more than twice that of female students.

Table 11

Descriptive Data for the Regression Model for Male and Female Participants

| | Male | | | Female | | |
|---|---|---|---|---|---|---|
| Source | N | M | SD | N | M | SD |
| MSAT | 85 | 466 | 88.3 | 40 | 451 | 80.6 |
| HSGPA | 85 | 2.94 | .46 | 40 | 3.03 | .49 |
| ERS | 85 | 3.05 | .73 | 40 | 2.92 | .89 |
| AMS | 85 | 2.73 | .70 | 40 | 2.82 | .80 |
| VI | 85 | 1.68 | .63 | 40 | .75 | .71 |

Second, an analysis of variance (ANOVA) for the regression model for male and female participants was performed. Results of this analysis are presented in Table 12. The Sig of F statistic for both male and female participants shows statistical significance at the .05 alpha level. Therefore, the independent variables, MSAT, HSGPA, ERS, AMS, and VI, are useful in predicting academic performance (CGPA).

Third, using regression analysis, the squared multiple correlation coefficient for the male and female participants was computed as follows:

$R^2$ = Ssreg/SStotal

$R^2$ = 17.88/26.92 = .619 (male)

$R^2$ = 13.402/16.014 = .837 (female)

The squared multiple correlation factor for female students is considerably higher than the males students at 83.7%. The value of 83.7% suggests that the total variability in academic performance (CGPA) is higher for female participants in the explanation of the independent variable (HSGPA, MSAT, ERS, AMS, VI). The squared multiple correlation factor is higher for the female students because of the number of female participants are lower than the male participants. The F statistic suggests that these results did not occur by chance. Similarly, statistical significance at the .05 alpha level was found for both male and female students which suggests that the regression model is useful in predicting academic performance (CGPA) for both male and female students.

Table 12

Analysis of Variance for Male and Female Participants

| Source of Variation | Sum of | DF | Mean | F | Sig of F |
|---|---|---|---|---|---|
| Male | | | | | |
| Regression | 17.88 | 5 | 3.57 | 25.61 | .000* |
| Residual | 11.03 | 79 | .14 | | |
| Total | 26.92 | 84 | | | |
| Female | | | | | |
| Regression | 13.402 | 5 | 2.68 | 34.89 | .000* |
| Residual | 2.61 | 34 | .07 | | |
| Total | 16.014 | 39 | | | |

p<.05 level

Fourth, parameter estimates for the regression model of male and female students were computed. For male students, math SAT scores (MSAT) and high school GPA (HSGPA) are not statistically significant in predicting academic performance. Self-efficacy (ERS and AMS) and vocational interests (VI) contribute a factor of 29.3% and 29.4% respectively in predicting academic performance for

the male students. For female students, math SAT scores (MSAT), high school GPA (HSGPA) and vocational interest (VI) are not statistically significant. However, the self-efficacy scores of 36% (ER-S) and 64% (AM-S are statistically significant. Hence, the analysis for the female students shows that the independent variables, self-efficacy (ERS) and academic milestones (AMS) are important in predicting the academic performance of female students. These data are presented in Table 13.

Table 13

Parameter Estimates for the Regression Model of Male and Female Students

| Independent Variable | b | Beta | t | Sig T |
|---|---|---|---|---|
| Male | | | | |
| MSAT | .001 | .166 | 1.97 | .051 |
| HSGPA | .107 | .085 | 1.02 | .311 |
| ERS | .235 | .293 | 2.95 | .004* |
| AMS | .175 | .210 | 2.27 | .026* |
| VI | .274 | .294 | 2.93 | .004* |
| Female | | | | |
| MSAT | .0002 | .025 | .285 | .778 |
| HSGPA | .058 | .045 | .563 | .577 |
| ERS | .257 | .36 | 2.26 | .030* |
| AMS | .510 | .640 | 5.16 | .000* |
| VI | -.08 | -.093 | -.722 | .475 |

*p<.05

Stepwise regression analysis was employed to exclude the variables that were not significant in predicting academic performance (CGPA). The new coefficient of the independent variables for male and female students is shown in Table 14.

Table 14

Stepwise Parameter Estimates for the Regression Model of Male and Female Students

| Independent Variable | b | Beta | t | Sig T |
|---|---|---|---|---|
| Male | | | | |
| MSAT | .001 | .202 | 2.66 | .009* |
| ERS | .245 | .305 | 3.09 | .003* |
| AMS | .155 | .187 | 2.08 | .041* |
| VI | .274 | .308 | 3.11 | .003* |
| Female | | | | |
| AMS | .506 | .636 | 5.40 | .000* |
| ERS | .224 | .315 | 2.67 | .011* |

*p<.05

According to the stepwise regression analysis the suitable model for predicting academic performance for male and female students is represented by the following regression equations:

Y = .224x3 + .506x4 (female)

Y = .001x1 + .245x3 + .155x4 + .274x5 (male)

where, x1 = MSAT, x2 = HSGPA, x3 = ERS, x4 = AMS and x5 = VI

# CHAPTER V

# SUMMARY, CONCLUSIONS, DISCUSSION, AND RECOMMENDATIONS

## Summary

The purpose of the study was to assess the extent to which the independent variables, career related self-efficacy beliefs, vocational interests, academic milestones, math SAT scores and high school GPA could predict the academic performance (college GPA-dependent variable) of students enrolled in Computer Science and Engineering Technology programs. This study was designed to extend the findings of Lent, Brown and Larkin (1986) and the applicability of Bandura's self-efficacy theory to the process of students' ability to complete the educational requirements of various science and engineering fields.

The problem this study addressed was the lack of a counseling model/tool useful in selection and preparation of students who enter Computer Science and Engineering Technology programs. Computer Science and Engineering Technology graduates are more and more in demand, however, the supply of academically prepared graduates is not sufficient to meet the demands of the industry. An extensive review of the literature failed to identify an effective, comprehensive counseling model/tool that would enable more students to graduate and become productive technologists in business and industry. Therefore, need for theory-based research that contributes information needed in the process of translating self-efficacy theory into a practical model/tool useful for counselors and educators to select and prepare students who enter Computer Science and Engineering

Technology programs became apparent. The following research questions were identified to address the primary purpose of this study:

Engineering Technology programs became apparent. The following research questions were identified to address the primary purpose of this study:

1. Is there a relationship between the academic performance (college GPA) of undergraduates enrolled in Computer Science and Engineering Technology programs and math SAT scores or high school grade point average (GPA)?

