

# IMPACT OF MENTORSHIP PROGRAMS ON AFRICAN-AMERICAN MALE HIGH SCHOOL STUDENTS' PERCEPTIONS OF ENGINEERING

by

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(Under the Direction of Roger B. Hill)

## ABSTRACT

The purpose of this study was to examine the impact of mentorship programs on African-American male high school students' perceptions of engineering. In this study, indicators of students' perceptions included students' perceptions of engineering, their self-efficacy in the area of math, and their self-efficacy in the area of science. This study used a two-group, posttest only, experimental design with randomly selected participants. A survey was used to collect data from 20 participants attending the Middle College at A&T.

Using an independent *t*-test to determine a difference of statistical significance, inferential statistics were provided to answer the following research questions; (a) Is there a significant difference in perceptions of engineering for students who participated in the NCETE/NSBE mentorship program when compared with non-mentored students?, (b) Is there a significant difference in self-efficacy in the area of math for students who participated in the NCETE/NSBE mentorship when compared with non-mentored students?, and (c) Is there a significant difference in self-efficacy in the area of science for students who participated in the NCETE/NSBE mentorship when compared with non-mentored students? The study did not produce significant findings in relation to the research questions. Nonetheless the study identified; a viable formal mentorship program,

instruments for use in evaluating mentorship programs, and qualitative feedback used for the improvement of mentorship programs.

INDEX WORDS: Mentorship programs, Perceptions, Self-efficacy, At-risk, Engineering, Systems thinking, Single-gender

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## CHAPTER 1

### INTRODUCTION

Since the United States' Supreme Court ruling in *Brown vs. Board of Education* (1954) proclaiming that separate schools were not equal, the nation has struggled for the last fifty odd years to seek equality in our school systems and equal opportunities for citizens in communities and workplaces. In the 21<sup>st</sup> century, this paradigm has been framed with a new set of guidelines as the nation fights to compete globally in a technological world. During recent decades, the nation has turned more to outsourcing as a way to compete with other nations shipping ever increasing quantities of products from across the Pacific, and Atlantic oceans, in lieu of investing in its own workforce. Many economists feel that the nation has failed to take advantage of its greatest resource, this being its diverse population. Some of the reasons for this failure are reflected in challenges that are apparent when seeking to attract a diverse population of students to the fields of engineering and other related professions.

Why is it so important that the U.S. look for ways to attract a diverse population to engineering and other technical fields? Culturally, the preclusion of minorities from technical fields has devastating ramifications. According to Jenkins (1999), for minorities to be able to skillfully adapt to an ever changing economy in a capitalist society it is pertinent that they become technologically efficient in the coming years. Technological efficiency not only speaks to the understanding and manipulation of technological devices but it also speaks to increased representation in fields that require technological literacy particularly engineering, computer science and technology education to name a few. Not only is this important to the socioeconomic and educational growth of

minorities, this also has implications for the nation as a whole in the competitive workforce.

As the global nature of our economy expands, Americans are increasingly becoming cognizant of the impacts that the global marketplace is having on the country. Over the next twenty years, the most valuable resource of any country will be its human and intellectual capital (National Academy of Engineering, 2004). The inequality of African-Americans in science and technology introduces vital issues concerning both equal opportunity and the capacity for America to produce an ample number of scientists and engineers for the future. In comparison to many of the non-technical fields, workers in engineering and technology have been less diverse (American Association for the Advancement of Science, 1998) foreshadowing a perilous future for minorities. This not only impacts the strength of engineering and technology-based fields but it also has implications for the welfare of our nation in relation to the global marketplace and world competition.

To effectively begin to diversify the fields of engineering and other technical fields, several challenges need to be addressed, including; (a) a current technical workforce that is undiversified in relation to the total workforce (Wheeler, 1996), (b) ineffective plans of action currently in use for recruitment and retention of minority students and faculty (Jeria & Gene, 1992), and (c) a pedagogical approach to Science, Math, Engineering, and Technology (SMET) that is culturally unresponsive (Carter, 2005). In turning to the literature, mentorship programs have provided some answers to these puzzling questions. Within organizations, formal mentoring programs have benefited the growth of women and minorities in the workplace by helping with

assimilation to the workplace (Hansman, 2002). As the nation fights through the disadvantages of an undiversified technical workforce (Wheeler, 1996) it has come time to turn to literature that supports the intervention of mentorship programs as a means to recruit minorities to the field.

As a grass-roots initiative, mentorship programs act as a vehicle for change, satisfying the needed connection of family and community as detailed in the following quote, “The structural and attitudinal changes required for instituting changes that transcend single professional field and agency auspices cannot occur without rooted connections with families and the community” (Oates, Weishew, & Flores, 1998, p. 53). Formal mentorship programs may offer a viable approach for recruiting minorities to the fields of engineering and other technical fields by serving as an extension of the community. As a tool of affirmative action, mentorship programs have been utilized since the 1970s and 1980s (Van Collie, 1998). Research shows that formal mentoring programs have become effective recruitment tools for many organizations looking to recruit and retain minorities in the workplace (Allen & O’Brien, 2006). Further illustrating the feasibility of mentoring as a tool to promote diversity in technical fields, Maughan (2006) proffered that mentoring has repeatedly been shown to enrich the process of learning, which in itself may positively impact retention, recruiting and knowledge management of organizational members.

To provide a rationale for the intervention of mentorship programs it must be reiterated that federal legislation distinctly mentions that one purpose for mentoring is to “encourage students from underrepresented groups to pursue scientific and technical careers” (U.S. Energy Policy Act, Sec. 1102, p. 10, line 16). As organizations and

institutions look to meet the demanding needs of the nation's workforce more research is needed that clearly delineates the benefits of formal mentorship programs. With respect to engineering and other technical fields, this study was particularly focused on the characteristics of mentoring and its functions in an academic setting while examining the ability of a mentoring relationship to facilitate and help organizations recruit and retain underrepresented populations. In this role the mentor usually acts as a sponsor who will provide his/her prospective protégé with exposure, coaching, and awareness of potential career opportunities (Allen & Day, 2002). Within the scope of the mentoring relationship, this mentoring function is categorized by the term *career functions*, which will be expounded upon later in the review of literature.

The field has experienced an increase in literature focused on mentoring, though lacking in comparative and experimental studies (Underhill, 2005). There is growing interest for experimental research that examines the benefits of mentorship programs on individual's perceptions and self-efficacy. This research study sought to examine the impact of mentorship programs on African-American students' perceptions of engineering. For the purpose of this study mentorship was defined as, "A structured mentoring relationship...with the primary purpose of systematically developing the skills and leadership abilities of less-experienced members of an organization" (Murray & Owen, 1991, p. 5).

In narrowing the focus, this study will examine one specific demographic and one particular technical field. Although there is research available that documents the effectiveness of mentorship programs on a student's academic success, especially for at risk students (Campbell-Whatley, Algozzine & Obiakor, 1997, Hall 2006), there is a need



for research that examines the impact of mentorship programs in relation to minorities' perceptions towards career choices specifically engineering. Using a very specialized group, the following study examined the impact of a formal mentorship program on African-Americans perceptions. Findings from this research study will help lay the groundwork for future initiatives seeking to introduce effective means of recruitment and retention of underrepresented populations.

### Purpose of the Study

The purpose of this study was to examine the impact of mentorship programs on African-American male high school students' perceptions of engineering. In this study, indicators of students' perceptions included students' perceptions of engineering, their self-efficacy in the area of math, and their self-efficacy in the area of science. This study used a two-group, posttest only, experimental design with randomly selected participants. After participation in the NCETE/NSBE mentorship program, the treatment for this study, a survey was used to collect data to answer the following research questions:

### *Research Questions*

1. Is there a significant difference in perceptions of engineering for students who participated in the NCETE/NSBE mentorship program when compared with non-mentored students?
2. Is there a significant difference in self-efficacy in the area of math for students who participated in the NCETE/NSBE mentorship program when compared with non-mentored students?

3. Is there a significant difference in self-efficacy in the area of science for students who participated in the NCETE/NSBE mentorship program when compared with non-mentored students?

#### Rationale

In the current educational climate, urban and other high poverty public schools are failing to meet the educational needs of students of color (Fenzel, Domingues, & Roughly, 2006). As students of color lag behind their white counterparts in measures of academic performance it is becoming increasingly clear that more research is needed to examine the effects of environment on student performance (Fenzel & O'Brennan, 2007). The inadequate number of minority scientist and engineers has implications for the future ability of the nation to attract minorities to science, technology, engineering and other related fields. In seeking to address the lack of minorities in technical fields, many university engineering programs have developed outreach programs that specifically target female and minority students (Holland & Vasquez de Velasco, 1998).

There has been a growing consensus that suggests the best way to achieve diversity in technical fields is through recruitment and retention of minority students and faculty (Holland & Vasquez de Velasco, 1998). However, this is not an easy task, as proffered by Douglass, Iversen & Kalyandurg (2004), and one of the stiffest challenges for the engineering profession is attracting students to the field from the entire spectrum of American society. The last decade has seen a few studies that investigate the effectiveness of mentorship programs for African-Americans in the area of career development and advancement (Hall, 2006; Reddick, 2006), and there is a litany of research that looks at the effectiveness of mentorship programs (Morgan, 1996; Marable,

1999; Campbell-Whatley, Algozzine & Obiakor, 1997). However; one glaring issue is the lack of literature that looks to address the problem of retention and recruitment through the use of mentorship programs (Jeria & Gene, 1992). Studies have shown that a child's perception of an occupation and their self-efficacy greatly influence the decision of a child to pursue the occupation. The researcher chose to focus on the social interactions of mentorship programs and their potential to influence participants' perceptions in this study.

Although previous studies have documented the effectiveness of mentorship programs (Campbell-Whatley, Algozzine & Obiakor, 1997; Hall, 2006; Reddick, 2006), a recent literature review suggested that there is a lack of literature on mentoring that is based on experimental designs (Underhill, 2005). Using a posttest only, control group approach, this research provided a comparative study that uses an experimental design to examine the impact of mentorship programs on African-American male high school students' perceptions of engineering. Findings from this study will help lay the groundwork for future studies seeking to investigate effective means of recruitment and retention of minorities to technical fields.

### Theoretical Framework

This research study examined the impact of mentorship programs on African-American male high school students' perceptions of engineering. Therefore, it is important to examine the construct of perception due to its potential to influence a student's interest in a field or career. Perception is identified as constructed knowledge. Jarvis (1992) posited that no experience is free of previous ones, and this affects the way we perceive and respond to other situations. In the field of engineering education, surveys

have been commonly used to determine the perceptions of individuals. This method has been particularly useful when presented in literature to show a lack of change in a particular field over time (Foster & Wright, 1996). Using this premise and definition of perceptions, the benefits of mentoring were examined in relation to students' perceptions and self-efficacy.

This study utilized Kram's (1983) theory of mentoring in an effort to gain insight into how mentorship programs influence students' perceptions. In mentoring, there are common characteristics that are associated with this theory such as teaching, guiding, counseling, and encouraging. Coaching is another element of mentoring whose purpose is to help a younger or less experienced person develop skills, knowledge, competence, interest or abilities in a chosen occupational field (Maughan, 2006). The actual act of mentoring has been known under other names including guild, artisanship, and apprenticeship. According to Kram (1983), mentoring is a relationship between an experienced member of an organization and an understudy where the experienced employee acts as a role model and provides support and direction to the protégé.

Kram developed a study that looked at the phases of the mentoring program, and was able to demonstrate that the mentorship relationship has enormous potential to facilitate career advancements. Mentors are generally categorized based on their mentoring functions. *Career functions* and *psychological functions* are the two main mentoring categories that have been supported by the literature (Allen & Day, 2002). For the purpose of this study the researcher focused on career functions, which includes sponsorship, coaching, exposure/visibility, and the provision of challenging assignments.

In an effort to impact students' perceptions, this research study will use mentoring theory as a theoretical framework to examine the construct of perceptions. Due to the dynamic characteristics of the mentoring relationship (including social interactions), social learning theory will be utilized to extend the understanding of this relationship.

In order to understand the impact of social interactions and environments, social learning theory and social cognitive theory were explored in an effort to extend mentoring theory. Merriam and Carafarella (1999) helped elucidate the relevance of social learning theories in reference to mentoring by stating "Social learning theories contribute to adult learning by highlighting the importance of social context and explicating the process of modeling and mentoring" (p. 139). The inclusion of social learning theories (inclusive of social cognitive theory) to extend mentor theory is the result of social learning theory's emphasis on how social context and the environment reinforce behavior (Ormond, 1999). This theory considers that people learn from one another, including concepts of observational learning, imitation, and modeling. Social learning theory is also relevant because it is seen as a bridge between behaviorist learning theories and cognitive learning theories (Ormond, 1999).

By examining the construct of perceptions and using social learning theory as the theoretical framework to extend mentoring theory, the researcher sought to obtain salient findings that would add to the existing literature on mentorship. Results will contribute to the foundation of previous research which future research can build upon. Mentorship programs have shown the potential to provide a variety of support functions, and the literature has many examples of the impact mentoring may have on career advancement (Kram, 1983). However, the literature lacks true experiments that examine the theory of

mentoring. In an effort to add to the existing literature, the researcher provided an experimental study on the impact of mentorship programs on African-American male high school students' perceptions of engineering.

### Significance of Study

The last 25 years have provided the field of education with a number of studies that have looked at the benefits of student mentorship (Allen & Day, 2002; Maughan, 2006; Underhill, 2005). Nonetheless, there is a lack of research that compares groups of students receiving and not receiving mentoring and across the field in general there is a lack of experimental research reporting the impact of mentorship programs (Underhill, 2005). Without the benefit of experimental research examining the impact of mentorship programs, accurate inferences cannot be made. Underhill's (2005) examination of mentoring research conducted since 1983 revealed that only 22% of studies compared the characteristics and outcomes of mentored versus non-mentored individuals. This study was important because it was a true experiment, with randomized selection of participants, which compared mentored students versus non-mentored students.

The impact of mentorship programs on African-American male high school students' perceptions of engineering was examined by using an experimental, posttest only, research design. Without conducting such a study, inferences made about the impact mentorship programs have on African-American male high school students' perceptions of engineering will have to rely on assumptions. Jeria and Gene (1992) have posited that the nation's ineffective means of recruiting and retaining minority students and faculty add enormously to a lack of diversity, especially in engineering and technology education. A study of this type helps lay the groundwork for effectively

dealing with issues of diversity by examining the effectiveness of mentorship programs to serve as a vehicle for recruiting and retaining African-American students and faculty.

With reported shortages in science, engineering, and technology fields (The Congressional Committee on the Advancement of Women and Minorities in Science, Engineering and Technology Development, 2000), it is increasingly apparent that effective means of recruiting and retaining underrepresented workers must be examined. To address the lack of diversity in technical fields and measure the potential impact of mentorship programs this study examined a formal mentorship program designed by the researcher.

The National Center for Engineering and Technology Education (NCETE) is a National Science Foundation (NSF) funded initiative, which looks to address challenges that are encountered when infusing engineering design into the K-12 classroom. It is stated that one of the impacts of the Center will be to revitalize engineering and technology education and prepare a diverse instructional workforce ([www.ncete.org](http://www.ncete.org), 2007). Developed in 2004 as a vehicle to drive the infusion of engineering design content into K-12 technology education curriculums, NCETE is one of 17 Teaching and Learning Centers funded by the National Science Foundation. The “ultimate” goal of the center is to infuse engineering design, problem solving, and analytical skills into the K-12 schools through technology education programs in order to increase the quality, quantity and diversity of engineering and technology educators ([www.ncete.org](http://www.ncete.org)).

In March of 2005, the leadership cohort of the NCETE developed a research framework to serve as a guide for possible research and dissertation topics. Research theme 2 was described as a research strand that focused on *How to Best Prepare*

*Technology Teachers* for secondary and post-secondary education. Embedded in this strand was the subtopic of *Diversity*, which asked the question “How can the involvement of females and minorities be enhanced?” (NCETE leadership, 2005, p. 3). This research study, which sought to measure the impact of mentorship programs on African-American male high school students’ perceptions of engineering, aligns well with the NCETE research framework and builds upon previously funded NCETE research namely, the study titled *African-American High School Students’ Perceptions of Engineering*. This qualitative study was designed in to gauge the current perceptions that African-American high school students have toward engineering as a field and career choice. Based on findings from the study and referenced data collected from the research participants, it was the goal of the researcher to develop an intervention that would effectively influence the perceptions that African-American high school students have of engineering as a field.

In order to effectively diversify the fields of engineering and other technical arenas it is paramount that research looks at effective means of recruiting potential students and educators. National centers such as the NCETE provide plausible avenues to seek funding and support for needed research. Nationally, there has been a call for mentoring future research in this area. Further highlighting this viewpoint, a National Science Board report recommended mentoring as a means to promote advancement in science and engineering fields (Maughan, 2006). A study of this sort is vital to the field of engineering and technology education because of its potential to highlight effective means of recruiting and retaining underrepresented populations. By aligning with the



goals of the NCETE and securing needed funding, this study developed a formal mentorship program and examined the impact of this program on students' perceptions.

As proffered earlier, the field has seen a few studies that investigate the impact of mentorship programs for African-Americans in the area of career development and advancement (Hall, 2006; Reddick, 2006). However, the lack of comparative studies in this realm suggests that many findings in this area may have exaggerated the actual effectiveness of mentorship programs (Underhill, 2005). The methodology and specific research interests that characterize this study make its potential contribution to the field unique. It was a goal of the researcher to add findings from this study to the burgeoning body of literature that addresses the needs of underrepresented populations and the potential of mentorship programs to influence students' perceptions.

This study has attempted to deepen the field's understanding of mentoring and its potential to influence African-American students' perceptions of technical fields, while boosting interest in science and engineering careers. The lack of literature in the area of comparative studies suggests that there is a need for more experimental research that broaches this topic. Overall, the fields of engineering and technology education are sparse in the area of experimental research. Studies, such as the research conducted, will endow the field with data and salient findings that will propel the field forward (Haynie, 1998).

## CHAPTER 2

### LITERATURE REVIEW

#### Introduction

The purpose of this study was to examine the impact of mentorship programs on African-American male high school students' perceptions of engineering. The following three research questions guided this study; (a) Is there a significant difference in perceptions of engineering disciplines for students who participated in the NCETE/NSBE mentorship program when compared with non-mentored students? (b) Is there a significant difference in self-efficacy in the area of math for students who participated in the NCETE/NSBE mentorship when compared with non-mentored students? (c) Is there a significant difference in self-efficacy in the area of science for students who participated in the NCETE/NSBE mentorship when compared with non-mentored students? This chapter explores literature on mentoring, mentorship programs, theories that extend mentoring and appropriate research methodologies that can help illustrate the effectiveness or lack thereof of mentorship programs. The review of the literature will be organized into the following four sections: foundations of mentoring, theories that extend mentoring theory, educational practice, and research.

#### Foundations of Mentoring

In an effort to provide a conceptual and philosophical rationale of mentoring and mentorship a brief overview pertaining to the history and origin of mentoring and mentorship is provided. A literary review of the term mentoring has also been used to explain the rationale for such an intervention. It is the goal of the following review to provide the reader with the critical features of differing mentoring models and explain the

use of the mentoring model that the researcher utilized for this particular study.

Alternatives to mentoring programs will be addressed along with an examination of the critical features of the proposed alternatives to the mentoring program.

### *Background*

The origin of the word mentoring dates back to the days of Greek mythology when Odyssey asked his female friend, the goddess of wisdom Athena, to take on the role of *Mentor* to watch over and guide his son Telemachus while he was away at sea (Hansman, 2002). This was the first record of any literature using the word *mentor* thus beginning the ontology of the term that is used to describe beneficial people in our lives who help guide, teach and coach their protégés (Levinson, Darrow, Klein, Levinson, & McKee, 1978). The benefits of this nebulous term have been well documented (Jacobi, 1991; Underhill, 2005; Eby & Lockwood, 2004), defining the term mentoring however, has been an arduous task over the years for the research field. Research pertaining to the study of mentoring unveils a plethora of differing definitions for the term based on its operational function. Levinson et al. (1978) provided one of the first general definitions of mentoring when he described its functions as that of a “*teacher, sponsor, an exemplar*” which begins to define the term conceptually but fails to provide any professional or personal connotation.