2. Is there a relationship between the academic performance (college GPA) of undergraduates enrolled in Computer Science and Engineering Technology programs and self-efficacy (scores) or vocational interests (scores) as measured by the Science and Engineering Questionnaire?

3. Is there a relationship between the academic performance (college GPA) of undergraduates enrolled in Computer Science and Engineering Technology programs and math SAT scores, high school GPA, self-efficacy (scores), or vocational interests (scores), based on gender?

The participants for this study were upper-level students enrolled in courses offered through the Department of Engineering and Technology, in the College of Science and Technology at Savannah State University. There was a combined total of 300 students enrolled in the degree areas offered through the Department of Engineering and Technology in Spring, 1999. Of the 300 students enrolled in the various engineering technology courses, only 175 were initially identified as upper-level (a criteria for the study), having completed four or more semesters of undergraduate course work. Therefore, a total of 175 upper-level students enrolled in courses offered by the Department of Engineering Technology met criteria for participation in the study. One hundred seventy five data collection instruments were distributed and 148 were returned. Twenty-three students were eliminated

because 8 were foreign students who had no reported SAT score, and 15 were transfer students, also with no reported SAT score. Therefore, a total of 125 participants (N = 125) were included in the statistical analyses, 85 males and 40 females. Similar to the demographics of the University, a majority of the students were African American.

Over forty percent (42.4%) of the students were enrolled in Computer Science Technology, 21.6% male, 20.8% female. Almost 21% (20.8) of the 300 students were enrolled in Electronics Engineering Technology, 17.6% male, 3.2% female. A smaller percentage (6.4%) of the students were enrolled in Electronics Engineering Technology with a Computer Engineering Technology option, 4% male, 2.4% female. The largest numbers of students (20%) were enrolled in the Electrical Circuit course and the Digital Systems I course (16%). The next largest numbers of students were enrolled in the Digital Systems II course (14.4%) and the Engineering Economy course (11.2%). Over half of the students (53.6%) had been enrolled at the University four semesters, and another 24.8% had been enrolled five semesters.

Self-efficacy of students enrolled in the Computer Science and Engineering Technology programs was measured using the Science and Engineering questionnaire developed by Lent et al (1983) which measured the independent variables: education requirement, academic milestones, and vocational interests. The variables measured using the Science and Engineering questionnaire, along with math SAT scores and college GPA, were entered into analysis to predict academic performance (college GPA) of the students enrolled in Computer Science and Engineering Technology programs.

Data for research questions one and three were analyzed using a four-step process that included using descriptive statistics (mean scores and standard

deviations), multiple regression and stepwise regression analyses. Data for research question two were also analyzed using descriptive statistics and multiple linear regression, however stepwise regression analyses were not necessary. The analyses were performed at the .05 level of significance.

Summary of Results

The present study was designed to investigate the applicability of Bandura's self-efficacy theory in the prediction of academic performance. Eighty-five male and 40 female students from Savannah State University participated in the study by properly completing the Science and Engineering Questionnaire. The following paragraphs summarize the results of the study.

Research question one examined the relationship of academic performance to the combined effect of math SAT scores and high school GPA. Regression analysis was conducted to assess the contribution of the independent variables. The results of the analysis of variance indicates that 23.2% of the total variability in the dependent variable (college GPA) is explained by the independent variables. The F statistics show that at alpha level of .05, the regression model is useful in predicting academic performance of the students in Computer Science and Engineering Technology program. Results drawn from the t statistics showed that high school GPA represented a minute significance with a beta value of .113, indicating that high school GPA is not a good predictor of academic performance. However, for the prediction equation of academic performance, math SAT score was a positive predictor with a beta value of .413. Consequently, the math SAT score significantly contributed to the performance of students enrolled in the program. Due to the insignificant effect of high school GPA, stepwise regression analysis was used. The stepwise regression analysis improved the coefficient of the math SAT variable and excluded the high school GPA to provide a better regression equation for predicting

academic performance. A change in the beta value from .413 to .47 indicates a high correlation of math SAT score in prediction of academic performance.

Research question two investigated the relationship of the academic performance (college GPA) and students' self-efficacy (scores) and vocational interests (scores) as measured by the Science and Engineering Questionnaire. The beta value of almost 50% (.499) indicated that self-efficacy was a strong predictor of academic performance. Likewise, the beta value of 32.6% for vocational interest also indicates a significant contribution to predicting academic performance. Therefore, both self-efficacy and vocational interest were highly correlated with academic performance, but the self-efficacy measure was r = .73 as compared to the vocational measure r =. 68, identifying self-efficacy as the stronger predictor of academic performance. Results of the multiple regression analysis showed that the squared regression coefficient ($R^2$ = .587) represented 58.7% of the total variability in the dependent variable, academic performance (college GPA), as explained by the independent variables. The analysis of variance was found to be statistically significant at the .05 alpha level. Therefore, the results suggests that all the variables in the regression model relative to research question two were strongly correlated in predicting student academic performance.

Research question three was designed to determine if there is a relationship between academic performance and students' math SAT scores, high school GPA, self-efficacy (scores), and vocational interests (scores) based on gender. To evaluate the results of this research question, first the multiple regression analysis was applied to all the participants and then the regression analysis was applied to the female and male groups. On the math SAT scores, no significant differences were found between the male students (M = 466) and female students (M = 451). The

average math SAT score for all participants in the regression model (M = 462) was not significantly different as compared to the male and the female group.

The squared multiple regression coefficient for the model for all participants was .668, which indicated that 66.8% of the total variability in the dependent variable is explained by the independent variables. In comparison, the $R^2$ value of .619 for the male students was lower than the $R^2$ value of .837 for the female students. The F statistics for both male and female students indicated that all the variables in the regression model were strongly correlated with academic performance. The t statistics showed that high school GPA was not significant for the male students. Results of the t statistics for the female students indicated that high school GPA, math SAT scores, and vocational interest were not contributing variables in predicting academic performance. Self-efficacy ($\beta$ = .293), academic milestones ($\beta$ = .21) and vocational interest ($\beta$ = .294) were strong predictors of academic performance for the male students. For the female students academic milestones ($\beta$ = .64) was the highest predictor of the college GPA. However, self-efficacy ($\beta$ = .36) was a significant variable in the predication of the academic performance. These results clearly indicate that the female students possess a much higher level of self-efficacy than their male counterparts. Stepwise regression analysis was used to exclude the variables that were not contributing in the prediction of academic performance. The results of the stepwise regression changed the value of ERS coefficient for both male (.224) and female (.245) students, resulting in a regression equation which provided more accurate prediction of the academic performance of the students enrolled in the Computer Science and Engineering Technology programs.

The major findings of this study support and extend results from previous studies that showed self-efficacy expectations to be highly correlated to the indices of academic performance behavior (Hackett & Betz, 1984; Lent et al., 1986) as well as vocational interests and range of perceived career choice. Multiple regression analyses indicated that self-efficacy does contribute significantly to the prediction of academic performance. The self-efficacy variable, academic milestone, also contributed highly in the prediction of college GPA, but was not as high as the self-efficacy variable, educational requirement. Self-efficacy scores were also significantly, but moderately correlated with the objective measure of academic ability (math SAT scores) for the male students. These relationships are consistent with those found by Betz and Hackett (1984). The results from the regression analyses that were not supported were the small relationship of high school GPA for the male students and a negative relationship of vocational interest to academic performance for the female students.

## Conclusions

The following conclusions were deduced based on the results of each research question:

1. Results obtained from research question one suggest that math SAT scores were strong predictors of academic performance, with the mean math SAT score for all participants at 462. Results drawn from the t statistics for the first research question showed that the high school GPA represented a minute significance, with a beta value of .113, in the prediction of the college GPA. However, the math SAT score significantly contributed in the performance of the students enrolled in the computer science and engineering technology programs. The stepwise regression analysis improved the coefficient of the math SAT variable and excluded the high school GPA to provide a better regression equation for

predicting academic performance. Thus, it was concluded that the math SAT score was a stronger predictor of academic performance than the high school GPA.

2. Results obtained from research question two indicated that the mean score for self-efficacy was slightly higher than the vocational interest mean score. Both self-efficacy and vocational interest were highly correlated with college GPA, with a value of ($r = .731$) for self-efficacy and ($r = .681$) for vocational interest. The beta value of almost 50% indicated that self-efficacy was a strong predictor of academic performance. The conclusion based on the results of research question two is that both self-efficacy and vocational interests were strongly correlated in predicting the academic performance of the students.

3. Results obtained from the third research question indicate that the average math SAT scores were almost the same for both male ($\underline{M} = 466$) and female ($\underline{M} = 451$) students. The results of the regression analysis showed that the high school GPA was not statistically significant in the prediction of academic performance. For the female students math SAT, high school GPA and vocational interest were not highly correlated to academic performance. Self-efficacy ($\beta = .293$), academic milestones ($\beta = .21$) and vocational interest ($\beta = .294$) were strong predictors of academic performance for the male students. For the female students academic milestones ($\beta = .64$) was the highest predictor of the college GPA. However, self-efficacy ($\beta = .36$) was also a significant variable in the predication of the academic performance.

## Discussion

The results of this study support and extend previous results showing that self-efficacy expectations are highly correlated to the indices of academic performance behavior (Hackett & Betz, 1984; Lent et al., 1986) as well as vocational interests and range of perceived career choice. The theoretical framework of

Bandura and implications emphasized by Lent et al (1986), are also supported. However, this study is unique in terms of addressing the research questions to computer science and engineering technology students in an educational environment where the student enrollment is predominantly African American. Therefore, the following discussion and implications focus on the uniqueness of this study, its results, research setting, and participants.

The research was conducted in order to investigate the relationship of scores on the Science and Engineering questionnaire measuring self-efficacy, academic milestone, and vocational interests to the academic performance of students enrolled in computer science and engineering technology programs at Savannah State University. Multiple regression analyses indicated that self-efficacy and vocational interest were the strongest predictors of academic performance. This finding supported results from a study conducted by Lent, Brown and Larkin (1986) showing that students who reported high self-efficacy and vocational interests' scores achieved higher grades in technical programs. It is important for counselors and advisors to focus on increasing self-efficacy to assist students in pursuing technical programs because self-efficacy is highly correlated to academic success.

In terms of implications for global counseling, the findings of the study suggest that self-efficacy beliefs and vocational interests be given greater consideration in academic and career counseling. It is important for academic advisors to conduct classes that will help students to develop better study habits, self-efficacy and vocational interest related to computer science and engineering technology programs.

Academic milestone self-efficacy (AM-S) measured students' ability to perform specific requirements such as mathematics, physics, and chemistry. Hackett and Betz (1984) have argued whether task specific measures might be

superior to the more global approaches to self-efficacy measurement. Results of this study show that the female students scored higher on academic milestone as compared to the male students. Based on this finding, it is important for academic advisors to conduct special tutorial sessions for male students to develop better study habits in specific areas such as mathematics, physics, and chemistry.

Results of this study confirm that math-SAT scores were a significant factor in predicting academic performance, but indicate that high school GPA is much less significant. This finding is somewhat different from the findings of Lent, Brown and Larkin (1986), in that their study showed math-SAT and high school GPA both were not highly correlated to academic performance of students enrolled in engineering and computer science programs. The difference in findings may have been due to higher requirements of math-SAT and high school GPA in the study conducted by Lent, Brown and Larkin. Although findings indicate that high school GPA is not significant in predicting academic performance at the college level, most technical programs require higher high school GPA. It is important that high school counselors emphasize better preparation in math and science courses in order to satisfy admission requirements at the college level. Results of the study indicate that math-SAT scores are stronger predictors of academic performance, therefore, counselors should attach substantially greater credence to math-SAT scores.

These important predictors, math SAT scores and self-efficacy scores, suggest a need for counselors, academic advisors, academic departments and administrators to provide career support to students interested in this field. Similarly, ways to enhance student self-efficacy should be explored as a means to increase student chances for academic success in computer science and engineering technology programs. Finally, it is important to extend this research to students from diverse racial, ethnic, socioeconomic backgrounds. The impact of these

findings should also be explored with high school students who have participated in a career planning course where careers in computer science and engineering technology have been a focus.

## Recommendations

The following recommendations are based on the results and conclusions of this study.

1. Counselors and advisors should adopt this or a similar model to assess the extent to which career-related self-efficacy beliefs, math SAT scores, high school GPA, academic milestones and vocational interests can predict academic performance (college GPA) of students enrolled in Computer Science and Engineering Technology programs. Since this study has shown that self-efficacy expectations are directly related to academic problems such as poor grades and overall academic performance, adoption of this model should provide a means to improve career counseling and advisor effectiveness. Also, counselors and advisors should be particularly sensitive to students who underestimate their ability with respect to desired educational goals. In such cases, programs might be designed to assists students in modifying their efficacy beliefs.