According to Kram (1983), mentoring is a relationship between an experienced employee and an understudy where the experienced employee acts as a role model and provides support and direction to the protégé. Conceptually, mentors may take on the role of a teacher, advisor, and a sponsor for their respective protégé (Haynes, 2004). Levinson (1978) believed that the primary function of a mentor was to serve as a transitional figure

for their respective protégé. The actual act of mentoring has been known under other names including guild, artisanship, and apprenticeship. In the *classical model* of mentoring, there is typically a one-on-one interaction of unrelated individuals of different ages who network on a regular basis.

An examination of mentoring conceptualizations in organizational settings supports literature that suggests that there is a wide degree of variance in the concept thus prompting numerous definitions. Merriam (1983) posited that “Mentoring appears to mean one thing to developmental psychologists, another thing to business people and, a third thing to those in academic settings” (p. 169). Though operational definitions of mentoring vary from program to program, it is generally considered to be a relationship where a person with greater experience supports a person with less (Hall, 2006).

In this research study, the researcher was particularly interested in the definition of mentoring and its functions in an academic setting while examining the ability of a mentoring relationship to facilitate and help organizations recruit and retain underrepresented populations. In this role the mentor usually acts as a sponsor who will provide his/her prospective protégé with exposure, coaching, and visibility into the potential career opportunities (Allen & Day, 2002). Within the scope of the mentoring relationship, this mentoring function is categorized as *career functions*.

#### *Phases of the Mentoring Relationship*

Kram’s (1983) seminal work on mentoring helped lay the groundwork for defining the phases of the mentoring relationship. Kram provided a study that described the phases of the mentoring program, and was able to demonstrate mentorship relationship’s enormous potential to facilitate career advancements. Furthermore, Kram

(1983) identified four distinct phases of this relationship to include; *initiations*- A period of six months to a year during which time the relationship gets started and begins to have importance for both managers, *cultivation*- a period of two to five years during which time the range of career and psychological functions provided expand to a maximum. *separation*- a period of six months to two years after a significant change in the structural role relationship and/or in the emotional experience of the relationship, *redefinition*- an indefinite period after the separation phase, during which time the relationship is ended or takes on significantly different characteristics, making it a more peer-like friendship (Kram & Isabella, 1985).

#### *Review of Mentoring Literature*

Though the history of mentoring has ancient origins dating back to Greek mythology it did not attract scholarly research until the mid-1970s (Wanberg, Welsh, & Hazlet, 2003). Merriam published the first critical review of mentoring literature in 1983, and although numerous studies provided conclusions that mentoring creates success in career advancement, these conclusions were not substantiated by comparative and experimental studies (Underhill, 2005). In lieu of this methodological mishap, the field still experienced an influx in scholarly literature pertaining to the benefits of mentoring. It was reported that during the 1990s, some 500 articles were published in popular and academic journals concerning the study and benefits of mentorship (Hansman, 2002). Though there is a plethora of literature (Allen & Day, 2003; Maughan, 2006), which speaks to the effectiveness of mentors for a student's self-esteem and self-efficacy little is known of how and why this relationship may affect the student's perceptions. Consistent with the omission of comparative studies on mentoring, the field is jettisoned of research

investigating exactly why mentoring often results in positive career outcomes (Allen & Day, 2002).

Underhill (2005) reported that over the last 20-25 years a number of studies have looked into the benefits of mentoring for the protégé and their respective organization. This increased interest of mentoring did come with one glaring caveat, Underhill's (2005) examination of mentoring research conducted since 1983 revealed that only 22% of studies compared the characteristics and outcomes of mentored versus non-mentored individuals. Although previous studies have documented the effectiveness of mentorship programs, the lack of literature on mentoring that is based on experimental designs is disconcerting. Underhill (2005) deduced that without a comparison group of non-mentored people, it is most difficult to attribute career benefits to mentoring alone. The lack of comparative studies in this realm suggests that many findings in this area may have exaggerated the actual impact of mentorship programs (Underhill, 2005).

### *Mentoring Theory*

The theory of mentoring postulates that through psychological support, a mentor is able to help a protégé develop a sense of competence, confidence and self-esteem (Allen & Day, 2002). Additionally, this theory suggests that mentoring has the ability to enrich the process of learning, which in-turn has the potential to impact recruiting and retention (Maughan, 2006). In mentoring, there are common characteristics that are associated with this theory such as teaching, guiding, counseling, and encouraging. Coaching is an essential element of mentoring whose purpose is to help a younger or less experienced person develop skills, knowledge, competence, interest or abilities in a chosen occupational field (Maughan, 2006). For the purpose of this study the *coaching*

element of mentoring is of particular interest pertaining to its implications for encouraging the participation of underrepresented minorities in technical arenas.

### *Mentoring Functions*

Mentors have been generally categorized based on their mentoring functions. Levinson et. al (1978) stated that mentoring cannot be defined in terms of its formal roles but in terms of the character and the function it serves. According to Allen & Day (2002), *career functions* and *psychological functions* are the two main mentoring categories that have been supported by the literature. In Table one below we are offered a glimpse into the conceptual roles that a mentor would take on for each of the mentoring functions.

*Table 1. Mentor Function Comparison*

<i>Career Functions</i>	<i>Psychological Functions</i>
Sponsorship	Role modeling
Exposure-and-visibility	Acceptance and confirmation
Coaching	Counseling
Protection	Friendship
Challenging assignments	

*Note. Career functions are those aspects of the relationship that primarily enhance career advancement.*

*Psychological functions are those aspects of the relationship that primarily enhance sense of competence, clarity of identity, and effectiveness in the managerial role.*

### *Mentoring Models*

It is widely accepted that although mentoring programs can be defined by their functions, the model of such a program falls within two distinct categories; *informal mentoring* and *formal mentoring*. Informal mentoring is defined as a naturally occurring relationship based on attributes, possibly similar interest and/or attraction. In this relationship the experienced member in the organization provides career and psychological support for the lesser-experienced member or protégé. In a formal

mentoring relationship, the program is developed and designed by the organization to facilitate structured mentoring relationships where experienced organizational members provide career and psychological development to lesser-experienced organizational members (Haynes, 2004). In an effort to clarify the two approaches Maughan (2006) provided a table that described the characteristics of the two mentoring models as presented in Figure one below.

*Figure 1. Definition of Mentor Models*

Informal Mentoring	Formal Mentoring
An unmanaged spontaneous relationship that occurs without external involvement from the organization.	A structured mentoring relationship....with the primary purpose of systematically developing the skills and leadership abilities of less-experienced members of an organization

Researchers (Chao, Waltz, & Gardner, 1992) have suggested that informal mentoring has been more effective than formal mentoring. Due to the success of informal mentoring, many corporate, government, and private organizations have attempted to replicate this success through increased efforts to develop formal mentoring programs. Formal mentoring programs do have various obstacles to overcome, namely trying to formalize a relationship that otherwise occurs naturally between the mentor and protégé.

#### *Advantages of Formal Mentoring Relationships*

For the purpose of this study a formal mentoring program was used to meet the goals of the study. Formal mentoring relationships are used extensively as a career



development tool (Eby & Lockwood, 2004), which aligned well with the scope of this study. A definition provided by Eby and Lockwood (2004) stated that formal mentoring refers to organizationally initiated efforts to match mentors and protégés. In this structured relationship the mentoring process is usually initiated through a third party matching process. Formal mentoring relationships are characterized by specific goals, timelines, and other guidelines as deemed necessary (Eby & Lockwood, 2004). Haynes (2004) provides a succinct and cohesive definition of the programs stating “Formal mentoring is a program designed and developed by the organization to facilitate structured mentoring relationships where experienced organizational members provide career and psychological development to lesser-experienced organizational members” (p. 351).

A formal mentoring model was chosen for this study mainly due to the structured nature of the relationship, which bodes well for a quantitative research study. Adding credence to the selection, it was reported that there has been a surge of formal mentoring programs throughout universities in the last decade in an effort to improve student retention (Salinitri, 2005). Formal mentoring relationships have been known to serve a much narrower focus and to serve an even different purpose than informal mentoring relationships. It is argued that formal mentoring relationships serve a rather short-term and a more limited purpose for the respective protégés (Eby & Lockwood, 2004).

Research has shown that there are many benefits to a well designed formal mentoring program, some of which are unique to formal mentoring (Eby & Lockwood, 2004). In a qualitative study provided by Eby and Lockwood (2004), *learning* was described as the most common benefit of the mentor and protégé relationship. This is not

uncommon to informal mentoring relationships but it illustrates some of the benefits for providing such a program. In examining characteristics that are unique to formal mentoring relationships it was reported that *career planning* was a benefit of formal mentoring that is not readily seen in informal mentoring relationships. *Networking opportunities* was also described by participants as a unique benefit of the formal mentoring relationship not to mention *work role clarification*, *enhance job performance* and a *sense of pride* (Eby & Lockwood, 2004).

#### *Weaknesses of Formal Mentoring*

There are many problems, revealed by research, that are common characteristics of formal mentoring programs. One of the most commonly noted issues of formal mentoring programs is mentor-protégé mismatch. The source of these mismatches can be linked to; differences in backgrounds, mismatches involved with age, interests, and/or personality (Eby & Lockwood, 2004). Difficulties in scheduling and geographic differences were duly noted as problems that were consistent with formal mentoring programs as described by Eby and Lockwood (2004). Other limitations of the formal mentoring relationship derive from a mentoring process and outcomes, which are frequently unexamined, uncritically applied, and power laden. In mentoring underrepresented populations these problems are compounded by issues of cross-gender and cross-racial mentors mentoring protégés of a different gender and/or race (Mott, 2002).

To combat the problematic nature of the formal mentoring program scholars have suggested that formal mentoring programs imitate those of informal mentoring programs (Ellinger, 2002). This would include having mentor and protégé provide input into the

pairing process thus attempting to acquiesce the need for better matching (Mott, 2002). Other frequently mentioned themes for improving the mentor-protégé relationship include “Clearer Communication of Program Objectives”, a clearly stated purpose or mission for the program; guidelines for meeting frequency, guidelines for relationship length (Mott, 2002,). It is recommended that mentors in formal mentoring programs receive training in order to deal with potentially challenging situations between the mentor and protégé. To deal with relationship problems it is suggested that mentors participate in interpersonal training as a way to help mentors effectively mentor their younger or less experienced colleagues (Maughan, 2006).

#### *Alternatives to Mentoring Relationships*

A recent examination of literature (Hall, 2006; Reddick, 2006) provided limited studies examining the effectiveness and advantages of viable alternatives to mentoring relationship as an effective intervention. Career development programs such as professional development workshops and intensive mentoring (*IM*) were able to produce favorable results for improving levels of self-efficacy and altering participants’ attitudes (Hall, 2006). However, the intervention that showed the most potential to serve some of the same critical functions of mentoring relationships was peer relationships. Peer relationships have displayed the ability to provide career-enhancing and psychosocial functions for individuals (Kram & Isabella, 1985). The table below (see Table 2) was provided by Kram and Isabella (1985) and represents a comparison of developmental functions that these two relationships provide for participants.

Table 2. Developmental Functions

Mentoring Relationships	Peer Relationships
<i>Career enhancing functions</i>	<i>Career enhancing functions</i>
Sponsorship	Role modeling
Exposure-and-visibility	Acceptance and confirmation
Coaching	Counseling
Protection	Friendship
Challenging assignments	
<i>Psychosocial functions</i>	<i>Psychosocial functions</i>
Acceptance and confirmation	confirmation
Counseling	emotional support
Role Modeling	Personal feedback
Friendship	Friendship
<i>Special attribute</i>	<i>Special attribute</i>
Complementarily	Mutuality

In a qualitative study conducted by Kram and Isabella (1985) it was revealed that peer relationships offer a prominent alternative to mentoring relationships by offering an array of developmental support for personal and professional support. The unique characteristics of the peer relationship include a degree of mutuality that allows for both participants to partake in being the giver as well the receiver of the described functions. The result of the mutual relationship appears to be vital in developing individuals through their careers to develop a continuing sense of competence, responsibility, and identity as experts (Kram & Isabella, 1985).

In seeking to address the growing disparity of minorities in technical fields, many universities have developed outreach programs that specifically target female and minority students. These interventions seek to introduce the underrepresented populations to the engineering discipline. Ostensibly this appears to be a good initiative but there are

questions regarding the ability of these programs to meet the needs of minorities as expressed by teachers and experts.

According to a survey conducted by the American Society for Engineering Education, these programs fall short of what is needed for effective recruitment and retentions of minorities (Douglass, Iversen & Kalyandurg, 2004). Although 79% of these programs reach African American students, of the total participation at these programs only 15% are African American. This trend continues for Hispanic and Asian students who only make up 5% and 3% respectively of the total participants belying the fact that 73% of these programs reach these students. The lowest figures are reserved for Native Americans. The outreach programs are able to reach about 44% of these students but they only make up 2% of the total participants (Douglass, Iversen & Kalyandurg, 2004). Overall, these outreach programs offer hope in the area of recruitment and retention but obviously more has to be done. The examination of alternatives to mentoring helped solidify the researcher's decision to utilize formal mentorship programs for the following study.

### Theories Extending Mentoring

The following study utilized mentoring theory in an effort to gain insight into how mentorship programs impact students' perceptions. The mentoring theory used suggests theoretical underpinnings in a number of areas including attitude, socialization, and perceptions. For the purpose of this study, the researcher focused on a review of predominant attitude and perception theories. In extending the mentoring theory, social learning theory and social cognitive theory have exhibited promise in their contribution to our understanding of how social contexts and social interactions impact knowledge

acquisition, attitude change and perceptions, warranting utilization for the following study (Merriam & Caffarella, 1999; Bandura, 1989). The learning theory (or epistemology) of constructivism as it relates to the impact of mentoring on students' perceptions towards engineering was also critically examined in an effort to determine its relevance for the following study. This study examined all of these theories in depth to determine their appropriateness in extending the mentoring theory and fitting the scope of this study.

### *Social Learning Theory*

Currently the researcher is interested in the impact of mentoring in the arenas of perceptions, and self-efficacy. Research is available which looks at the effectiveness of mentorship programs in the area of retention and/or academic success among students at-risk for failure or attrition (Jacobi, 1991) but does not study how this intervention influences participants' self-efficacy and perceptions. Recent research has applied social learning theory and social cognitive theory as an analysis tool to evaluate the effectiveness of mentorship programs (Haynes, 2004). A critical examination of the social learning theory is provided below an effort to justify its relevance for this study.

Social learning theory (Bandura, 1977) postulates that one mechanism by which individuals learn is observation of others individuals in their social environment. Similarly, the theory of mentoring proposes that through psychological support, a mentor is able to help a protégé develop his/her sense of competence, confidence and self-esteem (Allen & Day, 2002). The social learning theory extends this theory by contending that this development is achieved through observing and modeling the behaviors and attitudes

of others (Ormund, 1999). Bandura (1977) expounds upon this theory in the following quote:

Learning would be laborious, not to mention hazardous, if people had to rely solely on the effects of their own actions to inform them what to do. Fortunately, most human behavior is learned observationally through modeling: from observing others one forms an idea of how new behaviors are performed, and on later occasions this coded information serves as a guide for action (p. 22).

Merriam and Carafarella (1999) help elucidate the relevance of the social learning theory in reference to mentoring by stating “Social learning theories contribute to adult learning by highlighting the importance of social context and explicating the process of modeling and mentoring”(p. 139).

The inclusion of social learning theory to extend mentor theory is the result of social learning theory’s emphasis on how social context and the environment reinforce behavior (Ormund, 1999). This theory considers that people learn from one another, including concepts of observational learning, imitation, and modeling. Social learning theory is also relevant because it is seen as a bridge between behaviorist learning theories and cognitive learning theories (Ormund, 1999).

The advent of social learning theory helps explain human behavior in terms of continuous reciprocal interaction between cognitive, behavioral, and environmental influences (Bandura, 1977). Bandura’s version of social learning theory is unique in that it presents a sophisticated take on behaviorism by adopting a truly cognitive-behaviorism approach that addresses the interaction between how we think and how we act (Bahn,

2001). Its extension of the mentoring theory lies in the fact that it helps clarify how learned behavior can be prompted by others and a reward prospect (Bahn, 2001).

Modeling behavior is another key aspect of social learning theory. According to Bandura (1977) social learning theory consists initially of knowledge by the individual observing a variety of models. Children repeatedly observe and learn standards and behavior patterns, not only of parents but also of siblings, peers, and other adults. After this, performance may follow, developing a pattern of behavior different from the original model (Bahn, 2001). Modeling is considered a powerful means of transmitting values, attitudes and even patterns of thought and behavior (Bandura, 1977). This sort of imitative learning is highly likely to occur when the role model (i.e. mentor) is relevant, credible, and knowledgeable, and if the behavior is rewarded by others (Eby, Lockwood, & Butts, 2005). The potential of an effective mentor's influence on the behavior and perception's of a protégé are readily apparent and coalesce with social learning theory to form an analytical lens from which to view the impact of the mentoring relationship on a student.

### *Social Cognitive Theory*

Social cognitive theory builds upon social learning theory and posits that knowledge acquisition can be directly related to observing others within the context of social interactions, experiences, and outside media influences (Bandura, 1988). This theory further evolved when it was suggested that if there is a close identification between the observer and the model and if the observer has a good deal of self-efficacy learning will most likely occur (Bandura, 1989). Identification allows the observer to feel a one-on-one connection with the individual being imitated and will be more likely to



achieve those imitations if the observer feels that they have the ability to follow through with the imitated action (Bandura, 1988). The characteristics of social cognitive theory are inherent within an effective mentoring relationship, which looks to match protégé and mentor based on similar interests and backgrounds.

Social cognitive theory implores a model of causation involving triadic determinism. Further expounding on this model, Bandura (1989) explains the three determining factors; (a) behavior, (b) cognition and other (c) personal factors, including environmental influences that all conspire to act as interacting determinisms that influence each other. Environmental influences, consequently, partly determine the types of behavior that observers develop and activate. Many of these determinants include age-graded social influences that are provided by custom within familial, educational, and other institutional systems (Bandura, 1989).

Social resources are particularly important during the formative years when preference and personal standards are in a state of flux, and there are many conflicting sources of influence which to contend. Consistent with mentoring theory, social cognitive theory suggests that developing adolescents, need social supports to give incentive, meaning, and worth, to what they do (Bandura, 1988). Those individuals that figure predominantly in children's lives serve as an indispensable sources of knowledge that contribute to what and how children think. Guided instruction and modeling that effectively conveys abstract rules of reasoning promote cognitive development in children. Socially guided learning also encourages self-directed learning by providing children with the conceptual tools needed to gain new knowledge and to deal intelligently with the varied situations they encounter in their everyday lives (Bandura, 1989).

Social cognitive theory helps explain humans' advanced capacity for observational learning that enables them to expand their knowledge and skills on the basis of information conveyed by modeling influences. Bandura (1989) suggested that schools represent the place where children develop the cognitive competencies and acquire the knowledge and problem solving skills essential for participating effectively in society. Bandura (1989) further stated that in social cognitive theory, the adoption of values, standards and attributes is governed by a much broader and dynamic social reality. Juxtaposed with this theory is the belief that people tend to select activities and associates from the varying range of possibilities in terms of their acquired preference competencies (Bandura, 1989).

School-based mentoring programs have the potential to become part of the dynamic social reality that adolescents experience during their formative years. Social cognitive theory helps explain why many school-based mentoring programs have been successful in promoting career awareness and advancement (Underhill, 2005). In theory, mentoring programs initiated within an educational context, and imploring the strategies of an effective mentorship program, have the potential to greatly influence the perceptions of protégés as described by the social cognitive theory.

In concluding the examination of social learning theory and social cognitive theory it is beneficial to review the following quote provided by Bandura (1989):

Humans have an unparalleled capability to become many things. The qualities that are cultivated and the life paths that realistically become open to them are partly determined by the nature of the cultural agencies to which their development is entrusted. Social systems that cultivate generalizable

competencies, create opportunity structures, provide aidful resources, and allow room for self directedness, increase the chances that people will realize what they wish to become (p. 75).

This quote helps illuminate the importance of social systems and cultural influences on the decision-making ability of individuals. As the researcher contends to examine the impact that mentorship programs have on the perceptions of African-American males, it is vital that the researcher consider social learning theory and social cognitive theory as frameworks for the following study. Due to their emphasis on social interaction, environmental influences, and modeled behavior, it is the goal of this researcher to use these theories to help explain behavior and behavior change.