2. Results of research question one, indicates that math-SAT score was a significant contributor in predicting academic performance. However, the present admission requirements in colleges are based on a combination of high school GPA and math-SAT scores. It is highly recommended that students should be counseled to perform well in both the areas, with specific emphasis on achievement in math for those students showing interest in computer science and engineering careers.

3. The most important finding of this study is that self-efficacy and vocational interests are the strongest predictors of academic performance, a finding consistent with previous studies. It is strongly recommended that counselors and

advisors develop programs to enhance self-efficacy relative to careers in engineering technology in order to improve students' probability for academic success.

4. This study found little gender differences in self-efficacy and vocational interest, a finding at variance with the relatively small number of female students in computer science and engineering technology programs. It is recommended that greater efforts be made to direct more female students into these computer science and engineering technology programs.

Recommendations for Further Research

Results of this study suggests several directions for further research as stated in the following paragraphs:

1. This study was used to predict academic performance of students enrolled in Engineering and Computer Science Technology programs. However, participants had not been provided a previous educational experience that would introduce them to different areas in engineering. Therefore, it is recommended that future studies incorporate a pre-test and post-test to examine effects of the experimental study.

2. Further research to involve investigations that compare academic progress and career behavior across racial, ethnic and socioeconomic levels may expand the knowledge base useful for recruiting, counseling, and advising students considering Computer Science and Engineering Technology as a field of study.

3. Further research to involve a variety of comparison investigations such as size of institution (e.g., small versus large) and type of program (e.g., business versus education) may provide a means to devise a better tool for effective counseling in a more global sense which a can result in a productive workforce.

4. Further research should include counselor and advisor awareness of different engineering and computer science technology programs as a variable in

improving upon the model. This recommendation will enable counselors to provide students information about the requirements of computer science and engineering technology programs at the pre-college level.

5. Efforts must be made to examine the effects of self-efficacy on academic performance across different program levels (e.g. two-year four-year programs) and across program areas within engineering. Results from such comparative research will provide those in counseling, career, and academic advising a potentially useful framework to better understand the role of self-efficacy at differing academic levels.

## REFERENCES


Amatea, E.S., Cross, E.G., Clark, J.E., & Bobby, C.L. (1986). Assessing the work and family role expectations of career-oriented men and women. The life role salience scales. Journal of Marriage and the Family, 48, 831-838.

Ancis, J.R., & Phillips, S.D. (1996). Academic gender bias and women's behavioral agency self-efficacy. Journal of Counseling and Development, 75(2), 138-144.

Austin, H.S., & Sax, L.J. (1994). Undergraduate women in science: Personal and environment influences on the development of scientific talent. Los Angeles, CA: Higher Education Research Institute, University of California.

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change Psychological Review, 84, 191-214.

Bandura, A. (1982). Self-efficacy mechanism in human agency. American Psychologist, 37 (2), 122-147.

Bandura, A. (1983). Self-efficacy determinants of anticipated fears and calamities. Journal of Personality and Social Psychology, 45, 464-469.

Bandura, A. (1986). Social foundations of thought and action. A social cognitive theory. Englewood Cliffs, NJ: Prentice Hall.

Bandura, A. (1989). Human agency in social cognitive theory. American Psychologist, 44, 1175-1184.

Bandura, A. (1997). Self-Efficacy: The exercise of control. New York: Freeman.

Berg, H. M., & Ferber, M. A. (1983). Men and women graduate students. Who succeeds and why? Journal of Higher Education, 54, (6), 629-648.

Betz, N.E., & Hackett, G. (1981). The relationship of career-related self-efficacy expectations to perceived career options in college women and men. Journal of Counseling Psychology, 28, 399-410.

Betz, N.E., & Hackett, G. (1983). The relationship of mathematics self-efficacy expectations to the selection of science-based college majors. Journal of Vocational Behavior, 23, 329-345.

Betz, N.E., & Hackett, G. (1986). Applications of self-efficacy theory to

Brown, D. (1984). Trait and factor theory. In D. Brown & L. Brooks (Eds.), Career choice and development, applying contemporary theories to practice. San Francisco: Jossey-Bass Publisher.

Brown, S. D., Lent, R. W., & Larkin, K. C. (1989). Self-efficacy as a moderator of scholastic aptitude-academic performance relationships. Journal of Vocational Behavior, 35, 64-75.

Bruch, M., Chesser, E. S., & Meyer, V. (1989). The role of evaluative self-schemata in cognitive processing and performance: The impact on self-efficacy, self-evaluation and task outcome. Scandinavian Journal of Behavior Therapy, 18, 71-84.

Bruch, M. A. and Krieshok, T. S. (1981). Investigate versus realistic Holland types adjustment in theoretical engineering.

Brush, S. G. (1991). Women in science and engineering. American Scientist, 79, 404-419.

Butler, J. & K. Womer. (1985). Hierarchical vs. non-nested tests for contrasting expectancy-valence models: Some effects of cognitive characteristics. Multivariate Behavioral Research 20, 335-352.

Campbell, J. (1990). Self-perceived computer proficiency, computer attitudes, and computer attributions as predictors of enrollment in college computer courses. Annual Meeting of the American Educational Research Association Proceedings, 1-23

Campbell, N. K., & Hackett, G. (1986). The effects of mathematics task performance on math self-efficacy and task interest. Journal of Vocational Behavior, 28(2), 149-162.

Carlsen, M. B. (1984). Meaning-making: Therapeutic processes in adult development. New York: Norton.

Cheshier, S. R. (1998). Studying Engineering Technology. Prentice Hall.

Crites, J. (1981). Career counseling. New York: McGraw-Hill.

Crites, J. O. (1961). A model for the measurement of vocational maturity. Journal of Counseling Psychology, 8, 255-259.

Crites, J. O. (1965). Measurement of vocational maturity in adolescence: Attitude scale of the Vocational Development Inventory. Psychological Monographs, 79.

DeMoulin, D. F. (1993). Re-conceptualizing the self-efficacy paradigm: Analysis of an eight year study. Education Magazine, 114, (2), 167-201.

DeVellis, R. F. (1991). Scale development: Theory and applications, Newbury Park, CA: Sage.

Domino, G. (1982). Review of Ohio Vocational Interests Survey. Journal of Industrial Teacher Education, 19, 59-68.

Epstein, S. (1983). Development is a helix. Contemporary Psychology, 28, 366-367.