### *Perceptions*

Ontologically speaking, perceptions have been viewed as both knowledge and hypotheses (Jewell-Lapan, 1936; Gregory, 1980). In examining the Theory into Practice website (<http://tip.psychology.org/>) perceptions was classified as a learning domain while in the field of social science perceptions have been seen as hypotheses (Gregory, 1980). The ambiguity of the term *perceptions* only complicates and exacerbates the task of trying to measure the nebulous construct. Jewell-Lapan (1936) postulated that perceptions were not in-fact knowledge but that knowledge was developed perception, which add credence to the claim that perceptions is a hypotheses. It was stated to understand perceptions, the signal codes and the stored knowledge or assumptions used for deriving perceptual hypotheses must be discovered (Gregory, 1980).

Perception is also referred to as constructed knowledge. It was proffered that man (man and woman) is able to order his/her life by their perceptions. Jewell-Lapan (1936)

proclaimed that the average individual is able to conduct his/her life on the basis of their perceptions with minor mishaps. Hume's statement below helps illustrate the construct of perceptions and its value to decision-making and self-efficacy. "The only existence of which we are certain, are perceptions, which being immediately present to us by consciousness, command our strongest assent, and are the first foundation of all our conclusions (Hume, 1978, p.212). According to Hume all of our decisions and conclusions are first conceived as perceptions.

Studies have shown that a child's perception of an occupation and their self-efficacy greatly influence the decision of a child to pursue the occupation (Bandura, Barbaranelli, Vittorio, & Pastorelli, 2001). It was determined that children's perceived academic, social, and self-regulatory efficacy influence the types of occupational activities for which they judge themselves to be efficacious both directly and through their impact on academic aspirations. Perceived occupational self-efficacy gives direction to the kinds of career pursuits children seriously consider for their life's work (Bandura, Barbaranelli, Vittorio, & Pastorelli, 2001). Children's perceived efficacy rather than their actual academic achievements is the key determinant of their perceived occupational self-efficacy and preferred choice of work life.

In examining the construct of perceptions, it is important to identify characteristics of the theory in order to measure the desired construct. Seeman (1986) identified six essential characteristics to perceptions based on the Hume's philosophy of perception. As it follows Seeman (1986) identified that perception:

(a) is present to the mind and dependent on the mind, (b) passive, (c) particular, (d) ontologically independent, (e) appearing as having aspects or being in certain manners, (f) appear to be fleeting or perishing non-endurants.

### *Information Pickup Theory*

Information pickup theory suggests that perceptions depend on information in the “stimulus array” rather than sensations that are influenced by cognition. Gibson (1966) proposes that perception is a direct consequence of the properties of the environment and does not involve any form of sensory processing. Information pickup theory insists that perception have an active organism. The act of perception depends upon the interaction between the organism and the environment. Information pickup theory opposes most traditional theories of cognition that assume past experience play a dominant role in perceiving. This belief is in staunch contrast to many constructivist and cognition theories and greatly impacted its appropriateness for use in this study.

### *Attitudes*

Attitudes can be defined as a disposition or tendency to respond positively or negatively towards a certain thing. Attitudes are related to our opinions and beliefs and are based upon our experiences. Many times attitudes are related to interaction with others producing an important link between cognitive and psychology (Triandis, 1971). Our learned attitudes serve as general guides to our overt behavior with respect to the attitude object, giving rise to a consistently favorable or unfavorable pattern of response. According to Fishbein (1963), attitude is an independent measure of affect for or against the attitude object, which is a function of belief strength and evaluative aspect associated with each attribute.

An issue that the field of communication research has battled with relates to change in attitude brought about by a particular communication or type of communication (Kelman, 1958). Research suggests that change is brought about in action and attitude from a plethora of social influences (Kelman, 1958). Kelman (1958) proposed that there are three distinguishable processes of attitude change: compliance, identification, and internalization. In defining these terms, compliance is said to occur when an individual and/or protégé accepts influence because he/she hopes to achieve a favorable reaction from another person and/or group. Identification on the other hand is said to occur when an individual accepts influence because he wants to establish or maintain a satisfying self-defying relationship with another person and/or group. Finally, internalization is said to occur when an individual accepts influence because the content of the induced behavior is intrinsically rewarding (Kelman, 1958). The framework that Kelman proposed may be an effective instrument in evaluating the effects of social influence on actions and attitudes. Furthermore, this framework has seen to be helpful in the study of social influences on decision-making and career choices (Kelman, 1958).

### *Learning Theories Explored*

A learning theory is a systematic, integrated outlook with regard to the nature of the process whereby people relate to their environment and how they learn (Schunk, 2004). It is a structured approach to understanding human behavior that emphasizes the way in which learning comes about and takes place. Learning theories including those by Jean Piaget, William Perry and David Kolb (experiential learning) and should apply to education and human development in design theory and sciences illuminating meaningful associations among each other (Eder, 1994). Learning theories establishes the framework

for many research studies and helps individuals within a given field examine and synthesize data, organizes concepts, suggests new ideas or even explains a phenomenon.

### *Constructivism*

Constructivism is the view that all knowledge, and therefore all meaningful reality as such, is contingent upon human practices, being constructed in and out of interaction between human beings and their world, and developed and transmitted within an essentially social context. Meaning is not discovered, but rather constructed (Crotty, 1998) and constructivism contends that individuals construct what they learn and understand. Thus a number of educators have come to regard constructivism as a learning theory. As an epistemology, constructivism defines knowledge as temporary, developmental, socially and culturally mediated and thus non- objective. Learning under this theory is understood as a self-regulated process of resolving inner cognitive conflicts that often become apparent through concrete experience, collaborative discourse and reflection (Brooks & Brooks, 1993).

Constructivist theorists support the idea that people learn best when they actively construct their own understanding. Bruner's (1996, pg 1) posited that "Learning is an active process in which learners construct new ideas or concepts based upon their current/past knowledge. The learner selects and transforms information, constructs hypotheses, and makes decisions, relying on a cognitive structure" (as cited by Kizito, 2001). Bruner's constructivist theory is a general framework of instruction based upon the study of cognition, much of this theory is linked to child development research done by Piaget. The cognitive structure provides meaning and organization to experiences and

allows the individual to go beyond the information given. The emphasis is on learning rather than teaching, and on facilitative environments rather than instructional goals.

It has been suggested that constructivism is not a theory but that it is in fact an epistemology. Schunk (2004) explained that constructivism is not in-fact a theory but an epistemology that explains the nature of learning. For the purpose of this study the researcher sought to examine the characteristics of constructivism as an epistemology and determined its appropriateness for framing the study not as a theory but as an epistemology.

### Educational Practice

The educational field has experienced considerable debate focused on the under-representation of minorities in the fields of science, technology, engineering, and math (STEM). Within the scope of our fledging economy it has become a priority for universities across the nation to look for and develop effective ways to promote diversity, especially in regards to schools focusing on technical dexterity. To effectively begin to diversify the fields of science, engineering and technology, the following issues will be addressed: (a) lack of exposure, (b) absence of role models, and (c) difference in learning styles. Further more, a systemic approach is needed to properly address these compounding issues. Considering sustainability and providing long-term context, this study addressed the issue of diversity with long-term solutions in mind (over a 15-year period), while taking a systemic approach to change. Due to its analytical nature, the issue of diversity was framed as an engineering design problem pertaining to the three aforementioned factors contributing to the under representation of minorities in the science, technology, engineering, and math (STEM).



*Rationale*

Why is it so important that the U.S. looks for ways to focus on the under-representation of minorities in the fields of science, technology, engineering, and math? Well, according to one economist, for minorities to be able to skillfully adapt to an ever-changing economy in a capitalist society it is pertinent that they become technologically efficient in the coming years (Jenkins & Om-Ra-Seti, 1997). Technological efficiency not only speaks to the understanding and manipulation of technological devices but it also speaks to increased representation in fields that require technological literacy particularly engineering, computer science and technology education to name a few. Not only is this important to the socioeconomic and educational growth of minorities, this also has implications for the nation as a whole in the competitive workforce. Wheeler (1996) stated that “the diversification of the workforce can be seen as an opportunity to increase organizational effectiveness and competitiveness by maximizing talent, fostering innovation, and tapping into the skills and creativity of an increasingly diverse population” (p. 1).

In relation to the diverse population of America, current enrollment and participation in technical fields fail to reflect the country’s diverse population. Despite demographic shifts and an ever-growing minority population, technical courses are still taught mainly by middle-aged white men (Sanders, 2001). This unfortunately has ramifications for the field as a whole and only exacerbates the diversity issue. To effectively address this lack of diversity, the challenge for science, engineering, and technology will be to attract students and faculty from the entire spectrum of the American society (Douglass, Iversen & Kalyandurg, 2004). To begin to address this issue

of diversity, the lack of role models in STEM (science, technology, engineering, and math) fields will need to be addressed.

### *Absence of Role Models*

The lack of minorities in technical fields has implications that reach far into our school systems. The fields of STEM, based on the demographic make-up of their correspondents, have unknowingly created barriers for underrepresented minorities (Congressional Commission on the Advancement of Women and Minorities, 2000). In the year 2000, the Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development (2000) developed a carefully selected action-oriented design of systematic change that featured a national scope and sought to achieve immediate implementation. This legislation was developed and sponsored by Congresswoman Constance A. Morella as a way to analyze and describe the current status of women, underrepresented minorities, and persons with disabilities in the areas of science, technology, engineering and math (STEM). Their recommendations included: increased financial investments, aggressive intervention plans, adoption of high quality education standards, and a transformation of the STEM *professional image* (Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development, 2000). In the same report underrepresented minorities identified barriers to careers in STEM fields which included; (a) not having an influential mentor or sponsor, and (b) lack of company role models who are members of the same racial/ethnic group. In providing a concise picture, the Congressional Commission was able to thoroughly illustrate how the lack of diversity in STEM fields acts as its own barrier to inducing diversity.

An image overhaul is needed for the field as evidenced by the congressional report. One way to transform the image of the STEM professional is the encouragement of participation through peer advisement and counseling. Mentorship programs and outreach programs have also been suggested as an avenue (Douglas, Iversen, and Kalyandurg, 2004) to diversify the fields of STEM but research on their effectiveness is in the nascent stage. This research study sought to develop a sustainable mentorship programs and examine the impact of this program on students' perceptions.

### *Difference in Learning Styles*

People perceive and process information differently. Each individual is unique and has a learning style to which they prescribe when processing information. A learning style can be described as a person's characteristic strengths and preferences in the ways they take in and process information. Hitch and Youatt (1995) defined learning styles as the composite of characteristic cognitive, affective and physiological factors that serve as relatively stable indicators of how learners perceive, interact with and respond to the learning environment. According to Felder and Brent (2005) these characteristics vary from person to person, and may be strong, moderate, or almost nonexistent, may change with time, and may vary from one subject or learning environment to another. Thus, it is a particular way in which an individual learns and it describes a person's typical style of thinking, remembering or problem solving. Learning styles are important because they are important expressions of the uniqueness of an individual and specifically deal with the way individuals processes information.

Pedagogically speaking there are many challenges that lie ahead for minority students in their quest for higher education, particularly in the (STEM) fields. Modern

learning theories and cognitive research have made significant strides in relation to learning and effective pedagogical practices; however these advances are not particularly receptive to a diverse body of students, namely minorities. In many technological and design-based fields there is a perceived complexity in the learning environment that seems to drive women and minorities from these and related programs (DePasquale, 2003). DePasquale (2003) surmised that because of the great deal of attention on administering assignments and the grading system, little attention has been placed on the methodologies of what students learn through practice. Research within the realm of what students learn through practice may offer solutions to the many challenges that minorities face in achieving success in these design-based fields. However, this may prove difficult, for education like religion is conservative and if change does come, it will make haste very slowly (Carter, 1933). A shift in the paradigm may disturb the current order of thinking and this change is not always welcomed or promoted within the nation's educational system.

There is no apparent protocol for how researchers should proceed to address the challenges of the under-representation of minorities in technical fields (STEM) but it may behoove of them to look at the history of minorities in vocational fields to discover where schools systems have seemingly failed the youth and spurned their interest in design-based professions. In his epic opus about the plight of black America, Carter G. Woodson (1933) talked about how "vocational guidance" was a hindrance to blacks and minorities because the instructors' propensities to teach skills which students were not able to apply in life. This began a dangerous cycle that saw many willing learners becoming increasingly frustrated with the skills and lessons being taught. Frustration led to apathy

and this apathy throughout recent history has created a growing disparity in educational attainment among racial groups. It would be unjust to label these occurrences as culpable for the achievement gap experienced by minorities today without considering factors of socioeconomic disadvantages, inadequate educational opportunities, and limited financial resources among others (Gordon, 2003).

### *Early Exposure*

No one should have to wait until high school to be exposed to engineering. Early exposure to engineering will help high school students make better decisions on course selection. How many high school students do not know enough to even consider engineering as a career path, and how much of a loss is that (p.4)?

The quote was taken from a speech given by John Brighton, Assistant Director for Engineering, National Science Foundation (Douglas, Iversen, and Kalyandurg, 2004) and was part of a keynote address that was delivered at the ASEE Leadership workshop on K-12 Engineering Outreach. His statement was a reflection of the one of the stiffest challenges that the U.S. economy is facing today, attracting students from the diverse population of U.S. citizens. K-12 engineering outreach programs have shown potential to expose many types of students to the world of engineering through partnerships and collaborations between many groups (Douglas, Iversen, and Kalyandurg, 2004). Providing minority students with mentors from the STEM fields has the potential to not only provide students with viable role models but it serves as an early introduction to these complex fields. This does come with some apprehension. For in mentoring underrepresented populations problems arise stemming from issues of cross-gender and cross-racial mentors mentoring protégés of a different gender and/or race. Compounding

this issue is the fact that minorities have been less successful than white, male students in acquiring mentors inside and outside of their organizations (Haynes, 2004). This study sought to address issues of early exposure by providing students with role models and including engineering activities and challenges for the participants.

### *System of Change*

Systems are characterized by their unique behavior, one of which is their ability to adapt to environmental changes (Banathy & Jenlink, 1996). Clearly the landscape of science, technology, engineering, and math (STEM) is experiencing a similar change and this “makeover” has to be addressed through a systems approach. As with many complex systems there are many systems within systems whose interactions determine the outcome of the whole. This study attempted to address the issue of under-representation of minorities in STEM fields while looking at all of the identified components as earlier identified by the author. As with any problem the issue of diversity has many facets that must be ascertained. To do this in the most effective and resourceful manner, the researcher first attempted to critically look at this problem from an engineer's standpoint taking an engineering design approach. Upon addressing the pertinent components of the issue of diversity this study provided a literary and graphical picture of how each component of this complex system will have to work together to produce desired outcomes.

### *Engineering Design Approach*

If diversity were an engineering challenge how would engineers look to provide solutions? Simple, they would approach it like any other ill-defined problem that they are faced with. In the true example of systemic thinking within the engineering design

process it is plausible to address the need for diversity through the engineering design process. First, it is in the best interest to begin with the statement of need. This will not only frame the problem, but it is the first step when looking to focus energy and resources toward a desired solution. Here is a proposed scenario:

*Statement of Need;* The United States is currently suffering from a technical workforce undiversified (Wheeler, 2006), a pedagogical approach that is unbefitting of diverse learning styles (Carter, 2005) and lack of viable role models (Jeria & Gene, 1992).

*Problem Statement;* A diversity initiative within a systemic approach that looks to open up pathways for new career choices and opportunities for underrepresented populations is to be developed. *Constraints;* (a) must seek to improve minority representation in technical fields 20% by the year 2022 (15 years), (b) must ascertain the issues of lack of exposure, absence of role models, difference in learning styles, (c) must be implemented in a manner that is sustainable for all parties involved, and (d) must produce research and literature that will help set the foundation for science, technology, engineering, and math in the area of diversity. *Criteria;* Diversity initiative must be: (a) sustainable and ethically appropriate, (b) within a systems approach, (c) able to develop critical thinkers, and (d) appeal to pre-engineering as well as non pre-engineering students.

#### *Complexity of Diversity*

In evaluating the problem of diversity it appears that the diversity initiative many characteristics with “Organized Complexity” (D.Gattie, personal communication, September 17, 2006). Organized complexity is usually characterized by a sizable quantity of differing factors that are interrelated into an organic whole (Weaver, 1948). The issue of diversity in relation to STEM is a social systems challenge. While these systems are

highly complex, there are still a relatively simple collective of behaviors that are not well understood (Yaneer, 2000). The problem of diversity in the manner that it has been presented only has a small degree of predictability but there is the opportunity for mathematical modeling which could easily be thrown into an excel file to predict the assumed exponential growth that this field may expect from its underrepresented population. However, how can one really ever predict the behavior of not one person but a group of people? If we were to start in the doldrums of our field and take a reductionist view of our issue of diversity, the problem seems all too simple. Unfortunately, contrary to Newtonian mechanics (Capra, 1982) we cannot be reduced to material particles. As with Lamarck's proposal of biological evolution we as educators have to evolve to survive in the state of education.

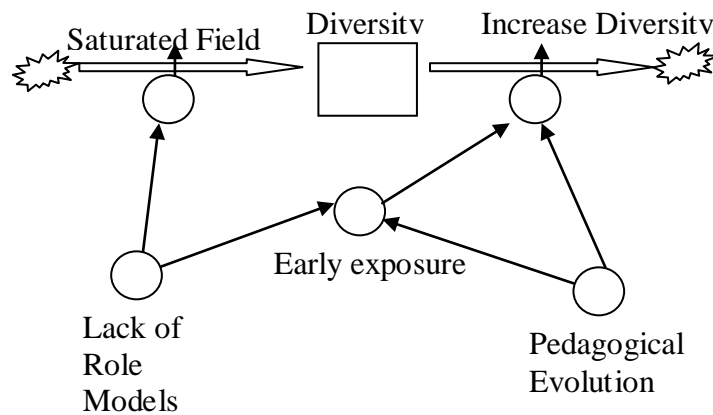
There is hope for the evolution of technical fields but the approach has to be more Banathy and Jenlink than Newton and Descartes. While Newton and Descartes looked at the world and living organisms as machines that could be manipulated and conquered (Capra, 1982), Banathy and Jenlink (1996) spoke about the organizational nature of human systems which provided a comprehensive way of understanding the behavior of these systems. In a definition provided by Banathy and Jenklin (p. 44, 1996) human system was described as the "human systems form-self-organize-through collective activities and around a common purpose or goal". In this case the common goal is the diversification of the STEM fields. To truly understand the intricacy of these complex systems, first a rudimentary understanding of systems has to be present. This study incorporated a systems approach to understanding the problem of diversity and attempted to introduce possible initiatives that can be employed.






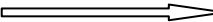
### *System of Diversity*

To effectively address the lack of diversity in STEM fields a holistic approach was taken. A litany of literature is available that seeks to address this problem (Carter, 2005; Gene & Gene, 1992; Wheeler, 1996) and many point to the areas of differing learning styles, lack of exposure, and a lack of role models. The correlational model (See Figure 1) below is an attempt by the author to illustrate the interactive relationship that these entities have with each other. According to the model the initial issue is that of a saturated field for science, engineering and technology, which leads to the lack of effective role models that minorities can identify with. With the initiative of diversity setting the stage, recruitment and retention is introduced in hopes of counteracting the effects of an undiversified field. The proposal of a pedagogical evolution that ascertains the differing learning styles will in all probability impact the interest and self-efficacy levels of minorities in the STEM subject areas. Recruitment and retention of minority students will in all probability provide earlier exposure for minority students and ultimately this interaction should produce increased diversity in the fields of engineering and technology education. The figure (see Figure two) provided below is a theoretical model that is not fully operational but it does provide a graphical representation of how each entity works together as a system of proposed change.

*Figure 2. Correlational Model. Representation of correlation between dynamic and static forces acting upon certain processes in a theoretical system of change.*



*Legend for Correlational Model.*

-  Represent respective static fields.
-  Represent dynamic forces that act upon the static fields and/or other dynamic forces.
-  Represent processes in the model.
-  Represent change and direction of change.