Farmer, H. S., Wardrop, J. L., Anderson, M. Z., & Risinger, R. (1995). Women's career choices: Focus on science, math, and technological careers. Journal of Counseling Psychology, 42, 155-170.

Felder, R. M., Felder, G. N., Mauney, M., Hamrin, C. E., & Dietz, E. J. (1995). A longitudinal study of engineering student performance and retention. Journal of Engineering Education, 84, (2), 151-163.

Frank, D. & Marolla, J. (1976). Efficacious action and social approval as interacting dimensions of self-esteem: A tentative formulation through construct validation. Sociometry, 39(4), 324-341.

Gardner, D. G. & Pierce, J. L. (1998). Self-esteem and self-efficacy within the organizational context: An empirical examination. Group & Organization Management, 23(1), 48-70.

Gati, I., Shenhav, M., & Givon, M. (1993). Processes involved in career preferences and compromises, Journal of Counseling Psychology, 40(1), 53-64

Gecas, V., & Schwalbe, M. (1986). Parental behavior and adolescent self-esteem. Journal of Marriage and the Family, 48(1), 37-46.

Girves, J. E, & Wemmerus, V. (1988). Developing models of graduate student degree progress. Journal of Higher Education, 59, (2), 163-189.

Graham, S., & Weiner, B. (1996). Theories and principles of motivation. Handbook of Educational Psychology, 21 63-84.

Gresham, F., Ellion, S., & Evans, F. (1993). Student self-concept scale. Circle Pines, MN: American Guidance Service.

Hackett, G. & Betz, N. E. (1984). Gender differences in the effects of relevant and irrelevant task failure on mathematics self-efficacy expectations. Paper presented at the annual convention of AREA, New Orleans.

Hackett, G., & Lent, R. W. (1992). Theoretical advances and current inquiry in career psychology. Handbook of counseling psychology, 2, 419-452.

Hackett, G., Betz, N. E., Casas, J. M., & Rocha-Singh (1992). Gender, ethnicity, and social cognitive factors predicting the academic achievement of students in engineering. Journal of Counseling Psychology, 39, (4), 527-538.

Hackett, G., Betz, N. E., Casas, J. M., & Rocha-Singh, I. A. (1992). Gender, ethnicity, and social cognitive factors predicting the academic achievement of students in engineering. Journal of Counseling Psychology, 39, 527-538.

Herr, E. L., & Cramer, S. H. (1996) Career Guidance and Counseling through life span. HaperCollins Publishers.

Herr, E. L., & Cramer, S. H. (1990). Career Guidance and Counseling through life span. HarperCollins Publishers.

Herzberg, F. (1966). Work and the nature of man. New York: World Publishing Company.

Horning, L. S. (1987). Women graduate students: A literature review and synthesis. In L.S. Dix (Ed).

Hotchkiss, K., & Borrow, H. (1984). Sociological perspectives on career choice and attainment. In D. Brown & L. Brooks (Eds.), Career choice and development: Applying contemporary theories to practice. San Francisco: Jossey-Bass.

House, J. D. (1993). The relationship between academic self-concept and school withdrawal. The Journal of Social Psychology, 133, (1), 125-127.

Holland, J. L. (1978). Vocational Preference Inventory. Palo Alto, California: Consulting Psychologist Press.

Hurtado, S. (1994). Graduate school racial climates and academic self-concept among minority graduate students in the 1970s. American Journal of Education, 102, (3), 330-351.

Isaacson, L. E. (1985). Basics of career counseling. Boston: Allyn & Bacon.

Isaac., P. D., Malaney, G.D., & Karras, J.E. (1992). Parental educational level, Gender differences, and sensors' aspirations for advanced study. Research in Higher Education, 33, (5) 595-606.

Kegan, R. (1982). The evolving self. Cambridge, MA: Harvard University Press.

Klein, K. L., & Wiener, Y. (1977). Interest congruency as a moderator of the relationship between job tenure and job satisfaction and mental health. Journal of Vocational Behavior, 10, 91-98.

Knowlton, C. (1990). "11 men's million dollar motivator," Fortune, 8-10.

Kuder, G. F., & Zytowski, D. G. (1991). Kuder Occupational Interest Survey. Form DD general manual, Monterey, CA: CTB MacMillan/ McGraw-Hill.

Landy, F.J. & Becker, W.S. (1988). Motivation theory reconsidered in research in organizational behavior, ed., L.L Cummingas and B.M. Straw. Greenwich, Connecticut: JAI Press.

Layton, P. L. (1984). Self-efficacy, locus of control, career salience, and women's career choice. Ph.D. dissertation, Department of Psychology, University of Minnesota, Minneapolis.

Lent, R, W., Brown, S. D., & Larkin, K. C. (1983). Science and Engineering Questionnaire. University of Minnesota.

Lent, R, W., Brown, S. D., & Larkin, K. C. (1986). Self-efficacy in the prediction of academic performance and perceived career options. Journal of Counseling Psychology, 33, (3), 265-269.

Lent, R. W., & Hackett, G. (1987). Career self-efficacy: Empirical status and future directions. Journal of Vocational Behavior, 30, 347-382.

Lent, R. W., Brown, S. D., & Larkin, K. C. (1984). Relation of self-efficacy expectations to academic achievement and persistence. Journal of Counseling Psychology, 31, 356-362.

Lent, R. W., Brown, S. D., & Larkin, K. C. (1986). Self-efficacy in the prediction of academic performance and perceived career options. Journal of Counseling Psychology, 33, (3), 265-269.

Lent, R. W., Brown, S. D., & Larkin, K.C. (1987a). Comparison of three theoretically derived variables in predicting career and academic behavior: Self-efficacy, interest congruence, and consequence, and consequence thinking. Journal of Counseling Psychology, 34, 293-298.

Lent, R.W., & Hackett, G. (1987b). Career self-efficacy: Empirical status and future directions. Journal of Vocational Behavior, 30, 347-382.

Malloch, D. C., & Michael, W. B. (1981). Predicting student grade point average at a community college from scholastic aptitude tests and from measures representing three constructs in Vroom's expectancy theory model of motivation. Educational and Psychological Measurement, 41, 1127-1135.

Maslow, A. H. (1943). A theory of human motivation. Psychological reports, 50, 370-396.

Matsui, T., & Tsukamoto, S. I. (1991). Relation between career self-efficacy measure based on occupational title and Holland codes and model environments: A methodological contribution. Journal of Vocational Behavior, 38, 78-91.