*Appropriate Approach*

It is insufficient to conclude that by implementing the intervention of mentorship programs and using the engineering design approach along with the implementation of systems thinking that the nation can solve the issue of diversity in the STEM fields. To ensure that the nation is invested in providing long-term (15 years) and sustainable changes for the STEM fields then it is imperative that an *appropriate* approach is taken when considering the issue of diversity. Wicklein (2005) spoke about appropriate technology and the central doctrine that embodies this ethical practice. For the purpose of

this study the following working definition to define appropriate technology is provided by Wicklein (2005) “Appropriate Technology seeks to aid and support the human ability to understand, operate, and sustain technological systems to the benefit of humans while seeking to be in harmony with the culture and the environment” (p.10). If the goal is to honestly develop a sustainable system of diversity in the profession it is paramount that Wicklein’s (2005) definition of appropriate technology be central in the development of a diversity initiative.

One may argue that the issue of diversity is not a technological one therefore should not even consider the elements of appropriate technology. This is true but we are dealing with the issue of diversifying the field of science, technology, engineering, and math so the technological aspect is very inherent. The diversification of this field will face many obstacles unique to the technological world. By definition appropriate technology seeks to aid the human ability to understand, operate, and sustain technological systems (Wicklein, 2005). For minorities to be able to effectively compete in the technical workforce an understanding of this field has to be present, not to mention the ability to operate and sustain technological systems. The same criteria that are vital to the sustainability of appropriate technology will have to be adhered to in order for the diversity initiative to be successful.

### *Addressing the Issue*

The challenges outlined in this study only give a microcosmic view of what the future will look like for minorities in the field of engineering and technology. Now, more than ever, the U.S. has to cultivate the scientific and technical talents of all of its citizens (Congressional Commission on the Advancement of Women and Minorities in Science,

Engineering and Technology Development, 2000). With an approach that is appropriate, holistic, and systemic, diversity in the technical workforce can be addressed with a systematic approach that is sustainable.

Bringing diversity to the fields of science, technology, engineering and math is not about simply teaching the engineering design process or science concepts to minority students. It is more about a movement. Weaver (1948) once spoke about how members of diverse groups can work together to form a unit that is much greater than the sum of its parts. Although this was presented to the public almost 60 years ago its sentiments still ring true to this day. For educators, professionals, and students alike there is a need of certain selflessness to be present for any system to work properly. This study attempted to provide selfless work that should impact the field and add to the growing movement of diversity.

#### *Increased Financial Investments*

One recommendation for diversifying the STEM fields provided in the Congressional Commission on the Advancement of Women and Minorities in Science, Engineering and Technology Development (2000) report was a need for increased financial investments. In a capitalist society that seeks reciprocity for any monetary investment made it is critical to look for ways to secure funding for diversity initiatives. In-service practitioners have to be a little more creative in securing funds and resources for STEM programs. Sun (1996) suggested that writing and applying for grant funds and looking towards equipment donation are two of the more palpable means of accumulating needed funds and resources for minorities lacking resources. In addition the value of grants may be increased if they are matched by local contributions. Grants and

equipment donation still provide a viable avenue for STEM (Sun, 1996) and it is the hope of the field that the new engineering focus being adopted will open new doors from which to receive funding through.

Increasing the resources allocated to the underrepresented and underprivileged for increased representation in the fields of science, technology, engineering, and math will not satisfy long-term goals for a systemic diversity initiative nor is it sustainable. Those funds have to be allocated towards effective interventions, which may help change, the face of STEM. The first initiative vying for funding is in response to the lack of role models and early exposure. The researcher was able to secure funding from the National Center for Engineering and Technology Education to help facilitate the mentorship program.

#### *Role of Mentorship Programs*

Due to challenges inherent in our modern school system, numerous students, especially African-American youth, require enhanced support and better assistance than those presently offered (Hall, 2006). Formal and informal mentoring programs have been utilized for the career functions within various organizations (Eby & Lockwood, 2004) and their potential for producing palpable role models for under-represented populations is plausible. In making the case for mentoring, this intervention has been assumed to enrich the process of learning, through the use of a mentor/role model, which may help impact recruiting and retention of minorities. Mentoring programs are able to distinguish themselves from other intervention programs through their emphasis on learning in general and the mutual learning experienced by mentor and protégé (Salinitri, 2005).

Further research should be conducted on the role of mentoring and outreach programs to assess their ability to provide needed role models for under-represented minorities.

### *Pedagogical Revolution*

The U.S. public school system is guilty of providing a pedagogical approach in technical fields that is culturally unresponsive (Carter, 2005). One of the causes for this unresponsiveness is the inability of education to effectively evolve. Richmond (1993) proposed an interesting take on the evolution of the education system. Richmond feels that schools have traditionally been *teacher-directed* where as learning is seen as more of assimilation. The *learner-directed* approach assumes that learning is fundamentally a construction where the student takes responsibility for their learning. Here lies the opportunity for students to build or *construct* learning from their own experiences, in a way that is relevant. This approach would work well with minority students because it provides rooms in the curricula for students to develop solutions to problems that they feel are authentic. No longer should it be acceptable to teach a new generation of students with practices that are out-dated and woefully ineffective. This study incorporated a learner-directed approach to learning by having the participants determine their own challenges to which they provided solutions.

### Research

The purpose of this study was to examine the impact of mentorship programs on African-American male high school students' perceptions of engineering. It was the goal of this study to provide statistical data that will help illustrate the impact or lack thereof of formal mentorship programs. The review has been provided below in an effort

to describe statistical analysis procedures that framed the study and ascertain any threats to the validity, and reliability of reported data.

### *The t-test*

Within research, the *t*-test is a technique used to determine whether the difference of two means is statistically significant. In determining significance of mean differences, the *t* test makes adjustments for the fact that the distribution scores for small samples become increasingly different from the normal distribution as sample size becomes smaller (Gay & Airasian, 2003). The *t*-test's strategy entails comparing the actual mean difference observed with the difference expected by chance. Even if the null hypothesis is true you cannot expect identical sample means, there is always chance of some variation. The *t*-test determines whether the observed difference in means is sufficiently larger than a difference that would be expected by chance.

It is possible to use a number of *t*-tests to determine the significance of the difference between several different means however, it is *not* possible to determine whether the differing means differ significantly with a single *t* test. Several separate *t*-tests would have to be computed to determine the significance of the means thus increasing the chances the overall Type I error rate for the experiment. In this case analysis of variance would be a more appropriate technique. The analysis of variance (ANOVA) is an effective means of determining whether the means of more than two samples are too different to attribute to sampling error (Best & Kahn, 2006).

In calculating an independent *t*- test, independent samples are represented by two samples that are randomly formed without matching. The members of each sample group are independent of each other, other than the fact that they were selected from the same

population. When forming two groups that are randomly selected, the expectation is that at the beginning of the study the two groups are essentially the same with respect to performance on the dependent variable (Gay & Airasian, 2000). For the following research study the researcher used random selection to select the members of the independent groups and parametric tests were used to determine any difference between the groups.

The following research study used a two group, posttest only, experimental design. Experimental studies pose many problems for researchers and should only be conducted when there is a good reason to believe that the effort will be rewarding (Gay & Airasian, 2000). Only in experimental studies can a researcher establish a cause-effect relationship. The procedure in an experimental research design allows the researcher the degree of control sufficient to establish such a relationship as cause-effect (Gay & Airasian, 2000). In the experimental design model, the researcher is able to randomly assign participants to treatment groups. In contrast, in the causal comparative design model the researcher cannot assign participants to treatments groups because they are already within those groups (Gay & Airasian, 2000). Random assignment is not possible in causal-comparative studies and this greatly impacts the determination of cause and effect. Random assignment is the best way to ensure equality of the two comparison groups and the retrospective nature of causal-comparative studies does not allow for such assignment (Gay & Airasian, 2000).

For the purpose of this study the researcher conducted a true experiment in lieu of a casual-comparative design in an attempt to answer the research questions guiding this study. The inability of casual comparative research studies to randomly assign their



participants does not allow for the data to be generalized to a larger population and the inability to attribute cause and effect is disconcerting.

### *Validity*

Validity may be the most important characteristic of a test instrument. Sure, other characteristics of a measuring instrument are important, but an instrument is useless if it is not valid (Mason & Bramble, 1997). Validity of an instrument can be defined as the extent to which inferences can be accurately made and decisions based on test scores. In research, there are three fundamental approaches to the validity of test and measures. The first, *content validity* is concerned with the degree to which the test items represent the domain of the construct being measured. The second approach, *criterion-related validity*, is concerned with the ability of the test to predict or estimate a criterion. The third and potentially the most important approach is *construct validity*. Construct validity is concerned with the degree of the relationship between the measure and the construct being measured (Mason & Bramble, 1997).

In this study construct validity was of the utmost importance. Construct validity refers to the degree to which a test can be considered to be an appropriate operational definition (Crocker & Algina, 1986). Construct validity is considered the most important form of validity because it is concerned with what the test is measuring. No single validation study can establish construct validity, usually content and criterion-related forms of validity are used in studies to determine a test's construct validity (Gay & Airasian, 2000). The method can be described as a series of convergent, divergent, and criterion-related evidence to determine whether the presumed construct is being measured.

### *Internal and External Validity*

In order to make significant contribution to the development of knowledge, an experiment must be valid. There are two types of experimental validity, *internal validity*, and *external validity* (Best & Kahn, 2006). An experiment has internal validity to the extent that the factors that have been manipulated (independents variables) actually has a genuine effect on the observed consequences (dependents variables) in the experimental setting. In any behavioral experiment, a number of extraneous variables are present that may influence the results of the experiment, therefore posing threats to the internal validity of the experiment. Though these extraneous variables cannot be completely eliminated, many can be identified. It is vital that researchers anticipate these factors and take all possible precautions to minimize the influence of the extraneous factors.

Campbell and Stanley (1963) identified the following factors impacting internal validity; *maturation, history, testing, unstable instrumentation, statistical regression, selection bias, interaction of selection and maturation, experimental morality, and experimenter bias*. Factors of internal invalidity that may be of particular concern in regards to this study include; differences in the individual's history, maturity level, and individual attrition rates. Random assignment among the participants was employed in an effort to spread the measurement error across the sample population.

External validity is the extent to which the variable relationships can be generalized to other settings, other treatments variables, other measurement variables, and other populations (Best & Kahn, 2006). Many times the artificial nature of experiments and laboratory research reduces the generalizability of findings derived from these studies. Campbell and Stanley (1963) illustrated factors that lead to reduced

generalizability of research to other settings, persons, variables, and measurement instruments. The factors that they described were; (a) interference of prior treatment, (b) the artificiality of the experimental setting, (c) interaction effect of testing, (d) interaction of selection and treatment, and (e) the extent of treatment verification.

Although this study sought to generalize back to the population of African-American male high school students attending the Middle College at North Carolina A&T, the probability of being able to generalize to a larger population is not particularly strong in this study. However, the participants' responses about their perceptions toward engineering should yield useful information toward answering the guiding questions without being directly impacted by the design of the study.

### *Reliability*

Reliability refers to the degree to which a test consistently measures whatever construct it is measuring (Gay & Airasian, 2000). The more reliable an instrument the more confidence that a researcher will have that the scores obtained from the test is the same scores that would be obtained if the test were re-administered to the same test takers. If a test is seen as unreliable it is assumed that scores from the respective test would be quite different each time the test is administered (Gay & Airasian, 2000).

Reliability is expressed quantitatively, usually as a reliability coefficient, which may be obtained using correlation tests. A high reliability coefficient indicates high reliability. If a test were to produce a perfect reliable, the reliability coefficient would be 1.00 (Gay & Airasian, 2000). This is not possible within test measurements but it is usually the goal of the researcher to provide a test instrument with a high reliability

indicating a minimum error variance. In other words the effect of errors of measurement would be minute.

There are generally five different kinds of test for reliability and consistency. The different kinds of consistency tests are: *stability*- referred to as test-retest, this tests the degree to which scores on the same test are consistent over time; *equivalence*- or *alternate forms*, refers to the test of whether two tests measuring the same variance, have the same number of items, the same structure, the same difficulty level, and the same directions, scoring and interpretation will yield scores that are equivalent, *equivalence and stability*- this form of reliability is a combination of equivalence and stability approaches. This approach assesses stability of scores over time as well as the equivalence of the two sets of items, *internal consistency reliability*- a commonly used form of reliability that deals with one test at a time. Considered the extent to which the items in a test are similar to one another in content, it can be obtained through three different approaches: split-half, Kuder-Richardson, and Cronbach's alpha, *rater agreement*-extent to which independent scores or a single scorer over time agree on the scoring of an open ended test. For the purpose of this study, the researcher was particularly concerned with the *stability* of the test. To ensure the reliability score-based inferences made from the survey instrument, the researcher conducted a pilot test and used Cronbach's alpha to determine the instrument's reliability and consistency.

### *Sampling Procedure*

The characteristics of a good quantitative study are thoughtful planning and diligent implementation (Olejnik, 1984). Careful consideration should be given to the process of instrumentation, research design, and statistical analysis procedures. Included

in this diligent observation is the selection of participants for a particular study, or *sampling*. Sampling is considered a process by which a number of individuals are selected for a study in such a way that they represent the larger group from which they were selected (Gay & Airasian, 2000). A sample would typically comprise of the individuals, items, and/or events selected from a larger group, known as the population. Of critical concern to all good researchers is determining the number of experimental units or participants which should be involved in the research study. In studies that involve hypothesis testing, there are four factors that researchers should consider when determining necessary sample size. The four factors are; criterion for statistical significance, level of statistical power, statistical analysis strategy, and the size of the effect judged to be meaningful (Olejnik, 1984).

#### *Statistical Significance*

In studies that involve hypothesis testing it is possible, due to sampling errors, to conclude that a relationship exists between variables when in fact this relationship does not exist for the total population (Olejnik, 1984). This is considered a Type I error and the level of significance chosen by the researcher is the probability that this type of error would occur. This is considered a serious mistake and generally, researchers attempt to minimize the probability of its occurrence. In relation to the sample size, the significance level is generally inversely related to this statistic. In layman's terms, a large sample size would be required to minimize the probability of a Type I error. If an increase in the probability of a Type I error is acceptable, then a smaller sample size is adequate (Olejnik, 1984). The criterion of significance is an arbitrary number but most hypothesis testing in social sciences is done at a .05 level of significance.

### *Statistical Power*

The probability of rejecting the null hypothesis when the null hypothesis is false is known as the statistical power. Without sufficient statistical power research studies have little opportunity of yielding useful information. A statistical power ranging between .70 and .85 are generally acceptable for research study. Research studies that have high statistical power decrease the likelihood that a Type II error will be committed. Type II errors are identified as the probability that a researcher would accept the null hypothesis when the null hypothesis is false (Olejnik, 1984).

### *Statistical Analysis*

The number of participants needed for an adequate testing of a hypothesis is affected by the statistical analysis strategy (Olejnik, 1984). The selection of an appropriate statistical test is dependent upon the research question of interest, the research design being adopted and the nature or types of variables being studied. In studies that are interested in more in-depth information on the subjects, fewer subjects are needed to conduct the study. So, research studies that involve quantitative independent variables generally require fewer participants than studies using qualitative independent variables. Also, investigations that include data collected both pretreatment and post-treatment require fewer subjects than studies based on post-treatment data by itself. The number of participants needed for an adequate testing of a hypothesis is affected by the statistical analysis strategy (Olejnik, 1984).

### *Effect Size*

According to Olejnik (1984) effect size is the “specified minimal relationship or minimal difference in populations means that the investigator believes would be

important to detect from a practical perspective.” In studies that require hypothesis testing of sample means Cohen suggests differences of .2, .5, and .8 standard deviation units as small, medium and large effects, respectively (Olejnik, 1984). For the purposes of this study the researcher used a medium effect size set at 0.5, alpha level set at  $p=0.05$  and a statistical power of .7.

#### *Non-respondents*

Response rate is one of the most important indicators of how much confidence can be placed in the results of a survey (StatPac, 1997). A low response rate can be devastating to the reliability of a study. One of the most powerful tools for increasing response rate is to use follow-ups or reminders. Traditionally, between 10 and 60 percent of those sent questionnaires respond without follow-up reminders. These rates are too low to yield confident results, so the need to follow up on non-respondents is clear (StatPac, 1997).

Researchers can increase the response from follow-up attempts by including another copy of the questionnaire. When designing the follow-up procedure, it is important for the researcher to keep in mind the unique characteristics of the people in the sample. The most successful follow-ups have been achieved by phone calls. Many researchers have examined whether postcard follow-ups are effective in increasing response. The vast majority of these studies show that a follow-up postcard slightly increases response rate, and a meta-analysis revealed an aggregate gain of 3.5 percent. The postcard serves as a reminder for subjects who have forgotten to complete the survey (StatPac, 1997).

For the purposes of this study the researcher made every effort to ensure all identified participants took the survey. To pre-empt problems with non-respondents the researcher administered the test in person. The researcher promptly dealt with non-respondents by rescheduling the time and place that a participant could complete the test within the scope of the research.

### Summary of Chapter

Taking an objective look at the potential of mentorship programs and the functions that these programs offer, formal mentorship programs were used to satisfy the needs of the study. In lieu of some of the benefits that other interventions offer for career development and altering perceptions, the parameters of this research study called for the use of a formal mentoring program. Due to time constraints and limitations on budget and spending, a structured program, such as that of a formal mentoring program, would satisfy the needs of the study. A formal mentoring model was chosen for this study mainly due to the structured nature of the relationship, which bodes well for a quantitative research study. The accommodating features of the formal mentoring program which include a narrow focus, short-term use, a more limited purpose, specific goals, and a defined timeline (Eby & Lockwood, 2004) make it ideal for use in this research study.

In the case of this study, constructivism served as the epistemological foundation, using social cognitive theory as the building blocks for the theoretical framework. An in-depth analysis of social cognitive theory suggests that it was an appropriate theory for this study. Since this study was concerned with determining how African-American male high-school students' perceptions were impacted by participating in a mentorship



program, factors that influence these perceptions were of concern. It was of use and importance to consider social cognitive theory and more specifically its ability to implore a model of causation involving triadic determinism. The three determining factors; behavior, cognition, and other personal factors, including environmental influences were considered when explaining any variance of scores from participants and their impact on an individual's perception.

Studies have shown that a child's perception of an occupation and his/her self-efficacy in said occupation, greatly influence the decision of a child to pursue the occupation. It was concluded that perceived occupational self-efficacy gives direction to the kinds of career pursuits children seriously consider for their life's work (Bandura, Barbaranelli, Vittorio & Pastorelli, 2001). Using Bandura, Barbaranelli, Vittorio and Pastorelli's (2001) previous work as a template the researcher attempted to measure the impact of mentorship programs on students' perceptions of a particular field(engineering) and their perceived self-efficacy to perform tasks associated with the profession. The mentorship program for this research study facilitated a systemic approach to encouraging interest in engineering as a field. It was the intention of the researcher to provide a conducive environment that provided the participants with (a) early exposure to engineering, (b) a role model, and (c) a revolutionary, culturally responsive, pedagogical approach to problem solving.

For the purpose of this study the researcher conducted a true experiment in lieu of a casual-comparative design to satisfy the needs of the study. The inability of casual comparative research studies to randomly assign their participants does not allow for the data to be generalized to a larger population and the inability to attribute cause and effect

is concerning. It was the goal of the researcher to provide viable interventions which would help set the groundwork for effectively diversifying the fields of science, math, engineering, and technology. The following study was designed in a manner suitable for experimental research and it was the intentions of the researcher to provide a comparative study that sought to investigate the *actual* impact of mentorship programs on students' perceptions of engineering as a field.

## CHAPTER 3

### METHODOLOGY

The purpose of this study was to examine impact of mentorship programs on African-American male high school students' perceptions of engineering. The following three research questions guided this study; (a) Is there a significant difference in perceptions of engineering for students who participated in the NCETE/NSBE mentorship program when compared with non-mentored students?, (b) Is there a significant difference in self-efficacy in the area of math for students who participated in the NCETE/NSBE mentorship when compared with non-mentored students?, and (c) Is there a significant difference in self-efficacy in the area of science for students who participated in the NCETE/NSBE mentorship when compared with non-mentored students? This chapter describes the research method that was used to examine how African-American male high school students' perceptions toward engineering as a career and how self-efficacy towards math and science are impacted by participating in a college-based mentorship program with current engineering students who are active members in the National Society of Black Engineers (NSBE). A description of the research design, participants, instruments, data collection procedure and analysis of data are included.