McClelland, D.C. (1985). How motives, skills, and values determine what people do. American Psychologist, 40, 812-825.

Multon, K. D., Brown, S. D., & Lent, R. W. (1991). Relation of self-efficacy beliefs to academic outcomes: A meta-analysis investigation. Journal of Counseling Psychology, 38, 30-38.

National Center for Education Statistics, (1996), Washington, D.C.

Nunnally, J. C. (1978). Psychometric theory. New York: McGraw-Hill.

Osipow, S.H. (1980). The Career Decision Scale. Columbus, OH: Marathon Consulting and Press.

Pajares, F. (1996). Self-efficacy beliefs in academic settings. Review of Educational Research, 66, 543-578.

Pascarella, E. T., Smart, J. C., Ethington, C., & Nettles, M. (1987). The influence of college on self-concept. A consideration of race and gender differences. American Educational Research Journal, 24, (1), 49-77.

Pitz, G. F., & Harren, V.A. (1980). An analysis of career decision-making from the point of view of information processing and decision theory. Journal of Vocational Behavior, 16, 320-346.

Post, P., Stewart, M. A., & Smith, P. L. (1991). Self-efficacy, interest, and consideration of math/science and non math/science occupations among college freshmen. Jounral of Vocational Behavior, 38, 179-186.

Rynes, S., & J. Lawlet. (1983). A policy-capturing investigation of the role of expectancies in decisions to pursue job alternatives. Journal of Applied Psychology, 68, 620-631.

Rotter, J.B. (1982). Social learning theory . Expectancy-value models in psychology, 73, 93-105.

Sax, L. J. (1994). Mathematical self-concept. How college reinforces the gender gap. Research on Higher Education, 35, (2), 141-166.

Schunk, D.H. (1990). Introduction to the special section on motivation and efficacy. Journal of Educational Psychology, 82, 3-6.

Sergiovann, T.J. (1967). Factors which affect satisfaction and dissatisfaction of teachers. Journal of Educational Adminstration, 5, 66-82.

Shavelson, R., Hubner, J., & Stanton, G. (1976). Self-concept: Validation of construct interpretations. Review of Educational Research, 46, 407-411.

Siegel, Glass, & Ware (1985). A comparison of two models for predicting mathematics performance: Social learning versus math aptitude anxiety. Journal of Counseling Psychology, 32(4), 531-538.

Skinner, B. F. (1953). Science and human behavior: New York: Macmillan

Stadjkovic, A., & Luthans, F. (1998). Social Cognitive theory and self-efficacy. Organizational Dynamics, 26, 62-78.

Stickel, S. A., & Bonett, R. M. (1991). Gender difference in career self-efficacy: Combining a career with home and family. Journal of College Student Development, 32, 297-301.

Stitt-Gohdes, W., (1997). American Vocational Education. Research Associations Proceedings, Annual Convention, Las Vegas, Nevada.

Super, D. E. (1984). Career and Life development. In D. Brown & L. Brooks (Eds). Career choice and development, 192-234. San Francisco, CA:Jossey-Bass.

Swanson, J. L. (1996). How do women perceive career barriers? Theoretical and measurement issues. Paper presented at the Annual Meeting of the American Psychological Association, Toronto.

Taylor, K, M., & Betz, N.E. (1983). Applications of self-efficacy theory to the understanding and treatment of career indecision. Journal of Vocational Behavior, 22, 63-81.

Taylor, K. M., & Betz, N. E. (1983). Applications of self-efficacy theory to the understanding and treatment of career indecision. Journal of Vocational Behavior, 22, 63-81.

Tinto, V. (1993). Leaving college: Rethinking the causes and cures of student attrition. (2nd ed). Chicago : University of Chicago Press. understanding career choice behavior. Journal of Social and Clinical Psychology, 28, 29-41.

Vollmer, F. (1986). The relationship between expectancy and academic achievement. How can it be explained? British Journal of Educational Psychology, 67-74.

Vondracek, F. W., Hostetler, M., Schulenberg, J. E., & Shimizu, K. (1990). Dimensions of Career Indecision. Journal of Counseling Psychology, 37(1), 98-106.

Vroom, V. H. (1964). Work and Motivation. New York: Wiley.

Walsh,, W, B. (1978). Theories of person-environment interaction: Implications for the college student. Iowa City, Iowa: American Testing Program.

Watts, A. G. (1981). Career development in Britain. Cambridge, England: Hobson's Press.

Wigfield, A., & Eccles, J. (1992). The development of achievement task values: A theoretical analysis. Development review, 12, 265-310.

Windall, J. L. (1988). AAAS presidential lecture. Voices from the pipeline. Science, 241, 1740-1745.

Zeldin, A. L., & Pajares, F. (1997). Against the odds: Self-efficacy beliefs of women with math-related careers. Paper at the meeting of the American Educational Research Association, Chicago.

Zilber, S. M. (1988). The effects of sex task performance, and attributional styles on task and career self-efficacy expectations. Ph.D. dissertation, Department of Psychology.

# APPENDIX A

# REQUEST TO USE

# THE SCIENCE AND ENGINEERING CAREER QUESTIONNAIRE

Dr. Robert W. Lent
Professor, Counseling Psychology
University of Maryland

April 6, 1998

Dear Dr. Lent:

I teach at Savannah State University in the Department of Engineering Technology. I am also a graduate student at the University of Georgia, and my dissertation topic is: Self-Efficacy and Vocational Interest in the Prediction of Academic Performance of students in Engineering Technology.

I would like to request permission to use your Science and Engineering questionnaire.

I appreciate your help.