#### Research Design

This experiment used a two-group, posttest only design, which framed the research (Campbell & Stanley, 1963). This research design is useful in studies where the administration of the pretest may influence the participants' behavior during the experiment or on the posttest (Gall, Gall, & Borg, 1996). The effects of the treatment

administered can be measured by comparing the posttest scores of two populations. This research design is appropriate when trying to influence a stable characteristic such as students' perceptions of engineering.

The dependent variables were students' perceptions, which included students' perceptions of engineering and their self-efficacy in the area of math and science after participating in the National Center for Engineering and Technology Education (NCETE) and National Society of Black Engineers (NSBE) mentorship program. The mentorship program that the students participated in represented the treatment for the study. Mentorship in this study has been defined as "a structured mentoring relationship...with the primary purpose of systematically developing the skills and leadership abilities of less-experienced members of an organization" (Murray & Owen, 1991, p. 5). This research study was carefully designed and yielded useful information that could be generalized within margins to the target population of male high school students attending the Middle College at North Carolina Agricultural and Technical State University (North Carolina A&T, hereafter).

Random assignment was used in this study to select participants, thus allowing all African-American male students attending the Middle College at North Carolina A&T an equal opportunity to be selected for the study. Mentors completed an exit interview at the conclusion of the study in an effort to monitor and better evaluate the mentorship program. For the purposes of this study an independent *t*-test was used to determine whether the difference of the group means were statistically significant. In determining significance, the *t*-test makes adjustments for the fact that the distribution scores for small samples become increasingly different from the normal distribution as sample size

becomes smaller (Gay & Airasian, 2003). *T*-tests strategy entails comparing the actual mean difference observed with the difference expected by chance. It reports very little else about the nature of that relationship, however it does reveal whether a significant difference exists between groups.

Factors of internal invalidity that were of particular concern were differences in the individual's history, maturity level and individual attrition rates as it relates to test taking. Random assignment among the participants was employed in an effort to spread the measurement error across the sample population. This study has been designed to generalize back to the population of African-American male students attending the Middle College at North Carolina A&T, however the ability to generalize to a larger population is not particularly strong in this study. The participants' responses about their perceptions toward engineering as a field will yield useful information toward answering the research questions without being directly impacted by the design of the study.

### Participants

The participants in this experiment were drawn from North Carolina A&T's Middle College, an initiative that began in 2003 that was designed to offer young men a new chance at success. North Carolina A&T's Middle College is a single gender high school in Greensboro, North Carolina that provides smaller classes and a nurturing environment with the goal of boosting self-esteem and providing opportunities for a promising future for at-risk male students ([http://www.gcsnc.com/magnet\\_schools/pdfs/a&t%20brochure.pdf](http://www.gcsnc.com/magnet_schools/pdfs/a&t%20brochure.pdf)).

The Middle College is a joint venture between North Carolina A&T and the Guilford County School System that serves students in the ninth through twelfth grade

school levels. Traditionally students have been matched with a student from North Carolina A&T to serve as a mentor, advisor, and big brother. However, this mentorship program traditionally has not focused on the *career functions* aspect of the mentoring relationship. The students at the Middle College represented an “at-risk” population of the type of students that prior research has indicated may have limited opportunities for career exposure and awareness (Hall, 2006). This has been identified as an accessible population because of its association with North Carolina A&T and this respective university’s relationship with the researcher and the NCETE.

In the literature, the term “at-risk” represents a construct used to designate a high probability of poor development and low academic achievement (Werner, 1986). At-risk students also suffer from a sense of alienation from the culture of schools (Fine, 1986). The ramifications of this negative social context are culpable for the low-achievement of at-risk students. For at-risk students in particular, public schools are failing to meet the educational needs of these students. Research has shown that perceptions of a caring relationship with a teacher and a positive environment were related to school satisfaction (Baker, 1999). It is stated that more research is needed that examines alternative interventions that can effectively impact the educational environment of at-risk students (National Center for Educational Statistics, NCES, 2004a, 2004b).

Previous research (Allen & Day, 2002; Maughan, 2006), has established the effectiveness of mentors to impact students’ self-esteem and self-efficacy, but little is known of how this relationship may influence students’ perceptions towards specific careers. This study randomly selected 10 students attending the Middle College at North Carolina A&T and matched them with pre-approved mentors from the National Society

for Black Engineers (NSBE), to represent the treatment group. Another 10 students were randomly selected from the remaining population, these students represented the control group. The posttest scores of the control group and treatment group were compared using an independent *t*-test in order to determine if the difference in mean was statistically significant.

To facilitate the mentorship program, the researcher recruited active members of National Society for Black Engineers (NSBE). NSBE is the largest student-managed organization in the country. Incorporated in Texas, in 1976 as a 501(c) 3 non-profit organization, NSBE has since grown from 6 to over 18,000 members and the annual meeting has blossomed into the Annual National Convention, hosting over 8,000 attendees. NSBE has 17 NSBE Jr. pre-college, 268 student and 50 alumni/technical professional chapters. Headquartered in Alexandria, Virginia, NSBE offers academic excellence programs, scholarships, leadership training, professional development and access to career opportunities for thousands of members annually. With over 2000 elected leadership positions, 12 regional conferences and an annual convention, NSBE provides opportunities for success that remain unmatched by any other organization (<http://www.nsbe.org/>). With its established name and reputation, NSBE serves as an exemplar student-based organization in the area of engineering and engineering education. Mentors were purposefully assigned to their respective participant based on adequate time schedules, similar backgrounds and other salient information gleaned from the student information sheet.

A simple random sample was used to select study participants. This sample was selected from the population of eighty-three Middle College students by a process that

provided every member of a given size an equal opportunity of being selected. In obtaining the simple random sample the researcher first defined the population of African-American male students, listed all students within this population and finally selected the sample for the study using a random selection process. The main advantage of randomly selected samples is that it yields information that can be generalized to a larger population within margins of error, which can be determined by statistical formulas (Gay & Airasian, 2000).

#### Instrumentation

The purpose of this study was to examine the impact of mentorship programs on African-American male high school students' perceptions of engineering. To accomplish this task the researcher used a posttest consisting of a survey that evaluated students' perceptions of engineering, to include students' perceptions of engineering and self-efficacy in the area of math and self-efficacy in the area of science. Posttest questions were structured in a manner that best represented the measurement of the desired construct of perceptions (Foster & Wright, 1996).

The survey consisted of 43 closed-ended questions, using a four-point Likert-type scale response whose range consisted of; Strongly disagree=1, Disagree=2, Agree=3, Strongly agree= 4. The survey was designed in an effort to gain information about students' perceptions toward the technical field of engineering. Perceptions included students' perceptions of engineering disciplines and self-efficacy in the area of math and science. Participants were not asked to put their name on the survey thus protecting their anonymity. At the time of the test, participants were notified of their rights of anonymity. Demographic information of the participants was collected at the beginning of the survey



during the evaluation phase, only identifying the participant's age (at last birthday), grade level and respective mentor. This descriptive data aided in forming group categories for data analysis.

The dependent variables were represented by data collected from the posttest survey that students completed after the mentorship program ceased. The survey scores were interpreted to represent students' perceptions toward engineering, which included students' perceptions of engineering disciplines and self-efficacy in the area of math and science. The independent variable in the study was represented by the experimental treatment of participation in the NCETE/NSBE mentorship program.

To ensure validity and reliability of the scale items, a panel of five experienced engineer and technology educators reviewed the scale used in the study and provided feedback regarding clarity of questions and their relevance to the construct being examined. The reliability of the test was achieved through Cronbach's alpha approach to reliability. Stability, referred to as test-retest, tests the degree to which scores on the same test are consistent over time. To gain the reliability coefficient the scores of the pilot test were correlated. To achieve test-retest form reliability the research sought to achieve a coefficient of  $r = .80$  or better (Crocker & Algina, 1986).

Validity of an instrument can be defined as the extent to which inferences can be accurately made and decisions based on test scores. In this particular study construct validity was of importance. Construct validity refers to the degree to which items on a test can be considered to have appropriate operational definitions (Crocker & Algina, 1986). To ensure that the instrument was measuring the desired construct, the researcher had the instrument reviewed for validity and after careful consideration of the feedback

provided from the panel of experienced engineer and technology educators the scale was revised and resubmitted for review. The final form only achieved approval after the researcher's panel of experts was satisfied with the revisions and consensus had been reached.

The survey instrument was designed using information based on literature related to perceptions of engineering disciplines and self efficacy in the area of math and science. Although there is a body of research that documents the effectiveness of mentorship programs on a student's academic success, especially for at-risk students (Campbell-Whately, Algozzine & Obiakor, 1997), there is little research available that looks at the effectiveness of mentorship programs and how they may impact students' perceptions towards career choices, particularly engineering disciplines. This study was able to produce findings that assisted in determining the impact of mentorship programs on African-American male high school students' perceptions of engineering. The instrument used in the research was developed using the following guidelines for writing attitude items identified by Bandolos (2006); (a) Avoid statements that are factual or capable of being interpreted as such, (b) avoid statements that can have more than one interpretation, (c) avoid statements that are irrelevant to the attitude being measured, (d) keep the language clear, simple, and direct, (f) statements should be short, rarely exceeding 20 words, (g) each statement should contain only one complete thought, (h) avoid use of vocabulary that may not be understood by respondents, (i) avoid the use of negatively phrased statements, and (j) statements should be clearly negatively or positively oriented.

A survey was used to collect data from the participants for the purpose of measuring the impact of the NCETE/NSBE mentorship program on African-American

male high school students' perceptions of engineering as a field. Surveys are appropriate when collecting data that is not observable. The advantages of using a survey in this study were that they greatly decrease the time and cost typically required when collecting data. However, surveys are limited by the fact that they do not probe deeply into a participant's opinions and feelings. Additionally, once the survey has been administered, it is not possible to modify the items even if the questions were discovered to be unclear to some respondents. A survey was used in this study because of its power to generalize back to a target population and its structured design is highly compatible with the approaches commonly found in quantitative research (Gall, Gall, & Borg, 1996).

#### Procedure

To measure the impact that the NCETE/NSBE mentorship program had on African-American male high school students' perceptions of engineering a posttest survey was administered to the students. Surveys in this study were used to collect data about the participants' attitudes, experiences and overall perceptions about engineering as a field. The survey was used in this study to gather data about the participants in the sample and to generalize these findings to the target population of African-American male students attending the Middle College at North Carolina A&T based on their comparison to the randomly sampled students who did not participate in the NCETE/NSBE mentorship program. The survey consisted of closed-end questions using a Likert-type scale response. A four-point Likert-type scale questionnaire was used to differentiate responses. This scale type is typically used to gauge the extent of agreement with an attitudinal item (Crocker & Algina, 1986).

The posttest survey was administered in the form of a pencil and paper written exam, which the researcher distributed in person. All respective participants attending the Middle College were instructed to complete the posttest survey with the researcher providing incentive to ensure full participation from the students. To protect the reliability of the results the researcher asked that all students take the posttest exam in the same classroom and within three hours of the first administered exam. To ensure anonymity of the students, identification numbers were used to distinguish the mentored students from the non-mentored students. Students were asked to identify their age and grade level in addition to the identification number that they were given. The identification number was only viewed by the researcher conducting the survey and was destroyed after the data analysis procedure concluded.

Permission to conduct the study was sought through submission of a human subjects approval form to The University of Georgia's Institutional Review Board (IRB), and Guilford County School System's IRB granting permission to work with a vulnerable population (see Appendix B). This study worked with a vulnerable population in that some of the participants were still minors at the time the study was conducted. Minor assent forms and parent consent forms were also drafted and submitted for IRB approval. The Middle College at North Carolina A&T was asked to sign off on a cooperative agreement form (see Appendix C) drafted by the researcher granting permission to the researcher to conduct the study with their students.

### Data Analysis

Results of the posttest survey were represented by three separate univariate, single scale data reports. For the purposes of this study, univariate techniques are particularly

useful when researchers will utilize only a single dependent variable. Although the proposed study utilized three different dependent variables, the data analysis consisted of analyzing the dependent variables independent of each other. Conclusions were drawn from each dependent variable in lieu of producing composite scores from the data.

This study sought to examine the impact that mentorship programs have on African-American male high school students' perceptions of engineering. The probability of rejecting the null hypothesis when the null hypothesis is false is known as the statistical power. Without sufficient statistical power research studies have little opportunity of yielding useful information. A statistical power ranging between .70 and .85 are generally acceptable for research study. Research studies that have high statistical power decrease the likelihood that a Type II error will be committed. Type II errors are identified as the probability that a researcher would accept the null hypothesis when the null hypothesis is false (Olejnik, 1984).

According to Olejnik (1984) effect size is the "specified minimal relationship or minimal difference in populations means that the investigator believes would be important to detect from a practical perspective." In studies that require hypothesis testing of sample means Cohen suggests differences of .2, .5, and .8 standard deviation units as small, medium and large effects, respectively (Olejnik, 1984). For the purposes of this study the researcher used a medium effect size set at 0.5, alpha level set at  $p=0.05$  and a statistical power of 0.7.

#### Summary of Chapter

This chapter has presented the methods, methodology and procedures that were used to investigate the impact of mentorship programs on African-American high school

students' perceptions of engineering. The research design, approach to sampling, data collection, and data analysis of the research process are proposed and described. A quantitative research design was employed and data was collected through surveys developed using relevant and germane literature as it pertains to perceptions and self-efficacy in the areas of math and science. A group of twenty (20) Middle College students were randomly selected to represent the population of African-American male high school students from the school. Data analysis consisted of running independent *t*-tests on the dependent variables of perceptions of engineering, self efficacy in math and self efficacy in science. Methods of ensuring the validity and reliability of the results of the study have been explained as well as measures to secure parental consent and minor assent from the participants.

## CHAPTER 4

### RESULTS

The purpose of this study was to examine the impact of mentorship programs on African-American male high school students' perceptions of engineering. To accomplish this task, students participating in NCETE/NSBE mentorship program were compared to non-mentored students on constructs of perception and self-efficacy related to engineering. The following chapter describes the findings and results of this research study. Due to the unique circumstances that characterize this study, findings will include logistics and results of mentor training as well as development of a measurement instrument. These activities entailed statistical analysis in order to establish construct validity and reliability of score-based inferences made from the administration of the measurement instrument.

#### Mentor Logistics

##### *Mentor Training*

Two separate dates were scheduled for mentor training provided by the researcher. The two training sessions lasted one hour and encompassed delineating the roles, responsibilities, and duties of each mentor participating in the mentorship program. Potential mentors who were not able to be present at the first training session on October 29, 2007 were subsequently given an opportunity to complete training on November 20, 2007. Mentors participated in a presentation on current educational practice as it pertains to engineering education and the under-representation of minorities in science, technology, engineering, and mathematical (STEM) fields. The mentor program was to address the following concerns; (a) lack of exposure at younger ages, (b) absence of role

models, and (c) difference in learning styles. The mentorship program solicited the services of nine mentors to facilitate the program. Mentors were assigned a design team of three African-American male students currently enrolled at the Middle College at North Carolina A&T for the purpose of mentoring.

#### *Four-Point Protocol*

Unique to this formal mentorship program was the *career function* which, notwithstanding the *psychological support* that mentors provided, focuses on influencing individual student's perception of a particular field or career (Allen & Day, 2003). A four-point protocol was developed as a general guide for the mentors to use in conducting their sessions. The four-point protocol included (a) a film presentation that was representative of some aspect of engineering as a field and/or profession, (b) a field experience selected by the mentor that offered the protégés an opportunity and exposure to engineering as a field and/or profession, (c) a design challenge that was culturally relevant to the protégés, that implemented the engineering design process and offered practical application of science and math principles, and (d) one-on-one counseling that offered the protégés psychological support in the way of a role model and/or counselor.

#### *CITI Training*

Prior to engaging in any activities with the Middle College students the mentors were asked to completed extensive training and background checks. In order to receive approval from North Carolina A&T allowing the mentors to work with the Middle College students, mentors had to complete the Collaborative Institutional Training Initiative (CITI). The mentors were registered as social behavior researchers for the purpose of this study. Those who successfully completed CITI training visited with the



principal at the Middle College and were given background check forms to be completed. The Middle College conducted background checks on all potential mentors seeking to participate in the mentorship program. Institutional Review Board (IRB) approval was secured from The University of Georgia allowing the researcher to conduct research involving a vulnerable population. The researcher also had to secure IRB approval from the Guilford County School District in order for the mentors to work with the students.

Following completion of mentor training, CITI training, and successful background checks, five mentors were available to participate in the study. Four other potential mentors were not able to participate in the program due to either (a) failing to complete mentor training, (b) failure to complete CITI training, (c) unsatisfactory reports on their background check, or (d) truancy.

Mentors were responsible for securing a space where their session could appropriately be facilitated. Mentors provided the researcher with their availability schedule and this was forwarded to the principal and administrative assistant at the Middle College. Mentors were asked to sign-out students when retaining the students for the session and the mentors were responsible for signing students back in at the end of the session. The mentors were allotted no more than an hour to conduct their mentorship sessions and were scheduled to meet students the second and forth week of each month. The mentorship program was initiated in February and lasted through May.

#### *Demographic Information of Mentors*

The five mentors selected to participate in this study were all students from North Carolina A&T and were active members in NSBE. There were four male mentors and one female mentor. The mentor group was comprised of one graduate student, one senior,

one junior, and two sophomores. The mentors' ages ranged from 18 to 23 years of age. Two of the mentors majored in electrical engineering, one in chemical engineering, one mentor was a computer science major while another double majored in electrical engineering and chemical engineer. Based on data provided from the Student Information Form (see Appendix E) mentors were assigned three students from the randomly selected experiment group.

### Instrument Development, Content, and Organization

A review of literature revealed a lack of existing instruments that could sufficiently answer the research questions framing this study. Articles and numerous publications from peer-reviewed journals describing the use and development of various instruments were reviewed. Instruments developed by the New Traditions Project and Marat's (2005) study entitled *Assessing Mathematics Self-efficacy of Diverse Students from Secondary Schools in Auckland* provided the basis for an instrument that could effectively measure perceptions and self-efficacy related to science and math. The New Traditions Project is one of five systemic chemistry curricular reform projects funded by the National Science Foundation (NSF). The mission of this project sought to "optimize" opportunities for all students to learn chemistry. The format of the instrument used in this study closely resembles the evaluation survey created by The New Traditions Project. Marat (2005) developed an instrument that measured mathematics self-efficacy for students learning in a multicultural environment of which the results are provided in *Assessing Mathematics Self-efficacy of Diverse Students from Secondary Schools in Auckland*. Using existing questionnaires and literature that examined the intended constructs, an instrument was drafted. This instrument, according to face validation,

measured the desired constructs that framed this particular study. The final instrument reflected changes and suggestions from a five person panel consisting of three technology educators, and two engineering educators.

#### *Instrument Details*

Section one of the instrument collected the background information of the participants including; (a) grade level, (b) gender, (c) race, (d) highest level of formal education of participants' parents, and (e) GPA.

Section two of the respective instrument pertained to participants of the NCETE/NSBE mentorship program. This section collected feedback on the participants' experience in the mentorship program, the program's characteristics, and activities encompassing the mentorship program. The control group, students not participating in the mentorship program, was asked to skip this particular section.

Section three of the instrument dealt with students' perceptions and self-efficacy as it related to their perceptions of engineering. This portion of the survey asked students about their conceptual knowledge of engineering as a field and career. Students were also questioned on their confidence and self-belief to do design and other related tasks of an engineer.

Section four of the instrument asked about students' confidence and self-belief to use math to solve technological problems and engineering problems. Section five of the instrument pertained to students' confidence and self-belief to use their understanding of science to solve technological and engineering problems.

### Pilot Test

To satisfy needs of construct validity and inter-item reliability, the formative instrument was put through a series of rigorous critiques. A panel of three technology and two engineering education experts were recruited in order to secure construct validity with respect to inferences made based on the results of the measurement. The panel represented the following institutions: Purdue University, Duke University, Robert Morris University, University of Southern Illinois, and North Carolina A&T. At a predetermined date copies of the instrument were sent to the expert panel. An email instructed the experts to carefully evaluate the instrument and identify items that (a) did not effectively address the desired construct, (b) were not clear in their instructions, (c) contained complex syntax, (d) and/or used difficult vocabulary (Popham, 2005). Based on recommendations from the panel, certain items were identified to be problematic at which time the researcher made the final determination of whether to eliminate or reword particular items. At the conclusion of the review, a formative instrument was produced in order to satisfy the needs for the pilot test.

#### *Demographic Data of Pilot Test Sample*

Due the sensitivity of the instrument and the unique population that it was to be used with, it was pertinent that the pilot test sample mirror that of the intended population. Northeast Georgia does not currently have single-gender high schools that cater to similar demographics of the Middle College, therefore it was determined suitable to seek out African-American male high school aged students who were considered “at-risk”. Impact Counseling and Consulting (ICC) LLC is a private firm that offers extensive services for juveniles throughout the state of Georgia

([www.impactcounseling.net](http://www.impactcounseling.net)). The firm offers services of incarceration prevention, probation violation prevention, and home reconciliation, just to name a few. Five students were recruited from ICC in order to participate in the pilot test of the instrument.

On April 17, 2008 in the College of Education building at The University of Georgia, the participants for the pilot test were administered the paper and pencil test. Serving as the test administrator, the researcher ensured that each participant had a sharpened number two pencil and adequate space in order to complete the test. Adequate lighting was provided and sufficient time was given for each participant completing the test. As incentive for the participants to answer each question truthfully and to the best of their knowledge, participants were provided with a short tutorial on video editing and production. Participants were also allowed to view a completed video which demonstrated the video principles described in the aforementioned tutorial.

The reliability of the instrument was verified through the pilot test. As recommended by Borg and Gall (1989), the results of the pilot test were used in order to determine Cronbach's alpha for inter-item reliability. For the purpose of this study a coefficient rate of  $r = .80$  was deemed adequate to establish inter-item reliability. Preliminary analysis of the results revealed that Cronbach's alpha had not reached the desired degree of  $r = .80$ . Three particular items were determined to be problematic and their "alpha if item removed" produced scores within the desired rating of  $r = .80$ . The exclusion of three items from the instrument (item 2, item 7 and item 16) produced a rating of  $r = .81$ . These items were not highly correlated within their intended construct and further examination revealed problems with the items which could potentially impact the reliability of score-based inferences. It is important to note that these results have to

be reviewed with caution due to the small number of participants included in the pilot test.

### *Final Instrument*

The final survey consisted of 43 closed-ended questions, using a four-point Likert-type scale response option, Strongly disagree=1, Disagree=2, Agree=3, and Strongly agree= 4. This reflected suggestions from the expert panel and results of the pilot study. The survey was designed in an effort to gain information about students' perceptions toward the field of engineering. Perceptions included students' perceptions of engineering as a field and self-efficacy in the areas of math and science. To determine participants' perceptions of engineering, fourteen items were provided to represent the construct of engineering perceptions and produce one mean score for each group in the study. To determine participants' self-efficacy in math, eight items pertaining to the desired construct were provided and combined to produce a group mean score. To determine self-efficacy in science, nine items pertaining to the desired construct were provided and combined to produce a group mean score.

Participants were not asked to put their name on the survey thus protecting their anonymity. At the time of the test, participants were notified of their rights of anonymity. Demographic information on the participants was collected at the beginning of the survey during the evaluation phase, only identifying the participant's age (at last birthday), grade level, and respective mentor. This descriptive data was used to form group categories for data analysis.

### *Mentorship Rating*

At the beginning of the survey descriptive statistics were collected from students who participated in the mentorship program. The descriptive statistics collected aided in the evaluation of the mentorship program and helped the researcher in forming conclusions and providing recommendations. The evaluation survey consisted of twelve closed-ended questions using a four-point Likert-type scale response whose range consisted of; Never=1, Occasionally=2, Often=3, and Very Often/Almost Always= 4. This section was included to provide a picture of the mentorship program, from the perspective of the students.

### Data Collection

Data was collected on May 15, 2008 at 3pm at the Middle College. The randomly selected experimental and control groups were administered the paper and pencil test in the “Smart-Room” located in the Hines Building at North Carolina A&T. The room was well-lit and provided adequate space for each participant. Each participant received a number two pencil and test booklet upon entering the testing site. The researcher guided the participants through the demographic portion of the test and answered any questions of the participants. The experimental group completed the mentoring section of the test and the entire group was advised of the hour time length for the examination section. At the conclusion of the test, fifteen participants were randomly selected to receive an Ipod *shuffle* as agreed upon for incentive.

## Findings

### *Descriptive Statistics*

Out of the fifteen students selected to participate in the mentorship program only twelve students completed the program. One mentor reported that two of his participants transferred to other high schools during the program. Another mentor reported that one of his participants declined to finish the program *after* agreeing to participate. At the conclusion of the mentorship program, twelve students participated in the treatment for this study. The top twelve students produced from the random sorting of the Middle College students were selected for the control group. A total of twenty male students (N=20) out of the eighty-three Middle College students were randomly selected to participate in the study.

Twenty male students (N=20) out of the eighty-three Middle College students were randomly selected to participate in the study. The treatment group (n=10) consisted of students who participated in the NCETE/NSBE mentorship program and the control group (n=10) consisted of students attending the Middle College who did not participate in the mentorship program. The treatment group consisted of ten Black/African-American male students. The control group consisted of ten Black/African-American male students as well. The grade level break down is as follows; seven participants were freshman (35%), five participants were sophomores (20%), three participants were juniors (15%), and another five participants were seniors (20%). The control group produced two freshmen, two sophomores, two juniors, and four seniors. The treatment group consisted of five freshmen, three sophomores, one junior, and one senior.



Twenty-four students participated in the study however, twenty-one surveys yielded useable data. One student was considered an outlier due to the fact that his ethnicity was determined to be White or Caucasian. Another student did not complete the survey, bringing the total number to twenty-two. Upon further analysis, one participant's responses were deemed invalid and unreliable. The markings on the paper and pencil test clearly demonstrated that the participant did not complete the survey to the best of his knowledge, which posed a problem to the validity and reliability of the results. With twenty-one valid entries to compare, the researcher randomly eliminated one participant to ensure an even amount of participants for the control and experiment groups. It is suggested that equal group size is required to account for mean variances among groups (Weinberg & Goldberg, 1990). The total number of useable data resulted in twenty participants (N=20). Data was recorded and analyzed using SPSS (Statistical Package for the Social Services). Descriptive statistics were computed including mean, median, and standard deviation to describe group means for each construct. Table three provides descriptive statistics of the evaluation survey.

*Table 3. NCETE/NSBE mentorship program*

<i>In the program:</i>		
	<i>M</i>	<i>SD</i>
a. Assignments and class activities are clearly explained.	3.70	.48
b. Assignments, presentations, and learning activities are clearly related to one another.	3.20	.63
c. I work cooperatively with other students on challenges	3.40	.22
d. Mentees teach, and learn from, each other.	2.80	.29
e. There are opportunities to work in groups.	3.30	.21
f. I am encouraged to show how a particular concept can be applied to an actual problem or situation.	3.10	.31
g. I have opportunities to practice the skills I am learning in the program.	3.20	.25
h. I discuss ideas with my classmates (either individuals or in a group).	3.00	.37
i. I get feedback on my work or ideas from my mentor.	3.20	.25
j. We do things that require students to be actively participants in the teaching and learning process.	3.40	.22
l. The mentor gives me <b>frequent</b> feedback on my work.	2.90	.23
m. The mentor gives me <b>detailed</b> feedback on my work.	2.90	.18

*Inferential Statistics*

The first research question sought to determine if there was a significant difference in perceptions of engineering for students who participated in the NCETE/NSBE mentorship program when compared with non-mentored students. An independent sample *t*-test was used to compare the means for each construct and determine differences that were statistically significant. For perceptions of engineering, the mean score for the treatment group equaled  $M = 40.30$  and  $M = 38.40$  for the control group. Standard deviations were  $SD = 5.72$  for the control group and  $SD = 3.95$  for the experimental group. Although the experimental group produced a higher mean score than

the control group, these results were not statistically significant at an alpha level of .05,  $t(18, .05) = .399$ . Table four provides inferential statistics pertaining to students' perceptions of engineering.

*Table 4. Perceptions of Engineering*

Group	<i>n</i>	<i>M</i>	<i>SD</i>
Treatment	10	40.30	5.72
Control	10	38.40	3.95
<i>N</i> =	20		

Statistically significant at  $*p \leq .05$

Research question two sought to determine if there was a significant difference in self-efficacy in the area of math for students who participated in the NCETE/NSBE mentorship program when compared with non-mentored students. Using the same analysis techniques as described above results are provided for participants' self-efficacy in the area of math as it relates to engineering. To answer the research question an independent  $t$ -test was used in the analysis of the group mean score. For self-efficacy in math the control group yielded a mean score of  $M = 23.30$  and  $M = 22.60$  for the treatment group. The standard deviation for the self-efficacy in math was  $SD = 3.75$  for the control group and  $SD = 3.62$  for the treatment group. Though there is a slight difference in the mean scores of the control and treatment group these results failed to reach significance,  $t(18, .05) = .676$ . Table five provides inferential statistics pertaining to students' self-efficacy in math.

Table 5. Self-efficacy in Math

Group	<i>n</i>	<i>M</i>	<i>SD</i>
Treatment	10	22.60	3.62
Control	10	23.30	3.75
<i>N</i> =	20		

Statistically significant at  $*p \leq .05$

Research question three sought to determine if there was a significant difference in self-efficacy in the area of science for students who participated in the NCETE/NSBE mentorship program when compared with non-mentored students. To answer this research it was important to determine participant's self-efficacy in science. In a comparison of mean scores for student's self-efficacy in science as it relates to engineering, an independent sample *t*-test yielded the following results. The experimental group produced a mean score of  $M = 28.10$  and the control group produced a mean score of  $M = 25.80$ . The standard deviation for each group equaled  $SD = 4.12$  and  $SD = 3.96$  respectively. The experimental group produced a mean score more than two points higher than the control group however, further analysis determined that this research question did not produce a mean difference that was determined to be statistically significant,  $t(18, .05) = .220$ . Table six provides inferential statistics pertaining to students' self-efficacy in science.

Table 6. Self-efficacy in Science

Group	<i>n</i>	<i>M</i>	<i>SD</i>
Treatment	10	28.10	4.12
Control	10	25.80	3.96
<i>N</i> =	20		

Statistically significant at \*  $p \leq .05$

#### Summary of Chapter

This chapter presented the results and findings from the study that investigated the impact of mentorship programs on African-American male high school students' perceptions of engineering. Indicators for perceptions included participants' perceptions of engineering as a field and self-efficacy in math and self-efficacy in science. The results of the mentor training and results of the instrument development were also presented in this chapter. Descriptive statistics collected from the survey aided in the evaluation of the mentorship program and helped the researcher in forming conclusions and providing recommendations. The results of the evaluation survey were also presented in this chapter.

The impact of mentorship programs on African-American male high school students' perceptions of engineering was examined using an independent *t*-test to indicate differences that were statistically significant. Results revealed that there were no significant differences among group mean scores for the desired constructs of perception of engineering, self-efficacy in math, and self-efficacy in science. However, analysis did reveal a favorable view of the NCETE/NSBE mentorship program with an average mean score of 3.17 on a four-point Likert-type scale. An *addendum* to the following study is presented below encompassing the results of exit interviews that the mentors completed

at the conclusion of the program. Chapter five will present conclusions, future implications and recommendations for this study.

#### Exit Interview

At the conclusion of the NCETE/NSBE mentorship program each mentor was required to participate in an exit interview. The purpose of this interview was to identify the perspective of the mentors as they participated in the program. The addition of this qualitative data was suggested at a professional conference and its merits confirmed by the researcher's major advisor. With the goal of constructing a complete picture from the words and experiences of the participant, the researcher used interview questions and follow-up questions based on the interviewee's responses. When seeking to gain in-depth knowledge from subjects about a particular experience, qualitative interview questions are the instrument of choice for many researchers (DeMarrais & Lapan, 2004). Subjects were asked to answer questions derived from an instrument developed for the purpose of evaluating the mentorship program.

A phenomenological approach was used for the theoretical framework in regards to the interviews conducted. Phenomenology is a research approach that closely examines an individual's interpretation of his/her experience (Lodico, Spaulding & Voegtle, 2006). It was the intention of the researcher to understand the meaning of an experience from the perspective of the participant. Based on experiences gained during the study, the researcher felt it critical to not only provide quantitative data on the experience of the Middle College students but to also provide qualitative data from the mentors' perspective. This data is pertinent to the implications of this research study and those wishing to examine the impact of mentorship programs.

An instrument was developed with the intentions of examining the experience of the mentors who participated in the NCETE/NSBE mentorship program. A research panel reviewed the instrument and provided feedback to improve validity and reliability of the survey instrument. The final instrument used to collect data represented changes and suggestions from the panel. Appendix F provides a copy of the questionnaire used to collect data. The instrument contained items that would help in the evaluation of the mentorship program. One-on-one interviews were schedule with the mentors at the conclusion of the mentorship program. Interviews were digitally recorded and transcribed using the services of a professional transcriber. To protect the anonymity of respondents, pseudonyms are provided for identification purposes. Analysis consisted of the identifying recurring themes throughout the study. These themes were identified as *emergent* themes. The following verbatim quotes represent data which supports each of the emergent themes identified.

#### *Pseudonyms for Participants*

The five mentors who participated in the mentorship program were given pseudonyms to protect their identity and for identification purposes. G-money is a chemical engineering major at North Carolina A&T in his/her junior year. Jordan is a sophomore at the university and is currently majoring in computer science. Tex is a senior at the university and has a double major in chemical engineering and electrical engineering. D. Fox is a graduate student in the area of electrical engineering. JJ is a sophomore at the university and is majoring in electrical engineering.

Participants were asked to rate the success of the mentorship program by providing a number between one and ten, with ten being the highest rating and one being

the lowest. The mean score for this item resulted in  $M=7.70$ . Asked to provide reasons for these ratings, mentors quotes have been provided below to help articulate their experience in the mentorship program. D. Fox justified his particularly low rating by stating that, “I don’t really think that a true representation of the field (was present)”. G-money felt that the program could have received a higher score if started earlier in the school year. He was quoted to say, “I say eight because it could have be higher because I think we could have did more if we would have started like towards the beginning of the year rather than just the second semester”. JJ said that he felt the program went well and that, “it was good to interact with (them).. get them interested in engineering and explain to them exactly what we do, and things like that”. Jordan was very complimentary of the program as he reflected on the experience of his students, he felt that, “their eyes were kind of more open to engineering because it was kind of a...(pause)..they thought it was kind of cool how things are invented and stuff like that”. Finally, Tex justified his/her rating by stating that, “I don’t think many of them (Middle College teachers) was too involved with the program.”

#### *Gathering them all together*

When asked to identify some of the biggest obstacles faced in the mentorship program, the majority of the mentors agreed that corralling the mentors together was an issue. The following excerpts provide a glimpse into the frustration expressed by the mentors. JJ stating that one of the biggest challenges of the program was, “Gathering them all together. It’s kind of rough to get them all together and find out where they are and search for them.” Jordan reiterated this difficulty by stating:



Some of the challenges were keeping in contact with my mentees. Some of them didn't have cell phones ...?.. at times. Sometimes they weren't there at the ..?.... So I guess it was keeping in contact with them.....

*Middle College not involved in program*

Several mentors expressed their concern for what they saw as a lack of communication between the Middle College and facilitators of the mentorship program. Though the administration were very cooperative in facilitating the program, there seemed to be a disconnect between the administration and the teachers. The following quotes are indicative of the issues faced by many of the mentors. Tex's quote describes the involvement or lack thereof of the Middle College. Tex stated that:

There were certain people, the secretary and sometimes the principal was involved with helping get students out of class but for the most part they weren't too involved.

When asked to speak about the Middle College's accommodation of the program

D. Fox stated:

The only problem I had was it seemed like the ...?...inaudible....nobody knew what was doing on, like the files and things like that. So I mean ..... everybody should be a little bit more well informed.

*More time with students*

One recurring theme for the mentors was the lack of time they were allowed with the students. Due to the fact that mentoring sessions were scheduled during class time, mentors were only allowed one (1) hour per session. Many mentors felt that this was not adequate time to spend with the students as it relates to the impact of the mentorship program. Jordan offered his suggestions for improving the program by stating:

Yeah, I think one more thing to improve is like the time length because, yeah definitely the time length because 50 minutes was like a very short time because I had to come from class and by the time I had to walk back over here, it was already 15 minutes gone by so I had to do everything in

15 minutes. Thirty minutes, and then it took like another ten minutes to get them back over there because I wanted to be there to the next session in class. So I would say time.

Tex also expressed this same concern by stating, “I think we could have did more if we would have started like towards the beginning of the year rather than just second semester.”

#### *Work with the same students*

All mentors who participated in the program expressed an interested in not only mentoring next year but they also expressed interest in working with the same group of students. Mentors feel that it was important to do so in order to establish a certain rapport with the students and elicit the greatest impact. Several quotes below provide emphasis to this point, JJ put it very succinctly when asked if he/she would be interested in continuing the mentorship program by stating, “I kind of like the same students, yeah.” Tex talked about his/her interest in continuing with the program with the statement, “I would want to and hopefully I could get the same students again....”

#### *Set activities*

Mentors felt that it would benefit all parties involved to present the mentors with set activities that the students could participate in. Many mentors felt it was difficult to develop challenges that were “culturally relevant” as it relates to the students. Featured comments below help cement this point. When asked for suggestions to improve the program JJ stated, “I would say just like as far as the activities like set activities. And like we can embellish off of those set activities.” Jordan seconded this notion. His suggestions for improving the program included, “I think some of the suggestions would be to have projects already ready for the mentees and mentors and what-not.”

*Summary of Interviews*

The five interviews conducted with the mentors provided this study with in-depth knowledge of their experience in the mentorship program. Their opinions and views were presented and resulted in five emergent themes in relation to the NCETE/NSBE mentorship program. The emergent themes identified were, (a) gathering them all together, (b) more Middle College involvement, (c) more time with students, (d) working with the same student, and (e) set activities. These themes should be considered in implementing future mentorship programs looking to impact students' perceptions and self-efficacy in a particular field. The following data presented has future implications for the field and provides a basis for future research related to formal mentorship programs.

## CHAPTER 5

### DISCUSSION

This study was designed to provide a viable intervention that could impact the perceptions and self-efficacy of African-American male high school students. In order to satisfy the needs of the study, a formal mentorship program was developed and facilitated by the researcher. The NCETE/NSBE mentorship program was a three month program that matched qualified members of NSBE with students from the Middle College at North Carolina A&T. This chapter will first provide a summary of the research study, restate the purpose of the study, and describe the methods used in this study. Following this summation, results will be discussed in relation to the research questions and theoretical framework guiding this study, and implications for how these findings may apply to practice and future research will be presented.

#### Summary of Research Study

This study derived from a funded study conducted by the researcher titled *African-American High School Students' Perceptions of Engineering*. The results of that study identified a lack of conceptual knowledge of engineering by many African-American high school students and low self-efficacy in the areas of math and science. The disconcerting findings from the above mentioned research provided the impetus for the following study.

The following study sought to examine the impact that mentorship programs have on African-American male high school students' perceptions of engineering to include self-efficacy in math and science. It was the goal of this study to identify a viable intervention that could positively impact the perceptions of African-American high

school male students. The following issues were addressed: (a) lack of exposure (b) absence of role models (c) difference in learning styles. A four-point protocol was enacted to provide a systemic approach to producing change in the participants including: (a) a film presentation that was representative of some aspect of engineering as a field and/or profession, (b) a field experience selected by the mentor that offered the protégés an opportunity and exposure to engineering as a field and/or profession, (c) a design challenge that was culturally relevant to the protégés, that implemented the engineering design process and offers practical application of science and math principles, and (d) one-on-one counseling that offered the protégés psychological support in the way of a role model and/or counselor.

Data collection took place on May 15, 2008 in Hines Hall at North Carolina A&T. The survey consisted of 43 closed-ended, Likert-type items. Descriptive statistics were provided along with inferential statistics which were used to answer the research questions guiding this study (see pg. 99). An independent *t*-test was used to determine if there was a significant difference in group means between each group. Exit interviews were also conducted with the mentors at the end of the program. This data was transcribed using the services of Grace Executive Services LLC and assisted in drawing conclusions from the study.