Sincerely,

Asad Yousuf
Professor, Engineering Technology
Savannah State University

## SCIENCE AND ENGINEERING CAREER QUESTIONNAIRE
## VOCATIONAL INTERESTS

**Part C(Vocational Interests): For each occupation listed below, please indicate your degree of interest—assuming you had the necessary education/training and that you were motivated to do your best. Indicate your response in terms of "like", "indifferent", and "dislike" with scores of 3, 2, and 1 respectively.**

| Occupation | Like | Indifferent | Dislike |
|---|---|---|---|
| Engineering (General) | 3 | 2 | 1 |
| Aerospace Engineering | 3 | 2 | 1 |
| Physics Scientist | 3 | 2 | 1 |
| Agricultural Engineer | 3 | 2 | 1 |
| Architect | 3 | 2 | 1 |
| Astronomer | 3 | 2 | 1 |
| Chemical Engineer | 3 | 2 | 1 |
| Civil Engineer | 3 | 2 | 1 |
| Computer Scientist | 3 | 2 | 1 |
| Electrical Engineer | 3 | 2 | 1 |
| Geologist | 3 | 2 | 1 |
| Mathematician | 3 | 2 | 1 |
| Mechanical Engineer | 3 | 2 | 1 |
| Physicist | 3 | 2 | 1 |

Other _____
Please Specify

SCIENCE AND ENGINEERING CAREER QUESTIONNAIRE

Academic Milestones – Strength (AM-S)

**Part B (AM-S): For each goals (milestones) listed below, please indicate whether or not you could successfully do each of the following:**

| Engineering and Computer Technology Goal (Milestones) | | | If yes, how sure are you ? Completely Unsure | | | | Completely Sure |
|---|---|---|---|---|---|---|---|
| Complete the mathematics requirements | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Complete the chemistry requirements. | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Complete the physics requirements | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Complete some technical or science degree | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Perform competently in some technical or scientific career field | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Remain in the program over the next two semester | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Excel in the program over the next semester | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Excel in the program over the next two semester | Yes | No | 1 | 2 | 3 | 4 | 5 |

# APPENDIX B

## PERMISSION TO USE

## THE SCIENCE AND ENGINEERING QUESTIONNAIRE

UNIVERSITY OF MARYLAND AT COLLEGE PARK

COLLEGE OF EDUCATION • COUNSELING AND PERSONNEL SERVICES

June 9, 1999

Asad Yousuf
Professor, Engineering Technology
Savannah State University

Dear Asad:

I have received your request for using the Science and Engineering Questionnaire for your study.

The questionnaire has three parts: Self-efficacy regarding technical/scientific educational requirements, job duties, and academic milestones. You have my permission to use all three parts for research purposes. Please keep me apprised of your findings.

Sincerely,

Robert W. Lent, Ph.D.
Professor, Counseling Psychology

# APPENDIX C

# INSTRUMENTS:

# CONSENT FORM

# AND

# THE SCIENCE AND ENGINEERING CAREER QUESTIONNAIRE

## Consent Form

I _____ agree to participate in the research titled "Self-Efficacy and Vocational Interests in the Prediction of Academic Performance of Students in Engineering Technology," which is being conducted by Asad Yousuf, Department of Occupational Studies, The University of Georgia, (912) 356-2514 under the direction of Dr. Myra N. Womble, Department of Occupational Studies, 706-542-4091. I understand that this participation is entirely voluntary; I can withdraw my consent at any time without penalty and have the results of the participation, to the extent that it can be identified as mine, returned to me, removed from the research records, or destroyed.

The following points have been explained to me:

1) The reason for the research is to assess the extent to which career-related self-efficacy beliefs, math SAT scores, high school GPAs, and vocational interests can predict academic performance (college GPA) of students enrolled in Computer Science and Engineering Technology programs. This research is expected to contribute information needed in the process of translating self-efficacy theory into a practical model/tool for career counseling and guidance.

   The benefit that I may expect from it is: This study is expected to provide information that will be helpful to counselors, academic advisors, and educators to identify parameters that will contribute to my academic performance in the Computer Science and/or Engineering Technology programs.

2) The procedures are as follows: The researcher will briefly describe the nature and purpose of the study, invite each student to participate in the study, and administer the questionnaire to all students agreeing to participate in the study. Those agreeing to participate will receive two copies of an assent form and the Science and Engineering Career (SEC) questionnaire. The researcher will review the assent form and the instructions for completing the questionnaire, then answer questions. The participants will be asked to sign the both copies of the assent form and complete the questionnaire. The researcher will collect the completed questionnaires and a copy of the signed assent form (participants will keep a copy of the signed assent form). Administration of the SEC will take from 20-30 minutes. The researcher will also obtain my math SAT scores, high school GPA, and college GPA as indicators of my academic performance.

3) The discomforts or stresses that may be faced during this research are: No discomforts or stresses are foreseen

4) Participation entails the following risks: No risks are foreseen

5) The results of this participation will be confidential, and will not be released in any individually identifiable form without my prior consent, unless otherwise required by law. To ensure that my name will not appear on any data collection forms, the researcher will use numbers to code my academic information (math SAT score, high school GPA, college GPA) and questionnaire responses. Any data collected from or about me will be held in confidence

6) The researcher will answer any further questions about the research, now or during the course of the project, and can be reached at 912-356-2514

| | | | |
|---|---|---|---|
| Signature of Researcher | Date | Signature of Participant | Date |

Please sign both copies of this form. Keep one and return the other to the investigator.

Research at the University of Georgia that involves human participants is overseen by the Institutional Review Board. Questions or problems regarding your rights as a participant should be addressed to Julia D. Alexander, M.A., Institutional Review Board, Office of the Vice President for Research, University of Georgia, 606A Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411, Telephone (706) 542-6514; E-Mail Address JDA@ovpr.uga.edu.

## SCIENCE AND ENGINEERING CAREER QUESTIONNAIRE
### Educational Requirements - Strength (ER-S)

**Part A (ER-S): For each occupation listed below, please indicate whether or not you feel you could successfully complete the job duties of that occupation—assuming you had the necessary education/training and that you were motivated to do your best. For each YES, indicate how sure you are on the 5-point scale.**

| Occupation | Could you Successfully complete The job duties and/or training? | | If yes, how sure are you? Completely Unsure | | | | Completely Sure |
|---|---|---|---|---|---|---|---|
| Engineering (General) | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Aerospace Engineering | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Physics Scientist | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Agricultural Engineer | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Architect | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Astronomer | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Chemical Engineer | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Civil Engineer | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Computer Scientist | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Electrical Engineer | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Geologist | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Mathematician | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Mechanical Engineer | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Physicist | Yes | No | 1 | 2 | 3 | 4 | 5 |
| Other _____ Please Specify | Yes | No | 1 | 2 | 3 | 4 | 5 |

# APPENDIX D

## REQUEST TO CONDUCT STUDY AT SSU

Ms. Majeda Nabban
Executive Secretary
Internal Review Board
Savannah State University
Savannah, GA 31404

January 9, 1999

Dear Ms. Nabban:

I would like to request permission to conduct a study titled " Self-Efficacy and Vocational Interests in the Prediction of Academic Performance of Students in Engineering Technology", in the department of Engineering Technology at Savannah State University.