Twenty-four participants were surveyed during the study including; eight freshmen, six sophomores, four juniors and six seniors. Only twenty participants (N=20) provided useable data for the comparative study.

### Purpose of the Study

The purpose of this study was to examine the impact of mentorship programs on African-American male high school students' perceptions of engineering. In this study, indicators of student's perceptions included students' perceptions of engineering and self-efficacy in the area of math and science. This study used a two-group, posttest only experimental design with randomly selected participants. After participation in the NCETE/NSBE mentoring program, the treatment for this study, a survey was used to collect data to answer the following research questions:

#### *Research Questions*

1. Is there a significant difference in perceptions of engineering for students who participated in the NCETE/NSBE mentorship program when compared with non-mentored students?
2. Is there a significant difference in self-efficacy in the area of math for students who participated in the NCETE/NSBE mentorship when compared with non-mentored students?
3. Is there a significant difference in self-efficacy in the area of science for students who participated in the NCETE/NSBE mentorship when compared with non-mentored students?

### Method

This experiment used a two-group, posttest only design, which framed the research (Campbell & Stanley, 1963). The dependent variables were students' perceptions, which included students' perceptions of engineering and their self-efficacy in the area of math and science after participating in the National Center for Engineering

and Technology Education (NCETE) and National Society of Black Engineers (NSBE) mentorship program. The mentorship program that the students participated in represented the treatment for the study.

### *Sample*

Twenty male students ( $N=20$ ) out of the eighty-three Middle College students were randomly selected to participate in the study. The treatment group ( $n=10$ ) consisted of students who participated in the NCETE/NSBE mentorship program and the control group ( $n=10$ ) consisted of students attending the Middle College who did not participate in the mentorship program. The treatment group consisted of ten Black/African-American male students. The control group consisted of ten Black/African-American male students as well. The grade level break down is as follows; seven participants were freshman (35%), five participants were sophomores (20%), three participants were juniors (15%), and another five participants were seniors (20%). The control group produced two freshmen, two sophomores, two juniors, and four seniors. The treatment group consisted of five freshmen, three sophomores, one junior, and one senior. The total number of participants failed to meet the desired sample size of  $N=27$  which was determined using the four factors of; criterion for statistical significance, level of statistical power, statistical analysis strategy, and the size of the effect judged to be meaningful (Olejnik, 1984). Failing to meet the intended sample size greatly impacts the ability to generalize results back to the Middle College population.

### *Constructs*

An independent sample *t*-test was used to compare the means for each construct and determine differences that were statistically significant. Perceptions included students' perceptions of engineering as a field and self-efficacy in the areas of math and science. To determine participants' perceptions of engineering fourteen items were provided to represent the construct of engineering perceptions and produce one mean score for each group. To determine participants' self-efficacy in math eight items pertaining to the desired construct were provided and combined to produce a group mean score. To determine self-efficacy in science nine items pertaining to the desired construct were provided and combined to produce a group mean score. To answer each research question an independent *t*-test was used in the analysis of the group mean score.

### *Addressing Research Questions*

Research question one sought to identify if there was a there a significant difference in perceptions of engineering for students who participated in the NCETE/NSBE mentorship program when compared with non-mentored students? The research findings pertaining to research question one did not produce a group mean score for students' perceptions of engineering. These results are a bit disconcerting and have implications for the field and especially mentorship programs. Analyses of the exit interviews helped provide answers to many questions that arise regarding the mentorship experience. It is increasingly evident that more time is needed to impact students' perceptions. The relatively short duration of the program and time allotted for each mentoring session appear to have been inadequate and greatly impacted the ability of the mentorship program to effect change.



Research question two sought to identify if there was a significant difference in self-efficacy in the area of math for students who participated in the NCETE/NSBE mentorship program when compared with non-mentored students? Findings from the research pertaining to research question two did not produce a group mean score that reached a level of significance. Upon further analysis, in addition to time constraints, the lack of set activities posed a problem for the mentors and participants alike. The four-point protocol called for mentors and participants to develop challenges that were deemed “culturally relevant”. However, this strategy backfired for many mentors because of some participants’ reticence to become more involved in the learning process. The time lost and uncertainty of activities likely contributed to the lack of significant difference.

Research question three sought to identify if there was a significant difference in self-efficacy in the area of science for students who participated in the NCETE/NSBE mentorship program when compared with non-mentored students? The study did not reveal a significant difference in group mean score for findings pertaining to research question three. As identified earlier, issues of time constraints and the lack of set activities in all probability contributed to the insignificant difference in group mean score.

### Addressing Theoretical Framework

Social learning theory (inclusive of social cognitive theory) and constructivism were the theoretical framework and epistemology respectively that guided this study. This framework contributed significantly to the perspectives of this study, including the design of the mentorship program, design of the study, analysis, and interpretation of data. Social cognitive theory builds upon social learning theory and posits that knowledge

acquisition can be directly related to observing others within the context of social interactions, experiences, and outside media influences (Bandura, 1988). This theory further evolved when it was suggested that if there is a close identification between the observer and the model and if the observer has a good deal of self-efficacy, learning will most likely occur (Bandura, 1989). Constructivism is the view that all knowledge, and therefore all meaningful reality as such, is contingent upon human practices, being constructed in and out of interaction between human beings and their world, and developed and transmitted within an essentially social context.

### *Procedures*

Approval was granted from The University of Georgia Institutional Review Board (IRB), Guilford County School System, school administration and teachers in the participating schools. Once consent procedures were completed, training for the mentors was provided by the researcher. A four-point protocol was reviewed and agreed upon for each mentor participating in the study. The mentorship program lasted approximately three months and involved a total of six meetings. At the conclusion of the mentorship program, data was collected, analyzed and reported.

### *Implications for the Field*

As minorities struggle to skillfully adapt to an ever changing economy, Jenkins and Om-Ra-Seti (1997) suggested that in a capitalist society it is pertinent that minorities become technologically proficient. This has implications for the economy, national workforce and the future condition of minorities in this country. Findings from this study including inferential statistics, exit interviews, and descriptive data provide several implications specifically for African-American males as it relates to engineering and

other related technical fields. The aforementioned implications apply specifically to diversifying the technical fields, specifically engineering, and any organizations looking to implement formal mentorship programs as a way to impact individual's perception and self-efficacy.

The purpose of this study was to examine the impact of formal mentorship programs. The NCETE/NSBE mentorship program was unique in its structure, facilitation, and unprecedented in the field. The mentorship program developed, including data collection instruments adds to a growing field of research directed towards the benefits of mentoring. The collaborative work between The University of Georgia, North Carolina A&T, the Middle College, NCETE and NSBE has major implications for engineering and other technical fields. The mentorship program developed was also unique in that it had a career function *and* a psychological function. Results from this study will assist organizations interested in promoting diversity in their respective fields and impacting the perceptions and self-efficacy of these individuals.

Although this study did not identify a significant difference between the control and treatment group, additional findings answered some questions regarding the facilitation of the mentorship programs. The qualitative interviews conducted provided insight to some of the barriers that precluded the study from achieving a difference of significance. More time is likely needed to see any difference of significance. Issues that took away from the mentoring time, including lack of involvement by Middle College staff, and issues with gathering the students together in a timely fashion, will have to be ascertained. The omission of set activities had major implications for this study. The time involved to create culturally relevant activities with the students more than likely affected

the overall impact of the mentoring sessions. It has been suggested that providing the mentors with set activities that they could embellish on, will have a positive impact on the overall mentoring experience.

As a researcher, it is important to examine all variables that may impact the results of a study. In relation to this research study, the disproportionate amount of upper classmen in the control group may help explain the lack of statistical significance. Furthermore, the precision of the instrument used in this study must come under scrutiny. When trying to measure sensitive constructs such as perceptions and self-efficacy it is pertinent to ensure that the instrument used is measuring what it is intended to measure. Further examination of the instrument may be in order to ensure its reliability and that the score-based inferences made from the data collected are valid.

Overall, the learning experience for the participants was viewed as a very favorable one. In a review of the evaluation of the mentorship program, the treatment group produced an average mean score of  $M=3.17$  and an average standard deviation of  $SD=.30$  on a four-point Likert-type scale. However, closer examination of the actual effectiveness of *each* mentor is vital. Each experience within the mentorship program will depend on several factors including, members of each design team, assigned mentor, entry behavior, and activities involved. To determine the impact of these and other contributing factors further analysis is needed to include an examination of the mentor training and its overall effectiveness.

The mentorship program was viewed very favorably by the mentors as evidenced by their responses on the exit interviews. Each participating mentor expressed an interest in continuing within the program and indicated a desire to work with the same students.

Mentors rated the success of the mentorship program by providing a number between one and ten, with ten being the highest rating and one being the lowest. The mentorship program produced a mean score of  $M=7.70$  as perceived by the mentors.

#### Future Research

Based on the experience of developing the NCETE/NSBE mentorship program, training the mentors, developing a measurement instrument, and facilitating the mentorship program, the researcher was able to gain invaluable insight into the process of mentoring and the potential that these programs have to influence and positively impact students. For future research studies it would behoove of facilitators to ensure that all parties involved are well informed on the procedures and components of the mentorship program. Keeping everyone abreast of the program would greatly impact the effectiveness and proficiency of the mentorship program. Additionally a similar study could look to collect qualitative data on the mentors and their protégés. Qualitative data provides a depth of knowledge that quantitative statistics are not able to provide.

Future research in this area should allow for more time for the mentorship program to properly develop. It was expressed several times that the three months allotted for this study was inadequate to produce real change. Mentors have also suggested extending the time for each session. These two factors are critical to the success of the mentorship program and future research should seek to make needed adjustments in these areas. Furthermore, a similar study should look to provide further analysis regarding between group differences and within group differences. The final results revealed a disproportionate amount of upper classmen in the control group, which potentially could have implications for total group mean score. Chi-squared analyses could be utilized to

discern if students' grade levels have any correlation with students' perceptions and self efficacy. Multiple-regression is another statistical approach that could be utilized to provide further analysis of the results. This procedure could be utilized to determine if the completion or lack thereof of each point of the protocol has any impact on the outcomes. This would help reveal if a particular point in the protocol is effective or ineffective.

### Conclusions

This research study has yielded valuable information to the field which may help in the diversification of engineering and other technical fields. The most vital contribution of this research was the formal mentorship model developed including techniques for training mentors, identifying mentor requirements, and developing and testing measurements instruments to evaluate mentoring outcomes. The aforementioned contributions of this study provide a blueprint that will assist organizations and institutions looking to positively impact the perceptions and self-efficacy of their constituents. The study provided a viable mentorship program that utilized federal funding and collaboration between the University of Georgia, North Carolina A&T, the Middle College at North Carolina A&T, NCETE, and NSBE. Although the study failed to produce any findings that were statistically significant, artifacts developed have major implications for future research projects. Past studies have failed in their evaluation of formal mentorship programs, which is evident by the lack of comparative studies that examine mentorship programs. The study reported here provided a very rigorous evaluation of the benefits of formal mentorship programs.

This study was instrumental in providing an example which could serve as a model for the evaluation of formal mentorship programs to positively influence

perceptions and self-efficacy of students. Although the survey failed to reveal a difference in mean score that was statistically significant, no researcher of note has attempted to compare the self-efficacy of students participating in a formal mentorship program against those not participating.

For the purpose of this study, the researcher felt it critical to not only provide quantitative data on the experience of the Middle College students but to also provide qualitative data from the mentors' perspective. This data is pertinent to the implications of this research study and those wishing to examine the impact of mentorship programs. The qualitative data provided by the mentors will assist future researchers by identifying barriers to effective mentorship.

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## APPENDICES

APPENDIX A  
*CONSENT FORMS*

**Parental Permission Form**  
**(experimental group)**

<b>Title of Research</b>	Effectiveness of Mentoring on African American High School Students' Perceptions of Engineering	
<b>Name of Researchers</b>	<b>Cameron Denson, Principal Investigator</b>	<b>Dr. Roger B. Hill, Faculty Advisor/Co-researcher</b>
<b>Phone Number &amp; Email</b>	(706) 542- 7059 / cdenson@uga.edu	(706) 542-4100 / rbhill@uga.edu
<b>School Address</b>	University of Georgia, Department of Workforce Education, 220 Rivers Crossing Building , Athens GA 30606	

**PURPOSE AND BACKGROUND**

My name is Cameron Denson. I am a graduate student at University of Georgia and I am conducting a research study about how students learn math and science within engineering and what ways we can impact student's perception of engineering. I am inviting your child to take part in the research because he/she it may help answer questions as to why more African-American students do not chose engineering as a career choice.

**PROCEDURES**

If you agree to let your child take part in this research study, the following will occur:

1. Your child will be asked to participate in mentorship program from January to April meeting twice a month with his assigned mentor. These activities will take place at a time and location that is convenient for you as designated by their principal to be no longer than 30min.
2. She or he will also be asked to complete survey about engineering as a career choice and math and science knowledge. The questionnaire will take about 30 min. to complete. The questionnaire can be completed at a designated time and location set by your child's principal.
3. My child's grades will not be affected if she or he does not participate or stops taking part in this research. My child will be missing some class work and will be responsible for making up any missed assignments.
4. My child will be asked to evaluate their experience in the mentorship program in an effort to facilitate the research study.

**DIRECT BENEFITS**

There are no direct benefits to your child but the findings from this project may provide information on help lay the groundwork for future studies that seek to introduce effective means of recruitment and retention for African-Americans not to mention changing the attitudes that individuals have towards certain disciplines.

**RISKS and DISCOMFORTS:**

There are no known risks or discomforts associated with this research.

**COMPENSATION OR INCENTIVE**

If your child completes all surveys, he or she will receive an opportunity to receive an Ipod shuffle. Students will be entered into a random drawing awarding ten students Ipods valued at \$80.

**CONFIDENTIALITY**

Any information that is obtained in connection with this study that can be identified with your child will remain confidential unless required by law. Any data containing individually identifying information will be securely kept a locked filing cabinet or password protected computer in the researcher's office. After analysis is complete, the researcher will erase any individually identifying information from the data and will remove any links between your child's name and results.

University of Georgia  
Institutional Review Board  
Approved: 1-14-08  
Expires 1-13-09

**PARTICIPATION AND WITHDRAWAL**

Participation is voluntary. You can refuse to allow your child to participate and can withdraw your child from participation without any penalty or any loss of benefits to which he or she is otherwise entitled. Even if your give permission for your child to participate, he or she can refuse to participate and can quit at any time. You can request to have the results of the participation, to the extent that it can be identified as your child's, removed from the research records or destroyed.

**QUESTIONS**

The researcher can be contacted for any further questions about the research, now or during the course of the project. See contact information for the researcher at the top of the page. Additional questions, concerns or complaints regarding your rights as a research participant should be addressed to The IRB Chairperson, University of Georgia, 612 Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411; Telephone (706) 542-3199; E-Mail Address: IRB@uga.edu

**I understand the study procedures described above. My questions have been answered to my satisfaction, and I agree to allow my child to take part in this study. I have been given a copy of this form to keep.**

Cameron Denson		
Name of Researcher	Signature	Date
Name of Parent Guardian	Signature	Date

**Please sign both copies, keep one and return one to the researcher.**

University of Georgia  
Institutional Review Board  
Approved: 1-14-08  
Expires 1-13-09

### Minor Assent

#### Effectiveness of Mentorship Programs on the Perceptions of African-American Male High School Students towards Engineering

1. My name is Cameron Denson
2. We are asking you to take part in a research study because we are trying to learn more about how students learn math and science within engineering and what ways we can impact student's perception of engineering.
3. If you agree to be in this study you will agree to have a mentor assigned to you and twice a month you will meet with this mentor. During the duration of the program you will be asked to participate in networking, video presentations and design challenges. You will also be asked to complete a survey about engineering as a career choice and math and science knowledge. The questionnaire will take about 30 min to complete. The questionnaire can be completed at a designated time set by your principal. At the conclusion of the program, participants will be asked to complete an evaluation form in an effort to facilitate the research study.
4. We won't tell anyone you took part in this study. The survey will not use any identifying information to describe you. Only Cameron Denson the lead researcher will have access to any collected data.
5. There are no known risks or discomforts associated with this research. Your participation in this project will not affect your grades in school.
6. Students who participate in the study will have an opportunity to receive an Ipad shuffle. Estimated value \$80.
7. Please talk this over with your parents before you decide whether or not to participate. We will also ask your parents to give their permission for you to take part in this study. But even if your parents say "yes" you can still decide not to do this.
8. If you don't want to be in this study, you don't have to participate. If you want to stop participating in this project, you are free to do so at any time. You can also choose not to answer questions that you don't want to answer. Remember, being in this study is up to you and no one will be upset if you don't want to participate or even if you change your mind later and want to stop.
9. You can ask any questions that you have about the study. If you have a question later that you didn't think of now, you can call me 336-254-7978 or ask me next time. You may call me at any time to ask questions.
10. Signing your name at the bottom means that you agree to be in this study.

Sincerely,

Cameron Denson  
Department and University Affiliation  
Contact Information

University of Georgia  
Institutional Review Board  
Approved: 1-14-08  
Expires 1-13-09

---

I understand the project described above. My questions have been answered and I agree to participate in this project. I have received a copy of this form.

---

Signature of the Participant/Date

**Please sign both copies, keep one and return one to the researcher.**

Additional questions or problems regarding your rights as a research participant should be addressed to The Chairperson,  
Institutional Review Board, University of Georgia, 612 Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411;  
Telephone (706) 542-3199; E-Mail Address IRB@uga.edu

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Institutional Review Board  
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Expires 1-13-09



**Parental Permission Form**  
**(control group)**

<b>Title of Research</b>	Effectiveness of Mentoring on African American High School Students' Perceptions of Engineering	
<b>Name of Researchers</b>	<b>Cameron Denson, Principal Investigator</b>	<b>Dr. Roger B. Hill, Faculty Advisor/Co-researcher</b>
<b>Phone Number &amp; Email</b>	(706) 542- 7059 / cdenson@uga.edu	(706) 542-4100 / rbhill@uga.edu
<b>School Address</b>	University of Georgia, Department of Workforce Education, 220 Rivers Crossing Building , Athens GA 30606	

**PURPOSE AND BACKGROUND**

My name is Cameron Denson. I am a graduate student at University of Georgia and I am conducting a research study about how students learn math and science within engineering and what ways we can impact student's perception of engineering. I am inviting your child to take part in the research because he/she it may help answer questions as to why more African-American students do not chose engineering as a career choice.

**PROCEDURES**

If you agree to let your child take part in this research study, the following will occur:

1. Your child will be asked to participate in a survey evaluating the perceptions of engineering.
2. She or he will be asked to complete a survey about engineering as a career choice and math and science knowledge. The questionnaire will take about 30 min. to complete. The questionnaire can be completed at a designated time and location set by your child's principal.
3. My child's grades will not be affected if she or he does not participate or stops taking part in this research. My child will be missing some class work and will be responsible for making up any missed assignments.

**DIRECT BENEFITS**

There are no direct benefits to your child but the findings from this project may provide information on help lay the groundwork for future studies that seek to introduce effective means of recruitment and retention for African-Americans not to mention changing the attitudes that individuals have towards certain disciplines.

**RISKS and DISCOMFORTS:**

There are no known risks or discomforts associated with this research.

**COMPENSATION OR INCENTIVE**

If your child completes all surveys, he or she will receive an opportunity to receive an Ipod shuffle. Students will be entered into a random drawing awarding ten students Ipods valued at \$80.

**CONFIDENTIALITY**

Any information that is obtained in connection with this study that can be identified with your child will remain confidential unless required by law. Any data containing individually identifying information will be securely kept a locked filing cabinet or password protected computer in the researcher's office. After analysis is complete, the researcher will erase any individually identifying information from the data and will remove any links between your child's name and results.

**PARTICIPATION AND WITHDRAWAL**

Participation is voluntary. You can refuse to allow your child to participate and can withdraw your child from participation without any penalty or any loss of benefits to which he or she is otherwise entitled. Even if your

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Expires 1-15-09

give permission for your child to participate, he or she can refuse to participate and can quit at any time. You can request to have the results of the participation, to the extent that it can be identified as your child's, removed from the research records or destroyed.

### QUESTIONS

The researcher can be contacted for any further questions about the research, now or during the course of the project. See contact information for the researcher at the top of the page. Additional questions, concerns or complaints regarding your rights as a research participant should be addressed to The IRB Chairperson, University of Georgia, 612 Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411; Telephone (706) 542-3199; E-Mail Address: IRB@uga.edu

**I understand the study procedures described above. My questions have been answered to my satisfaction, and I agree to allow my child to take part in this study. I have been given a copy of this form to keep.**

<i>Cameron Denson</i>		
Name of Researcher	Signature	Date
Name of Parent Guardian	Signature	Date

**Please sign both copies, keep one and return one to the researcher.**

University of Georgia  
Institutional Review Board  
Approved: 1-14-08  
Expires 1-15-09

**ASSENT (CONTROL) FORM**

<b>Title of Research</b>	Effectiveness of Mentoring on African American High School Students' Perceptions of Engineering	
<b>Name of Researchers</b>	<b>Cameron Denson</b> , Principal Investigator	<b>Dr. Roger B. Hill</b> , Faculty Advisor/Co-researcher
<b>Phone Number &amp; Email</b>	(706) 542- 7059 / Email @uga.edu	(706) 542-4100 / Email@uga.edu
<b>School Address</b>	University of Georgia, Department of Workforce Education, Rivers Crossing Building , Athens GA 30606	

**PURPOSE AND BACKGROUND**

My name is Cameron Denson. I am a graduate student at University of Georgia and I am conducting a research study about how students learn math and science within engineering and what ways we can impact student's perception of engineering. I am asking you to take part in this research study because it may help answer questions as to why more African-American students do not chose engineering as a career choice.

**PROCEDURES**

If you agree take part in this research study, the following will occur:

1. You may be asked to complete a survey about engineering as a career choice and math and science knowledge. The questionnaire will take about 30 min to complete. The questionnaire can be completed at a designated time set by your principal.
2. In addition, I may contact you 2-3 weeks after you participate to seek clarification or more information regarding your responses. (Students in the control group will not be asked to fill out an evaluation form.)

**DIRECT BENEFITS**

There are no direct benefits to you but the findings from this project help lay the groundwork for future studies that seek to introduce effective means of recruitment and retention not to mention changing the attitudes that individuals have towards certain disciplines.

**RISKS and DISCOMFORTS:**

The researchers do not foresee any risks to you for participating in this study. It is possible that you may feel uncomfortable answering some of the research questions. You can skip any questions that you do not wish to answer. In addition, you may stop answering questions or discontinue participation at any time. If you experience any distress as a result of your participation in this research, you may contact the investigator or his advisor for other referrals, assistance, and resources

**COMPENSATION OR INCENTIVE**

As compensation, you will receive an opportunity to receive an Ipod shuffle. Students will be entered into a random drawing awarding ten students Ipods valued at \$80.

**CONFIDENTIALITY**

Any information that is obtained in connection with this study that can be identified with you will remain confidential unless required by law. Any data containing individually identifying information will be securely kept a locked filing cabinet or password protected computer in the researcher's office. After analysis is complete, the researcher will erase any individually identifying information from the data, and will remove any links between your name and results.

University of Georgia  
Institutional Review Board  
Approved: 1-14-08  
Expires 1-13-09

**PARTICIPATION AND WITHDRAWAL**

Your participation is **voluntary**. You can refuse to participate and can withdraw from participation without any penalty or any loss of benefits to which you are otherwise entitled. You can request to have the results of the participation, to the extent that it can be identified with you, removed from the research records or destroyed.

**QUESTIONS**

The researcher can be contacted for any further **questions about the research**, now or during the course of the project. See contact information for the researcher at the top of the page. Additional questions, concerns or complaints regarding **your rights as a research participant** should be addressed to The IRB Chairperson, University of Georgia, 612 Boyd Graduate Studies Research Center, Athens, Georgia 30602-7411; Telephone (706) 542-3199; E-Mail Address: IRB@uga.edu

**I understand the study procedures described above. My questions have been answered to my satisfaction, and I agree to take part in this study. I have been given a copy of this form to keep.**

<i>Cameron Denson</i>		
Name of Researcher	Signature	Date
Name of Participant	Signature	Date

**Please sign both copies, keep one and return one to the researcher.**

University of Georgia  
Institutional Review Board  
Approved: 1-14-08  
Expires 1-13-09

APPENDIX B  
*IRB APPROVAL FORMS*



December 14, 2007

Cameron Denson  
224 River's Crossing  
Athens, GA 30602

Ref: 0708011

Dear Mr. Denson:

The Research Review Committee has concluded that your proposal, *National Center for Engineering and Technology Education: Effectiveness of Mentorship on African American High School Student's Perception of Engineering*, meets the requirements of state legislation and the current research policy of the Guilford County Schools. Committee approval does not guarantee access to schools or to individuals. School principals have the final decision regarding their participation this research project.

We encourage researchers to provide direct feedback to the school community where they have conducted research. This could involve an open session for parents, teachers, and administrators; a summary of the research that is accessible to all members of the schools' communities; or other accessible forms of direct feedback to the schools. In addition, you must provide the Research Review Committee copies of any publications and presentations.

We hope that the project is successful in helping to achieve your goals. Please feel free to contact me at 370-8061 if you have any questions.

Sincerely,



Sadie Bryant Woods  
Chair, Research Review Committee

**STRIVING. ACHIEVING. EXCELLING.**

712 North Eugene Street Greensboro, NC 27401 P 336.370.8100



Office of The Vice President for Research  
DHHS Assurance ID No. : FWA00003901

Institutional Review Board  
Human Subjects Office  
612 Boyd GSRC  
Athens, Georgia 30602-7411  
(706) 542-3199  
Fax: (706) 542-3360  
www.ovpr.uga.edu/hso

### APPROVAL FORM

Date Proposal Received: 2007-10-29

Project Number: 2008-10308-0

Name	Title	Dept/Phone	Address	Email
Mr. Cameron Denson	PI	Workforce Leadership and Social Foundations 706-542-7059	224 Rivers Crossing + 2639	cdenson@uga.edu
Dr. Roger B. Hill	CO	Workforce Education, Leadership And Social Foundations 209 River's Crossing +4809 706-542-4100		rbhill@uga.edu

Title of Study: Effectiveness of Mentoring on African American High School Students' Perceptions of Engineering and Technology Education

45 CFR 46 Category: Expedite 7

**Parameters:**

Please use date-stamped Consent Documents; Reviewed per Subpart D (46.404) - Permission of one parent may be sufficient.

Approved for Institutions with Authorization Letters on File;

**Change(s) Required for Approval:**

Receipt of Survey;  
Revised Application;  
Revised Consent Document(s);  
Revised Procedures;

Approved : 2008-01-14 Begin date : 2008-01-14 Expiration date : 2009-01-13

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:

Funding Agency:

Your human subjects study has been approved.

Please be aware that it is your responsibility to inform the IRB:

- ... of any adverse events or unanticipated risks to the subjects or others within 24 to 72 hours;
- ... 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;
- ... that you have completed your data collection as approved, within the approval period shown above, so that your file may be closed.

For additional information regarding your responsibilities as an investigator refer to the IRB Guidelines.

Use the attached Researcher Request Form for requesting renewals, changes, or closures.

Keep this original approval form for your records.

Chairperson or Designee,  
Institutional Review Board

APPENDIX C  
*COOPERATIVE AGREEMENT*



## COOPERATIVE AGREEMENT

By and Between

**THE UNIVERSITY OF GEORGIA**

And

**MIDDLE COLLEGE AT NORTH CAROLINA  
AGRICULTURAL AND TECHNICAL STATE UNIVERSITY**

This Agreement is made and entered into this \_\_\_\_\_ day of October 23, 2007, by and between The University of Georgia through the Board of Regents of the University System of Georgia and the MIDDLE COLLEGE AT NORTH CAROLINA A&T STATE UNIVERSITY. All obligations of the Board of Regents of the University System of Georgia under this Agreement will be performed by The University of Georgia.

**WHEREAS** The University of Georgia and the Middle College at North Carolina A&T State University desire to engage in cooperative educational and research activities, for the mutual benefit of both institutions, the parties have agreed the following:

1. The University of Georgia and the Middle College at North Carolina A&T State University will jointly develop cooperative mentorship programs for students of the Middle College within the framework of this agreement.
2. The cooperative activities to be covered by this agreement will include collaborative research and mentorship programs, workshops and other service programs.
3. Each activity to be performed under this agreement will be undertaken pursuant to an addendum which will contain the specific terms and conditions governing the activity. These terms and conditions will be mutually agreed upon by the two institutions on a case by case basis.

IN WITNESS WHEREOF the parties hereto have executed two (2) copies of this instrument, two in English, each of which shall be considered an original.

UNIVERSITY OF GEORGIA

MIDDLE COLLEGE  
AT  
NORTH CAROLINA A&T

\_\_\_\_\_

\_\_\_\_\_

APPENDIX D  
*MENTORSHIP PROTOCOL*

## MENTORSHIP PROTOCOL

Designed for

**NATIONAL CENTER FOR ENGINEERING  
AND TECHNOLOGY EDUCATION**  
And  
**NATIONAL SOCIETY OF BLACK ENGINEERS**  
MENTORSHIP PROGRAM

This Protocol is made and entered into this \_\_\_\_\_ day of October 24, 2007, for the purposes of the NATIONAL CENTER FOR ENGINEERING AND TECHNOLOGY EDUCATION and the NATIONAL SOCIETY OF BLACK ENGINEERS mentorship program. Mentors are responsible for performing the identified tasks in completion of the NCETE/NSBE mentorship program.

**WHEREAS** the NATIONAL CENTER FOR ENGINEERING AND TECHNOLOGY EDUCATION and the NATIONAL SOCIETY OF BLACK ENGINEERS desire to engage in cooperative educational and research activities, for the mutual benefit of both institutions, the parties have agreed to the following mentorship protocol:

1. A film presentation that is representative of some aspect of engineering as a field and/or profession.
2. A field experience to be determined by the mentor that offers the protégés an opportunity and exposure to engineering as a field and/or profession.
3. A design challenge that is culturally relevant to the protégés, which implements the engineering design process and offers practical application of science and math principles.
4. One-on-one counseling that offers the protégés psychological support in the way of a role model and/or counselor.

By signing I have acknowledged understanding of my responsibilities for mentoring in the NCETE/NSBE mentorship program.

UNIVERSITY OF GEORGIA

NATIONAL SOCIETY  
OF  
BLACK ENGINEERS  
MENTOR

\_\_\_\_\_

\_\_\_\_\_

APPENDIX E  
*STUDENT INFORMATION FORM*

**Student Information Form**  
**NCETE/NSBE MENTORSHIP PROGRAM**

Name \_\_\_\_\_ Name You  
Prefer to use \_\_\_\_\_

Address \_\_\_\_\_ Hometown \_\_\_\_\_

Phone Number \_\_\_\_\_ Cell Phone # \_\_\_\_\_

E-Mail Address \_\_\_\_\_ MySpace page Yes \_\_\_\_ No \_\_\_\_

Age \_\_\_\_\_ Classification \_\_\_\_\_

Major \_\_\_\_\_ Favorite Subject Area \_\_\_\_\_

Hobbies/Interest \_\_\_\_\_

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Favorite Sport \_\_\_\_\_ Favorite Sports Athlete \_\_\_\_\_

Favorite Professional Sports Team \_\_\_\_\_ College \_\_\_\_\_

Favorite Music Genre \_\_\_\_\_ Favorite Magazine \_\_\_\_\_

Favorite artist (i.e. musician, writer, painter) \_\_\_\_\_

Last book read (For leisure purposes) \_\_\_\_\_

APPENDIX F  
*INTERVIEW GUIDE*

**NCETE/NSBE MENTORSHIP PROGRAM**  
**Exit Interview**

Please answer each question truthfully and to the best of your knowledge.

- 1) How would you rate the success of the NSBE/NCETE mentorship program on a scale of 1 to 10, with 10 being the highest rating? Please justify this rating.
- 2) What were some of the highlights of the mentorship program?
- 3) What were some of the biggest challenges that you had to face in the mentorship program?
- 4) How well was the mentorship program facilitated by the principal researcher? Please explain.
- 5) How well did the Middle College accommodate you as a mentor during sessions?
- 6) How receptive were the Middle College students to the activities and challenges within the program?
- 7) What suggestions would you recommend to improve the mentorship program?
- 8) If asked would you be interested in participating next year in the NSBE/NCETE mentorship program? Why or why not?
- 9) Any questions or comments?

APPENDIX G  
*PERCEPTIONS AND SELF-EFFICACY SURVEY*



## Perceptions and Self-efficacy Survey

**Directions:** Please write the requested information in the space provided or **circle** the number that best reflects your answer to the question. There are no right or wrong answers to these questions. We appreciate your assistance.

### I. BACKGROUND INFORMATION

1. Home Room Teacher: \_\_\_\_\_
2. High School: \_\_\_\_\_
3. Grade Level: \_\_\_\_\_
4. Gender: 0 = Female 1 = Male
5. Race/Ethnicity with which you most closely identify:

1 = Black/African American    4 = American Indian/Alaskan Native  
 2 = Hispanic/Latino American    5 = White/Caucasian  
 3 = Asian/Pacific Islander    6 = Other: \_\_\_\_\_

6. What is the **highest level** of formal education **completed** by your parents?

	Mother		Father		Mother		Father
Grammar school or less	1	1	College Degree	1	1		
Some high school	2	2	Some graduate school	2	2		
High school graduate	3	3	Master's degree	3	3		
Some college/assoc. degree	4	4	Doctorate/professional degree	4	4		

7. Highest degree expected in your lifetime:  
 1 = Associate/technical (2 year degree) 2 = Bachelors (4 year degree) 3 = Masters 3 = Doctorate
8. Approximately **how many hours per week** are you employed:  
 (a) Off-campus: \_\_\_\_\_hours/week
9. GPA:

In high school: \_\_\_\_

No. of courses **successfully completed** to date in:

Engineering \_\_\_\_\_ Math \_\_\_\_\_ Science \_\_\_\_\_

10. Did you:

1 = enter the school year at the Middle College

2 = transfer from another high school

**II. Note: If you participated in the NCETE/NSBE mentorship program please fill out section. All others please SKIP section. This section asks about the characteristics of the mentorship program and the kinds of activities that go on in it. Using the scale below, please circle the number that best reflects how often you have experienced the following in the mentorship program**

**1 = Never 2 = Occasionally 3 = Often 4 = Very Often/ Almost Always**  
**n/a = Not Applicable**

**In this course:**

a. Assignments, presentations, and learning activities are clearly related to one another.	1	2	3	4	n/a
b. I work cooperatively with other students on design challenges	1	2	3	4	n/a
c. The team teaches, and learns from each other.	1	2	3	4	n/a
d. There are opportunities to work in groups.	1	2	3	4	n/a
e. I am encouraged to show how particular knowledge can be applied to “real-world” problem.	1	2	3	4	n/a
f. I have opportunities to practice the skills I am learning in the mentorship program.	1	2	3	4	n/a
g. I discuss ideas with my classmates (either individuals or in a group).	1	2	3	4	n/a
h. I get feedback on my work or ideas from my mentor.	1	2	3	4	n/a
i. We do things that require us to be active participants in the mentoring process.	1	2	3	4	n/a
j. The mentor makes clear what is expected of students regarding activities and effort.	1	2	3	4	n/a
k. The mentor gives me <b>frequent</b> feedback on my work.	1	2	3	4	n/a
l. The mentor gives me <b>detailed</b> feedback on my work.	1	2	3	4	n/a

### III. Perceptions of Engineering

**This section asks about conceptual knowledge of engineering as a field and career. Using the scale below, please circle the number that best reflects your extent of knowledge 1= Disagree 2 = Slightly Agree 3 = Agree 4 = Strongly Agree**

**I feel confident in my:**

- |   |   |   |   |   |
|---|---|---|---|---|
| a. Understanding of what engineers do in industry as professionals  | 1 | 2 | 3 | 4 |
| b. Understanding of engineering as a field which often calls for non-technical considerations (e.g., economic, political, ethical, and/or social issues). | 1 | 2 | 3 | 4 |
| c. Knowledge and understanding of the <b>engineering graphics</b> in engineering.   | 1 | 2 | 3 | 4 |
| d. Knowledge and understanding of the <b>process</b> of design in engineering.  | 1 | 2 | 3 | 4 |

**I feel confident in my ability to:**

- |  |   |   |   |   |
|--|---|---|---|---|
| e. Do design.  | 1 | 2 | 3 | 4 |
| f. Solve an <b>ill-defined</b> problem (that is, one that is not clearly defined).                                     | 1 | 2 | 3 | 4 |
| g. Identify the knowledge, resources, and people needed to solve an ill-defined problem.                               | 1 | 2 | 3 | 4 |
| h. Evaluate arguments and evidence so that the strengths and weaknesses of competing alternatives can be judged.       | 1 | 2 | 3 | 4 |
| i. Apply an abstract concept or idea to a real problem or situation.   | 1 | 2 | 3 | 4 |
| j. Divide ill-defined problems into manageable components.   | 1 | 2 | 3 | 4 |
| k. Clearly describe a problem orally.  | 1 | 2 | 3 | 4 |
| l. Clearly describe a problem in writing.  | 1 | 2 | 3 | 4 |
| m. Develop several methods that might be used to solve an ill-defined problem.   | 1 | 2 | 3 | 4 |
| n. Identify the tasks needed to solve an ill-defined problem   | 1 | 2 | 3 | 4 |
| o. Visualize what the product of a project would look like.  | 1 | 2 | 3 | 4 |
| p. Weigh the pros and cons of possible solutions to a problem.   | 1 | 2 | 3 | 4 |
| q. Figure out what changes are needed in prototypes so that the final engineering project meets design specifications. | 1 | 2 | 3 | 4 |

#### IV. Self Efficacy in Math

This section asks about student's confidence and self belief to use math to solve technological and engineering problems. Using the scale below, please circle the number that best reflects your perceived ability 1= Disagree 2 = Slightly Agree 3 = Agree 4 = Strongly Agree

##### I feel confident in my:

a. ability to accurately calculate numerical problems mentally.	1	2	3	4	n/a
b. ability to accurately calculate numerical problems on paper.	1	2	3	4	n/a
c. ability to estimate and make approximations.	1	2	3	4	n/a
d. ability to interpret the accuracy of results and measurements.	1	2	3	4	n/a
e. ability to calculate the effects of change in variables using mathematical models.	1	2	3	4	n/a
f. ability to predict the rate of change of variables using mathematical models.	1	2	3	4	n/a
g. ability to use the knowledge and skills in mathematics to interpret presentations of mathematics	1	2	3	4	n/a
h. ability to learn the material taught in your math courses.	1	2	3	4	n/a

#### IV. Self Efficacy in Science

This section asks about student's confidence and self belief to use their understanding of science to solve technological and engineering problems. Using the scale below, please circle the number that best reflects your perceived ability 1= None 2 = Slight 3 = Moderate 4 = A Great Deal

**I feel confident in my:**

- |   |   |   |   |   |     |
|---|---|---|---|---|-----|
| a. ability to understand the laws of science and nature to solve problems.                                  | 1 | 2 | 3 | 4 | n/a |
| b. ability to understand natural systems.   | 1 | 2 | 3 | 4 | n/a |
| c. ability to understand basic concepts of science and technology.  | 1 | 2 | 3 | 4 | n/a |
| d. ability to use logical and systematic thinking in scientific contexts.                                   | 1 | 2 | 3 | 4 | n/a |
| e. ability to use science to solve technological problems.  | 1 | 2 | 3 | 4 | n/a |
| f. ability to predict the rate of change of variables using scientific equations.                           | 1 | 2 | 3 | 4 | n/a |
| g. ability to use science to solve ill-defined problems?  | 1 | 2 | 3 | 4 | n/a |
| h. ability to be part of a problem solving team, expressing your ideas, listening and responding to others. | 1 | 2 | 3 | 4 | n/a |
| j. ability to learn the material taught in your science courses.  | 1 | 2 | 3 | 4 | n/a |

**THANKS VERY MUCH FOR YOUR HELP!**

**Please return completed questionnaires to whomever distributed them to the class.**