The study will asses the extent to which career self-efficacy beliefs, math-SAT scores, high school GPA and vocational interests could predict the academic performance of the students enrolled in Computer Science and Engineering Technology programs at Savannah State University.

The results of the study will be used in my dissertation for a doctoral degree in Occupational Studies at the University of Georgia.

Sincerely,

Asad Yousuf
Professor, Engineering Technology
Savannah State University

# APPENDIX E

## PERMISSION TO CONDUCT STUDY AT SSU

Internal Review Board.
Human Research:
Chair: Dr. R.M.G. Nair,
P.O. Box 20163
Dr. R. Madyastha M.D., Ph. D.
Clinical specialist.
Dr. Bowen. LLM, M.Lit., Legal Specialist.
Ms Majeda Nabhan, Executive Secretary

Tel. (912) 353-5290
Fax (912) 356-2874
EMail: nairr@tigerpaw.ssu.peachnet.edu

SAVANNAH STATE UNIVERSITY
DEPARTMENT OF CHEMISTRY
Savannah, GA 31404

January 25, 1999

**RE: Research Project "Self-Efficacy and Vocational Interests in the Prediction of Academic Performance of Students in Engineering Technology"**

Mr. Asad Yousuf
Professor, Dept. of engineering Technology
P.O. Box 20089
Savannah State University

Dear Professor Yousuf,

Your research project entitled "Self-Efficacy and Vocational Interests ....." has been subjected to an expedited review. The Questionnaire as well as the informed consent form presented by you for the survey among students are very well planned and the Principal Investigator has agreed to adhere to the OPRR guidelines. Approval is granted for the research and we wish you success in this important research project. For the sake of record keeping this project is assigned an identification number #IRB/Eng/1/99. Please make the required copies of your informed consent forms, get these duly signed by the students under study and keep the forms in a separate file for inspection by NIH/NSF or any granting agency, when required. Thanks.

Sincerely,

Raghavan Nair

Raghavan M.G. Nair, Ph.D.,
Professor & Chair, IRB

cc: Dr. George Williams, Dean, Office of Graduate Studies and Research
Ms. Majeda Nabhan, Executive Secretary, IRB
Dr. Charlesworth Martin, Dean, College of Sciences & Technology
Dr. Joseph H. Silver, Sr., Academic Vice President

# APPENDIX F

## UGA APPROVAL OF HUMAN SUBJECTS FORM

The University of Georgia
Office of Vice President for Research
Office of the Vice President for Research
DHHS ASSURANCE ID NO. : M1047

Institutional Review Board
Human Subjects Office
606A Graduate Studies Research Center
Athens, Georgia 30602-7411
(706) 542-6514; 542-3199
FAX No. (706) 542-5538

# STATUS REPORT FORM

Date Received: 02/03/1999 Project Number: H990386

Major Investigator: Mr. Asad Yousuf Soc. Sec. No.: 283-76-3674
Co-Investigator(s): None Indicated Soc. Sec. No.: N/A
Dept./Bldg./Phone: Occupational Studies / 207 River's Crossing

Off-Campus Address: 107 Meadowlark Circle, Savannah, GA 31419 / (912)356-2514 or (912)927-2007

TITLE OF STUDY: Self-Efficacy and Vocational Interests in the Prediction of Academic Performance of Students in Engineering Technology

45 CFR 46 Category: 46.101 (2) Modifications Required for Approval and Date Completed: 3/3/99 Supplied Savannah State University approval; modified consent form; clarified procedures for maintaining confidentiality

Reviewer: Alexander -

Approved: 3/3/99 (date study approved) for the period 3/3/99 (date can begin data collection) to 4/30/99 (date to end data collection)

*NOTE. Any research conducted before the approval date or after the end data collection date shown above is not covered by IRB approval, and cannot be retroactively approved.*

Number Assigned by Sponsored Programs: N/A | Funding Agency: N/A | Form 310 Provided: No

Your human subjects study has been approved as indicated under IRB ACTION above.

PLEASE BE AWARE THAT IT IS YOUR RESPONSIBILITY TO INFORM THE IRB ...

... of any significant changes or additions to your study and obtain approval of them before they are put into effect; ...

... that you need to extend the approval period beyond the expiration date shown above; ... or, ...

... that you have completed your data collection as approved, within the approval period shown above, so that your file may be closed.

For your convenience in obtaining approval of changes, extending the approval period, or closing your file, we are providing you with a second copy of this form. Detach the second copy (*RETURN COPY stamped in red*), complete the form as appropriate, sign and date it, then return the form to the IRB Office. Keep this original copy for your records.

Julia Alexander

Julia Alexander, M.A.,
Chairperson, Institutional Review Board

Copy: Dr. Helen C. Hall

# APPENDIX G

# STUDY DESCRIPTORS

Table G1

Gender and Degree/Major of Participants (N = 125)

| Degree/Major | Male | % | Female | % |
|---|---|---|---|---|
| Chemical Engineering Technology | 9 | 7.2 | 2 | 1.6 |
| Civil Engineering Technology | 11 | 8.8 | 3 | 2.4 |
| Electronics Engineering Technology | 22 | 17.6 | 4 | 3.2 |
| Electronics Engineering (Computer) Technology | 5 | 4 | 3 | 2.4 |
| Mechanical Engineering Technology | 11 | 8.8 | 2 | 1.6 |
| Computer Science Technology | 27 | 21.6 | 26 | 20.8 |

*Computer Engineering Technology Option

Table G2

Courses in which Study Participants Were Enrolled (N=125)

| Course | N | % |
|---|---|---|
| Electrical Circuit | 25 | 20 |
| Digital Systems I | 20 | 16 |
| Digital Systems II | 18 | 14.4 |
| Microcomputer Interfacing | 2 | 1.6 |
| Communications Data Acquisition Systems | 10 | 8 |
| Structural Design I | 2 | 1.6 |
| Heating, Ventilating, and Air Conditioning | 7 | 5.6 |
| Computer Graphics | 10 | 8 |
| Material/Energy Balances | 12 | 9.6 |
| Engineering Economy | 14 | 11.2 |
| VLSI Design | 5 | 4 |

Table G3

Number of Semesters Completed (N=125)

| Semester | N | % |
|---|---|---|
| 2 | 2 | 1.6 |
| 3 | 5 | 4 |
| 4 | 67 | 53.6 |
| 5 | 31 | 24.8 |
| 6 | 6 | 4.8 |
| 7 | 9 | 7.2 |
| 8 | 5 | 4 |